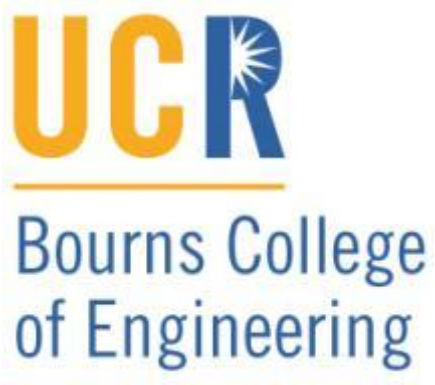

University of California Riverside

Bourns College of Engineering

Computer Engineering

July 1, 2012

Submitted to the

Engineering Accreditation Commission
Accreditation Board for Engineering and Technology, Inc.
111 Market Place, Suite 1050
Baltimore, Maryland 21202-401

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ABET
Self-Study Report

for the

Computer Engineering
at

University of California Riverside
Riverside

July 1, 2012

CONFIDENTIAL

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BACKGROUND INFORMATION

A. Contact Information

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All requests for additional information will be acknowledged within 24 hours.

Note to evaluators: We have mostly used a consecutive numbering scheme for the tables in this document. I.e. the tables are numbered Table 1, Table 2 etc. However we realize that ABET evaluators are used to considering certain canonical tables, such as *Table 5-1 Curriculum* and *Table 6-1. Faculty Qualifications* etc. For these handful of ABET canonical tables we use the standard ABET numbering system.

B. Program History

In the next two subsections we briefly review *history* of the Computer Science Department and the Electrical Engineering Department (from which the Computer Engineering program emerged), before consider the *recent history* of Computer Engineering in more detail.

B.1 Complete Program History of the Computer Science Department

We begin with a brief timeline of significant events in the computer engineering history, shown in Table 1.

Table 1: A Brief Timeline of Significant Events in the Programs History

1972: CS track added to BS in math.	1995: Susan Hackwood resigns deanship and Lee Rudi (retired UCSD dean of engineering) becomes interim dean
1972: BS and MS in Applied Science approved, both with CS tracks.	1997: Satish Tripathi becomes BCoE dean.
1976: Applied Science shut down and BS in CS established within Math Dept.	1998: First CS PhD (Torsten Berger) graduated.
1977: First graduates from BS in CS.	1998: Dept of Computer Science renamed Department of Computer Science and Engineering.
1982: MS in CS started in Math Dept.	1999: Mart Molle becomes CS chair.
1984: First graduates from MS in CS.	2001: BS in Computer Engineering established (jointly administered by CS and EE)
1984: Math Dept changes name to Department of Mathematics and Computer Science.	2001: CS&E moves to Surge Building.
1988: CoE proposal approved. Glenn Everett appointed as Acting Dean	2002: Tom Payne begins second term as chair.
1989: First BS students admitted to CoE.	2003: Mark Matsumoto becomes Acting Dean of Engineering.
1990: Math and CS become separate departments within CNAS	2005: Reza Abbaschian becomes dean of BCoE
1990: Larry Larmore becomes chair of new CS Department	2005: CS&E and EE move to Engineering II (now renamed Winston Chung Hall).
1990: College of Engineering hires Susan Hackwood as founding dean.	2007: BS in Computer Science and BS in Computer Engineering both receive ABET accreditation.
1991: CS moves from Sproul Hall to University Office Building.	2007: BS/MS in CS approved.
1992: CS joins CoE as its first "department" --- others are still "programs."	2007: Laxmi Bhuyan becomes chair of CS&E.
1992: Teodor Przymusinski becomes chair	2010: Computer Engineering becomes an official interdisciplinary program with its own committee-in-charge.
1994: PhD in CS approved.	2012: MS in Computer Engineering approved.
1994: Tom Payne becomes CS chair	2012: BS/MS in Computer Engineering proposed.
1995: CoE becomes BCoE, Bourns Hall opens, CS moves in along with rest of BCoE.	2012: BS/MS in Computer Engineering approved.

From its inception in 1976, UCR's BS degree in Computer Science was envisioned to involve a balance of both hardware and software and of both theory and practice. It was housed in the Department of Mathematics which taught both the theoretical and the software components of the program, including required courses introduction to programming (Pascal); assembly language; algorithms and data structures; architecture; compilers; operating systems; automata, formal languages, and computability; plus electives in switching theory; information theory; and modeling and simulation. The hardware portion of

the program was taught by the Physics Department and included digital electronics and the design, construction and programming of microprocessor-based systems.

In 1982, an MS in CS was established. It provides TAs with an excellent CS background for the BS program.

Y.C. Hong was hired in 1983. He improved the offering in architecture and established an elective in data bases. Marek Chrobak was hired in 1986 and strengthened the offerings in data structures and algorithms, and in automata, formal languages, and computability.

In 1989, Lawrence Larmore was hired, further strengthening the offerings in those areas.

In 1990, the Department of Mathematics and Computer Science split, amicably, into two separate departments, which remained within the College of Natural and Agricultural Sciences, and the Campus Computing Center took over administration of both departments' computing facilities.

In 1991, Yu-Chin Hsu, whose area was design automation (for digital systems) was hired and instituted a more design-oriented approach to architecture.

Also, Teodor Przymusinski was hired and instituted elective offering in artificial intelligence.

In 1992, per prior plans, CS became part of the College of Engineering and structured laboratories were instituted for all undergraduate courses except those in theory of computation. Also, at that point the courses in digital electronics and in microprocessor-based design were moved from Physics to Electrical Engineering.

In 1993, the Department got funding to establish its own computing facilities and decided to standardize on Linux as the OS for its desktop facilities. At roughly the same time the Department switched from Pascal to C++ as the main programming language for its undergraduate offerings.

In 1994, a Ph.D. in CS was begun, which made support of PhD students a significant consideration in the awarding of TAships. At that point the faculty grew rapidly and the breadth and depth of the undergraduate offerings grew accordingly. Among the resulting innovations were:

- A required two quarter sequence in logic design and embedded systems jointly listed and taught with Electrical Engineering, plus additional electives in design automation and embedded systems.
- A required three course introductory sequence in programming and data structures.
- Electives in graphics, computational geometry, and video games.
- Electives in data mining and machine learning were added.
- The AI offering became more statistics oriented.
- An elective in software engineering was added.
- Electives in networking and in security were added.
- Separate degrees in Computer Engineering and in Information System (later changed to Business Informatics) were established.

B.2 Brief History of Electrical Engineering Department

The Electrical Engineering undergraduate program was established in 1989. The first EE under-graduates degrees were awarded in 1993. The EE Program officially became the EE Department in 97/98. A graduate program with MS and PhD degrees was added in Fall 1997. The first PhD student completed his degree in Spring 2001.

The EE program was first ABET accredited in 1994 and has been accredited continuously thereafter.

B.3 Recent Program History of Computer Engineering

In the UC system there is a distinction between a major and a program. An interdepartmental *major* is run by two or more departments. The faculty members of all participating Departments must approve all curriculum changes, admission policies etc. The Chairs of the participating Departments must agree on an undergraduate advisor.

A *program*, on the other hand, has its own set of participating Faculty members drawn from two or more Departments. It is administered by a Program Director (Prof. Walid Najjar, CS Dept) and an Associate Director (Prof. Sheldon Tan, EE Dept) , both appointed by the Dean from the participating Faculty members. Curricular decisions are made by the participating Faculty members.

In 2009 the faculty members most concerned with the CEN major took the initiative to study how it can be changed from a Major to a Program, based on the experience of other UC campuses. The objective is to better address the specific needs of CEN majors by having targeted advising and better mentoring. Another objective was the proposal of a MS CEN and an eventual BS+MS CEN.

This effort was led by Dr. Walid Najjar and the Program was created in the BCOE in 2011. The CEN Faculty is in the process of re-evaluating the complete BS CEN curriculum to better address the rapidly changing training requirements and expectation in CEN. These might result in the creation of CEN specific activities such as CEN Senior Design Project or Senior Research Seminar.

In 2011 we have started the process of organizing Computer Engineering (CEN) as a program within the UCR Bourns College of Engineering. The participating Faculty consists of:

- Laxmi N. Bhuyan, Professor, Computer Science and Engineering
- Philip Brisk, Assistant Professor, Computer Science and Engineering
- Rajiv Gupta, Professor, Computer Science and Engineering
- Roger K. Lake, Professor, Electrical Engineering
- Walid Najjar, Professor, Computer Science and Engineering, Director CEN
- Sheldon Tan, Associate Professor, Electrical Engineering, Associate Director CEN
- Frank Vahid, Professor, Computer Science and Engineering
- Albert Wang, Professor, Electrical Engineering
- Qi Zhu, Assistant Professor, Electrical Engineering

Since then the CEN Faculty has been working with the CSE and EE Departments to update the CEN curriculum. We have proposed a new MS degree in CEN and will be proposing this year a 5-year BS/MS degree in CEN.

Table 2 shows the CEN enrollment and number of degrees awarded since the 1999/2000 academic year.

Table 2: Computer Engineering Enrollment and Degrees

	New Students		Total Enrollment	Degrees Granted
	Freshmen	Transfer	Total	Total
1999-00	8		11	2
2000-01	77	6	118	3
2001-02	80	3	183	5
2002-03	74	4	226	10
2003-04	55	1	226	20
2004-05	72	1	207	29
2005-06	56	2	164	14
2006-07	83	3	202	21
2007-08	57	3	175	28
2008-09	102	3	195	14
2009-10	77		210	54
2010-11	106	4	234	16
2011-12	72	7	234	

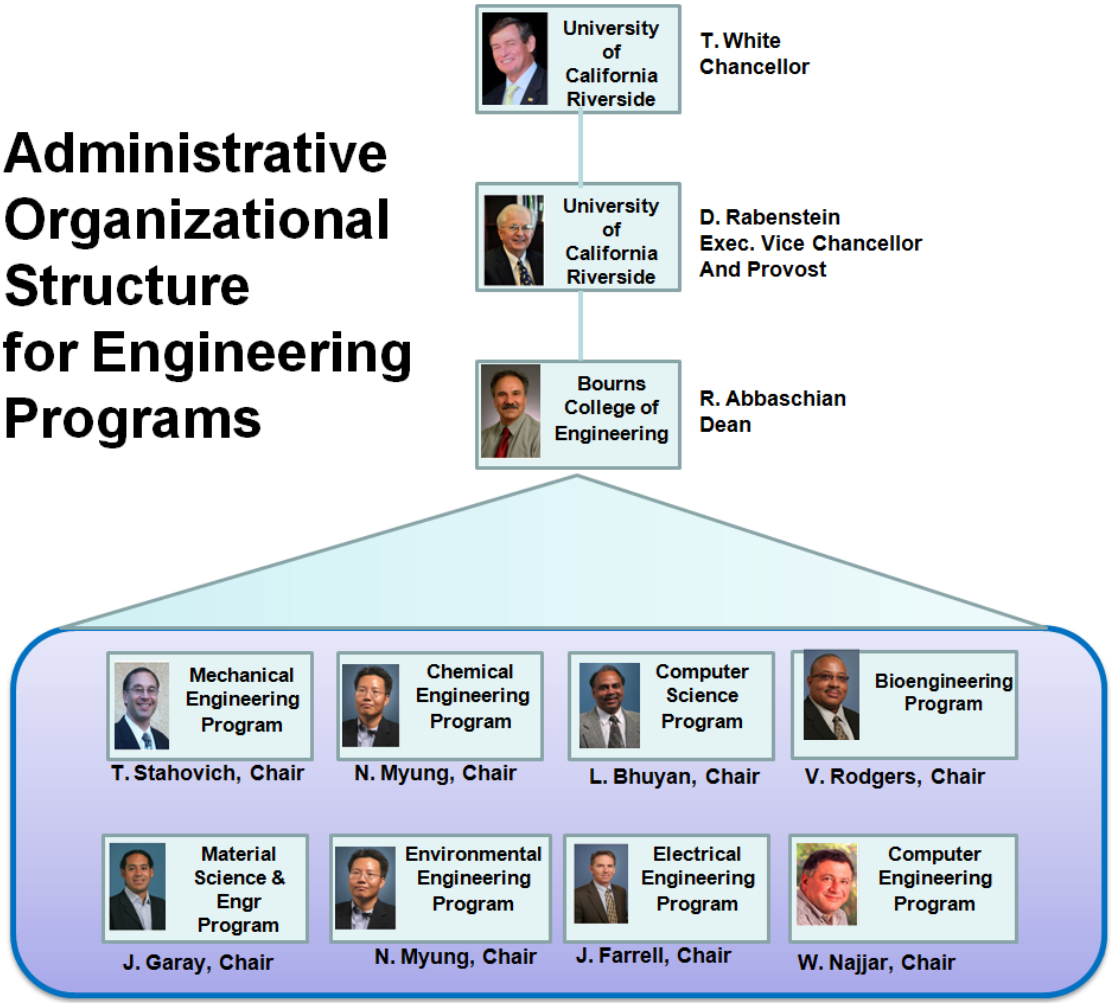
C. Options

The program has no options, tracks or concentrations at this time.

D. Organizational Structure

Table 3 shows the administrative structure of the Computer Engineering program

Table 3: The Organizational Structure of CE



E. Program Delivery Modes

All courses for the bachelor's degree are delivered in campus classrooms and laboratories on weekdays and weeknights. The curriculum includes no cooperative education, distance education, or web-based instruction.

F. Program Locations

All courses are delivered on the campus of the University of California, Riverside.

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

This is addressed in great detail in a 109-page document. This document ("*CE-response-062008.pdf*".) was sent to ABET on June 20th 2008 (it is also available on request).

Below we briefly review the two issues, and how we resolved them, however we emphasize that the detailed and carefully documented response is in "*CE-response-062008.pdf*".

We had both a Criteria 2 and 3 Weaknesses:

Weaknesses 1: Criterion 2. Program Educational Objectives.

> Criterion 2 states, "*... program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve."* The program's objectives are not broad statements that describe the accomplishments of computer engineering graduates and their achievements; instead they describe skills more appropriately articulated in program outcomes. In addition, it is not clear that these objectives were reached based on the needs of program constituents (students, faculty, employers, advisory boards, and the community at large). Since these objectives were not defined based on the needs of program constituents, it is not clear how the results are used to improve program outcomes and for graduates to attain the objectives.

Weaknesses 2: Criterion 3. Program Outcomes and Assessment

> Criterion 3 states, "*There must be processes to produce these outcomes and an assessment process, with documented results, that demonstrates that these program outcomes are being measured and indicates the degree to which the outcomes are achieved. There must be evidence that the results of this assessment process are applied to the further development of the program*." Course objectives are defined for each course but they are not clearly related to program outcomes that are referred to as departmental outcomes. It is stated in the report that the college will administer a new assessment tool in the fall of 2006 but the process used presently in measurement of program out comes is not documented. Achievement of program outcomes is demonstrated using course objectives and grades in homework assignments and exams. Sufficient evidence was not provided to demonstrate students attain the outcomes articulated by the computer engineering program.

We note that the department *fully acknowledged* both weaknesses, and worked tirelessly to address them.

We addressed **Weakness 1** by the following:

In late October 2007, the two faculty members most responsible for ABET, Dr. Eamonn Keogh and Dr. Tom Payne, had a series of meetings with the interested parties, including the CE Assessment and Accreditation committee, the EE Assessment and Accreditation committee (Dr. Amit K. Roy-Chowdhury and Dr Roger Lake), the CE Undergrad education committee and the Chair of CS&E, Dr. Laxmi Bhuyan.
On November 6th 2007, Dr. Eamonn Keogh and Dr. Tom Payne wrote new PEOs. They based them very closely on the EE PEO. The Electrical Engineering Department was consulted and asked for feedback at this stage.

On November 8th 2007, Dr. Eamonn Keogh presented the new PEOs to the CSE Board of Advisors, from 1:00pm to 1:30pm. Each member got a take home copy, and was invited to discuss the PEOs both at the meeting, and offline by email at a later date.
On November 14th 2007, Dr. Eamonn Keogh presented the new PEOs with notes from the Board of Advisors to the entire CS&E faculty, 40 minutes were spent discussing the PEOs and they were adopted by a majority vote.
Dr. Eamonn Keogh solicited feedback and approval for our new PEOs from employers of our CE students. This process was conducted by phone, email and in four cases, by an onsite visit by a delegation from our department. We also solicited comment and approval for our new PEOs from our students.
In summary, we created new PEOs after soliciting input and approval from all our constituents, our Board of Advisors, employers of our students, faculty, and the students themselves. Furthermore, we have carefully documented this process at every step. This detailed documentation can be found in "*CE-response-062008.pdf*".

We addressed **Weakness 2** by the following:

To remedy the Criterion-3 weakness, UCR's Computer Engineering program (CEN) adopted the outcomes-assessment process of UCR's Electrical Engineering program (EE). This was done for the following reasons:

1. CEN is jointly administered by the Department of Electrical Engineering and by the Department of Computer Science and Engineering (CS&E).
2. The engineering portion of CEN's curriculum is composed of EE courses, taught by the Electrical Engineering Department, and CS courses, taught by CS&E.
3. The CEN and EE programs have the same outcomes, namely ABET's A-K outcomes.
4. Following EE's due-process response, EAC's Final Statement of 2007 judged EE's outcomes-assessment process to fulfill ABET's Criterion-3 requirements, and indeed extensively complemented them.

The complication of joint administration by two departments is handled as follows. Both departments follow the same (EE's) outcomes-assessment process with analysis and evaluation being performed by their respective Assessment Committees. Recommendations go to their respective faculties. Changes to courses are handled within the corresponding department following standard interdepartmental consultation. Before 2010 changes to the curriculum had to be approved by both departments. However since then Changes to the CEN curriculum are approved by the CEN Faculty and are NOT referred to either the CSE or EE Departments.
The detailed documentation for all the above can be found in "*CE-response-062008.pdf*".

H. Joint Accreditation

This program is seeking EAC accreditation only. Note the both the EE program and the CSE program are requesting a simultaneous visit.

Key: Where possible, we have placed the names of courses *inline* in this document. However, in most of the tables, and some of the text, this is unwieldy. Thus we have produced this key. We suggest you print this page separately and use it for reference.

CS 010: Introduction to Comp Sci for Science, Math, and Engineering I:
CS 011: Introduction to Discrete Structures:
CS 012: Introduction to Comp Sci for Science, Math, and Engineering II
CS 013: Introductory Computer Science for Engineering Majors:
CS 014: Introduction to Data Structures and Algorithms:
CS 021: Introduction to UNIX:
CS 030: Introduction to Computational Science and Engineering:
CS 049 (E-Z): Language Laboratory:
- CS 049E: Introductory C and C++:
- CS 049G: Advanced C++:
- CS 049I: C#:
- CS 049J: Introductory Java:
- CS 049M: Matlab:
- CS 049N: Hardware Description:
- CS 049Q: Perl:
- CS 049S: Bash:
- CS 049Y: Python:

CS 061: Machine Organization and Assembly Language Programming:
CS 066: Introduction to Three-Dimensional Digital Modeling:
CS 067: Three-Dimensional Digital Modeling and Animation:
CS 100: Software Construction:
CS 111: Discrete Structures:
CS 120A: Logic Design:
CS 120B: Introduction to Embedded Systems:
CS 122A: Intermediate Embedded and Real-Time Systems:
CS 122B: Advanced Embedded and Real-Time Systems:
CS 130: Computer Graphics:
CS 133: Computational Geometry:
CS 134: Video Game Creation and Design:
CS 141: Intermediate Data Structures and Algorithms:
CS 143: Multimedia Technologies and Programming:
CS 145: Combinatorial Optimization Algorithms:
CS 150: The Theory of Automata and Formal Languages:
CS 151: Introduction to Theory of Computation:
CS 152: Compiler Design:
CS 153: Design of Operating Systems:
CS 160: Concurrent Programming and Parallel Systems:
CS 161L: Laboratory in Design and Architecture of Computer Systems:
CS 162: Computer Architecture:
CS 164: Computer Networks:
CS 165: Computer Security:
CS 166: Database Management Systems:
CS 168: Introduction to Very Large Scale Integration (VLSI) Design:
CS 169: Mobile Wireless Networks:
CS 170: Introduction to Artificial Intelligence:
CS 171: Introduction to Expert Systems:
CS 177: Modeling and Simulation:
CS 179(E-Z): Project in Computer Science:
- CS 179E: Compilers:
- CS 179F: Operating Systems:
- CS 179G: Database Systems:
- CS 179I: Networks:
- CS 179J: Computer Architecture and Embedded Systems:
- CS 179K: Software Engineering:
- CS 179M: Artificial Intelligence:

CS 179N: Graphics and Electronic Games:
CS 180: Introduction to Software Engineering:
CS 181: Principles of Programming Languages:
CS 183: UNIX System Administration:
CS 190: Special Studies:
CS 193: Design Project:
CS 194: Independent Reading:
CS 198I: Individual Internship in Computer Science:

EE 001A: Engineering Circuit Analysis I:
EE 001B: Engineering Circuit Analysis II:
EE 002: Electrical and Electronic Circuits:
EE 010: Introduction to Electrical Engineering:
EE 01LA: Engineering Circuit Analysis I Laboratory:
EE 020: Linear Methods for Eng. Analysis and Design w MATLAB:
EE 100A: Electronic Circuits:
EE 100B: Electronic Circuits:
EE 105: Modeling and Simulation of Dynamic Systems:
EE 110A: Signals and Systems:
EE 110B: Signals and Systems:
EE 114: Probability, Random Variables, and Random Processes in Electrical Engineering:
EE 115: Introduction to Communication Systems:
EE 116: Engineering Electromagnetics:
EE 117: Electromagnetics II:
EE 120A: Logic Design:
EE 120B: Introduction to Embedded Systems:
EE 123: Power Electronics:
EE 128: Data Acquisition, Instrumentation, and Process Control:
EE 132: Automatic Control:
EE 133: Solid-State Electronics:
EE 134: Digital Integrated Circuit Layout and Design:
EE 135: Analog Integrated Circuit Layout and Design:
EE 136: Semiconductor Device Processing:
EE 137: Introduction to Semiconductor Optoelectronic Devices:
EE 138: Electrical Properties of Materials:
EE 139: Magnetic Materials:
EE 140: Computer Visualization:
EE 141: Digital Signal Processing:
EE 143: Multimedia Technologies and Programming:
EE 144: Introduction to Robotics:
EE 146: Computer Vision:
EE 150: Digital Communications:
EE 151: Introduction to Digital Control:
EE 152: Image Processing:
EE 153: Electric Drives:
EE 160: Fiber-Optic Communication Systems:
EE 162: Introduction to Nanoelectronics:
EE 165: Design for Reliability of Integrated Circuits and Systems:
EE 175A: Senior Design Project:
EE 175B: Senior Design Project:
EE 190: Special Studies:
EE 191(E-Z): Seminar in Electrical Engineering:
EE 194: Independent Reading:
EE 197: Research for Undergraduates:
EE 198I: Individual Internship in Electrical Engineering:

ENGR 001G	Professional Development & Mentoring
ENGR 101G	Professional Development & Mentoring
ENGR 180W	Technical Communications
ENGL 001A	Beginning Composition
ENGL 001B	Intermediate Composition
MATH 009A	First-Year Calculus
MATH 009B	First-Year Calculus
MATH 009C	First-Year Calculus
MATH 113	Linear Algebra
PHYS 040A	General Physics
PHYS 040B	General Physics
PHYS 040C	General Physics
CHEM 001	General Chemistry
CHEM 003	Concepts of Chemistry

GENERAL CRITERIA

CRITERION 1. STUDENTS

A. Student Admissions

The admissions processes for all our engineering degree programs conform to the UCR Academic Senate's interpretation of the admission policies of the University of California, which, in turn, interpret the mandates of the California Master Plan for Higher Education.

In broad terms, the Master Plan constrains the University of California to admitting only students ranking in the top 12.5% of the high school graduates in the State. Students in lower tiers are eligible for admission to campuses of the California State University system, or to community colleges. Placement in the top 12.5% of the graduating class is determined by the UC Eligibility Index, which is computed centrally by the UC Office of the President, based on criteria defined by the UC System-Wide Academic Senate.

Figure 1 summarizes the freshman admissions process to our college. Prospective students submit their applications to the Office of Admissions for the University of California, which serves all ten campuses. Applicants may apply to multiple campuses, and to multiple programs at these campuses. They may also designate primary and alternate majors. The UC Office of Admissions determines whether each applicant meets the UC Eligibility criteria (which specify GPA and coursework requirements) and forwards each eligible application to the campuses to which admission is being sought. Ineligible applicants are rejected.

If a student is UC-eligible but is not selected for admission to the campus(es) that he or she applied to, admission to another UC campus is offered. It is notable that the Riverside campus switched from a referral campus to a selective campus within the past four years. That is, because of the increasing number and quality of students applying directly to UCR, we no longer offer admission to students who are UC-eligible but declined by their first-choice campuses. Nevertheless, we remain the most diverse campus of the UC system (in terms of overall numbers; on a percentage basis, UC Merced has greater diversity because of its very small student population), with a substantial number of students who are the first in their families to attend college.

Within UCR, processing of these freshman applications begins through the Campus Office of Admissions, in accordance with guidelines defined by the Undergraduate Admissions Committee (UAC) of the UCR Academic Senate. An Enrollment Management Council (EMC) also exists at the campus level to make decisions annually on the enrollment targets at the campus and college levels. These decisions are informed by the strategic planning processes at the campus and College levels.

UCR follows a multi-tier admissions process, which operates as follows. At the first tier, an Academic Index Score (AIS) is computed for each applicant, based primarily on academic parameters such as the Grade-Point-Average (GPA), the Scholastic Aptitude Test (SAT) score, and the number of completed Advanced Placement or International Baccalaureate (IB) courses. College-specific upper and lower AIS thresholds are determined in accordance with the planned

enrollment targets. All applicants to a college whose AIS scores exceed the upper threshold are automatically admitted to their program of interest. All applicants with AIS scores below the lower threshold for each college are removed from that college's pool. The remaining applicants are forwarded to the respective colleges for further processing.

Once these forwarded applications arrive at BCOE, a, BCOE-specific Index Score (BIS) is computed for each applicant. This BIS score is a function of the applicant's grades in Mathematics and Science, as well as the math part of the SAT Reasoning Test (the SAT Advanced test is not required by UC). The applicants to each program are ranked by BIS score, and applicants are admitted starting at the top of the list for each program until the program's enrollment target is met. Applicants may be placed on a wait list, to be admitted if the yield rate from the admitted pool is insufficient to satisfy program targets.

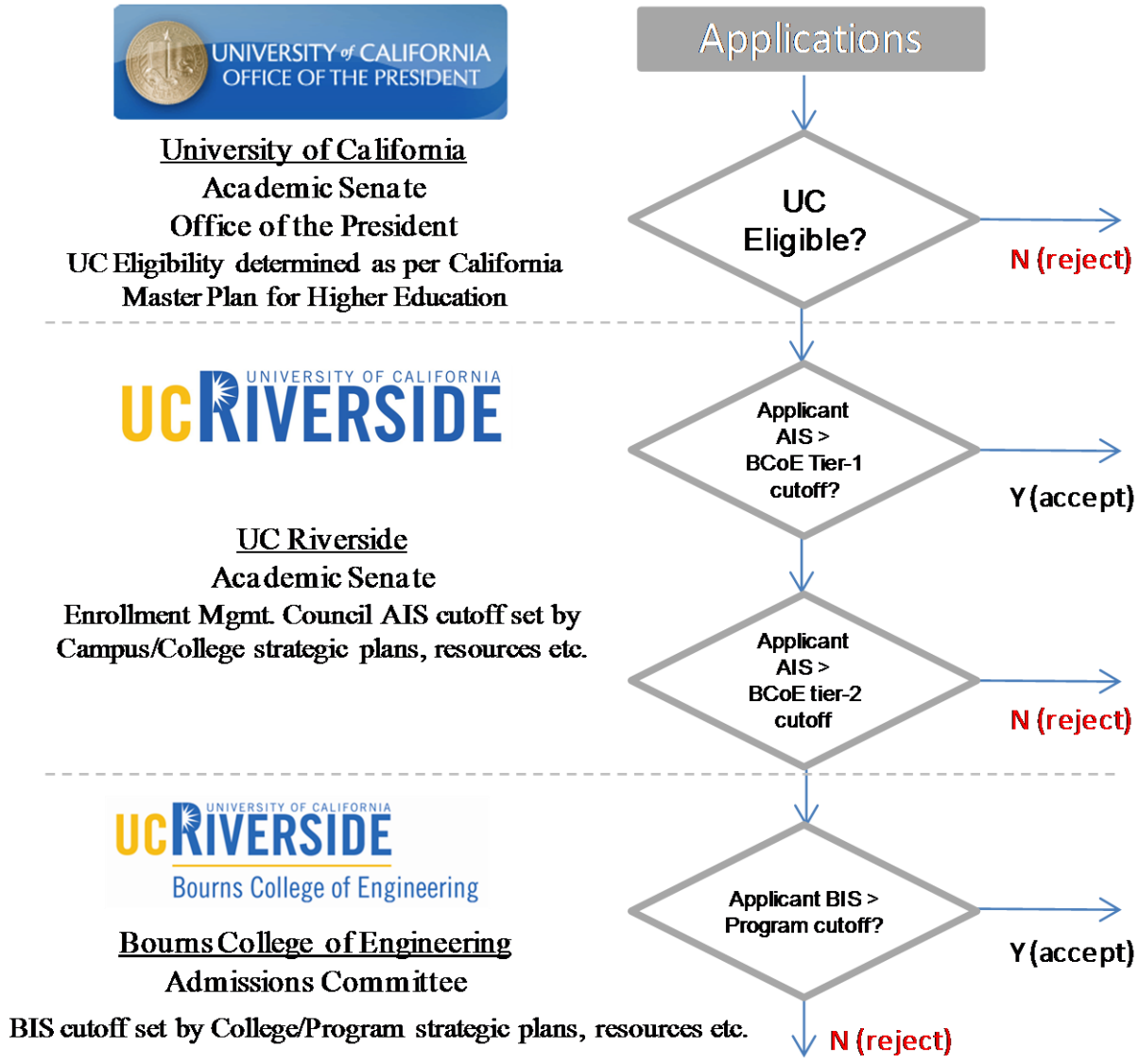


Figure 1: The admissions process begins with an application to the UC system, which is forwarded to the campus and then to the college for consideration.

B. Evaluating Student Performance

Student performance monitoring is primarily the role of the Office of Student Affairs, under the supervision of the Associate Dean for Undergraduate Affairs, Professor C.V. Ravishankar. Each program also has a faculty member designated as the Program Faculty Adviser, who serves as the primary departmental contact for program-specific policy decisions. College-level policy is under the purview of the Associate Dean. The staff of the Office of Student Affairs (OSA) supports the undergraduate programs.

Each student is assigned to a staff adviser in the OSA, and encouraged to meet with this adviser whenever the need arises, but at least once per quarter. In addition, attendance at a mandatory Annual Major Advising session is required of all undergraduates in the college. The Annual Major Advising session is conducted jointly by the OSA staff and the Program's Faculty Adviser, and provides information on a variety of topics to students, including program requirements as well as academic success strategies and professional development opportunities.

Figure 2 depicts the process for monitoring student progress. Students are required to maintain a GPA of 2.0 each quarter, as well as cumulatively. Students are reminded of these requirements regularly, first during the registration process in their first quarter as freshmen, and again each year during Annual Major Advising. Grades are posted by instructors each quarter to the central Student Information System (SIS) database, which tracks student performance, and provides degree audits to check for completion of degree requirements. At the end of each quarter, staff advisers in the OSA review the academic records of BCOE students and identify all whose term and cumulative GPAs are below 2.0.

A failure to meet these GPA requirements results in a student being placed on probation. The student is notified of this probationary status, and advised that a failure to obtain at least a 2.0 GPA the following term will result in dismissal. A registration hold is now placed on the student's record at that point, to be released only upon the completion of Academic Success Workshops and other advising and mentoring activities through the OSA. A student who receives a dismissal notice may appeal the dismissal to the Associate Dean, who may grant or reject the appeal based on extenuating circumstances.

The primary source of information regarding student performance is the campus-wide Student Information System (SIS) (which is maintained by the campus Computing and Communications office), that records all student registrations and grades, and which is maintained by the Computing and Communications organization. All staff and faculty advisers have access to this system, either directly, or through the Student Advising System (SAS) front-end that provides access to student transcripts and degree audits. The staff of the OSA uses this system regularly to monitor student progress.

Students who are about to graduate are required to complete a graduation application. At this point, the student's academic adviser in OSA performs a detailed manual check to ensure that all degree requirements have been met. If the requirements have been met, the Office of the Registrar is notified of degree completion, so that the degree may be awarded.

B.1 Enforcing Prerequisites

All students are given a term-by-term course plan that ensures timely graduation as long as courses are completed in a timely manner. This course plan incorporates prerequisites, so that students who follow the course plan automatically satisfy prerequisites.

Whether or not students follow this course plan, prerequisites are enforced by the registration system. Students register for courses through the GROWL[1] system that interfaces with SIS, and is able to enforce prerequisites. A student prevented from taking a course due to lack of prerequisites can petition the course instructor, who has the authority to grant the student a prerequisite waiver. The student is not permitted to take the course without such a waiver. Such waivers are generally approved for outstanding students, transfer students and in very special situations.

[1] GROWL is the secure student portal used to complete the majority of administrative transactions needed during a student's academic career. This includes submission of a student's Statement of Intent to Register, control of all privacy through FERPA based controls, access to their bill, submission of payment, term registration, review of administrative or advising holds, grades, transcript requests and review and acceptance of their financial aid to name a few.

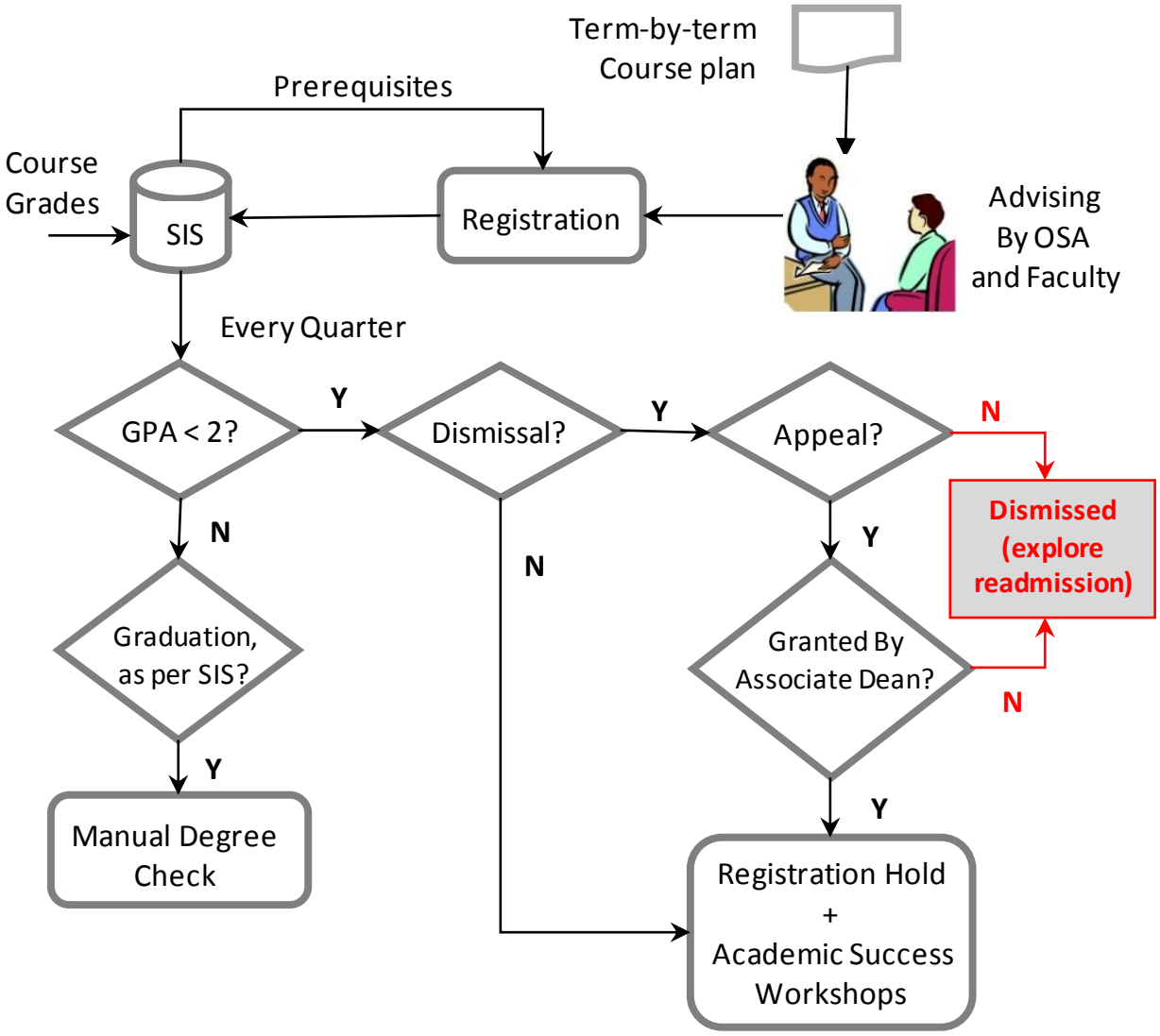


Figure 2: Academic Advising and Performance Monitoring

C. Transfer Students and Transfer Courses

Transfer students apply using the same application portal that freshmen use. This portal is maintained by the System-Wide Office of Admissions, located in Oakland, CA. This office collects applications and forwards them to the UCR Office of Admissions.

In accordance with the California Master Plan for Higher Education, the University of California maintains extensive articulation agreements with Community Colleges in the State. Course articulations are reviewed and approved by the cognizant departments, and are tracked and maintained by the Campus Articulation Officer. All system-wide articulation agreements are available at the website *www.assist.org*, which is open access. The transfer route appears to be gaining popularity, especially given recent increases in tuition. When a transfer applicant (typically, from out of state) presents a transcript containing courses that have not already been articulated, the staff of the BCoE OSA collect the relevant course syllabi and work with the cognizant departments at UCR to determine articulations.

All BCOE programs have published detailed requirements for transfer admission. Admission to our programs requires a minimum GPA of 2.8/4.0, and the completion of coursework specific to the major being applied to. Incoming transfer students may transfer up to 105 quarter units (70 semester units) towards their degrees from the University. To ease the burden of consulting *www.assist.org* for each major an applicant may be interested in, we have prepared brochures showing transfer requirements for each of our majors. We make these brochures available both in hardcopy, as well as on the Web. Some examples appear at *www.engr.ucr.edu/undergrads/transferring/SpecialAgreements.html*.

If the transfer applicant for a major meets all the requirements specified by that major, the UCR Office of Admissions admits that applicant. Applicants who satisfy most transfer requirements are forwarded to the College for additional review. The OSA staff reviews these applications, and in consultation with the departments and the Associate Dean, grants exceptions as warranted. Conditional admission is also sometimes granted, subject to the completion of some requirements that may not have been met at the time of application. Below we explicitly list the UCR Transfer Admission Criteria:

UCR Transfer Admission Criteria:

- Complete 60 transferable units (90 quarter units) with a minimum GPA of 2.4 for California residents and 2.8 for nonresidents
- Complete (with a grade of C or better) the following course pattern:
  - Two transferable college courses (3 semester or 4-5 quarter units) in English composition
  - One transferable college course (3 semester or 4-5 quarter units) in mathematical concepts and quantitative reasoning
  - Four transferable college courses (3 semester or 4-5 quarter units) chosen from two of the following subject areas: arts & humanities; social & behavioral science; physical & biological sciences.

Given these, students must also meet General BCOE Transfer Admission Requirements:

General BCOE Transfer Admission Requirements:

- A cumulative GPA of at least 2.80.
- Completion of 2 major-specific sequences for your intended major with a minimum 2.50 GPA. One sequence must be single-variable calculus (MATH 9A, 9B, 9C). The second sequence may be a sequence such as PHYS 40A, 40B, 40C.
- Completion of one year of college level English Composition (ENGL1A, 1B, 1C).

Students considering transferring to CEN are counseled that in addition to the general requirements listed above, students applying for transfer admission to BCOE must also complete major-specific course work as listed below.

Computer Engineering Transfer Admission Requirements:

The following courses must be completed at the time of application:

- one course in computer programming (CS 10)
- one course in object oriented programming (CS 12)
- one course in calculus based physics with lab (PHYS 40A)

A minimum of three additional courses (shown below) must also be completed in order to form a coherent sequence. A list of potential sequences for this major is listed below.

- two courses in calculus based physics with labs (PHYS 40B, 40C)
- one course in introduction to discrete structures (CS/ MATH 11)
- one course in data structures (CS 14)
- one course in machine organization and assembly language programming (CS 61)
- one course in engineering circuit analysis I with lab (EE 1A/LA)

These transfer rules may appear somewhat intimidating to students, but fortunately, as we discuss in the next section, we have an excellent advising program and staff.

D. Advising and Career Guidance

The Office of Student Academic Affairs (OSAA) implements and enforces academic policies developed by UCR/BCOE & its Departments/programs. There is constant consultation and feedback between faculty and academic advisors. Below we review the mission of OSAA.

MISSION: The Office of Student Academic Affairs mission is to support engineering students in achieving their educational goals by providing guidance and services which enhance their academic development. We strive to fulfill this mission by:

- *Upholding academic policies of the university, BCOE and its departments.*
- *Assisting students in acclimating to and navigating the academic environment, policies and expectations.*
- *Working intentionally to build respect, trust and cooperation with students in support of their academic success.*
- *Considering individual student needs while encouraging student development.*
- *Encouraging academic planning, self-awareness, accountability and resourcefulness.*
- *Helping students respond proactively and productively to issues impacting academic success.*
- *Committing to excellence, the academic counseling profession and continued development.*

In Table 4 we list the current OSAA staff, with brief biographical details. Note that they have decades of combined experience, and that we have an exceptionally low turnover rate.

Table 4: The OSAA Staff with Brief Biographic Details

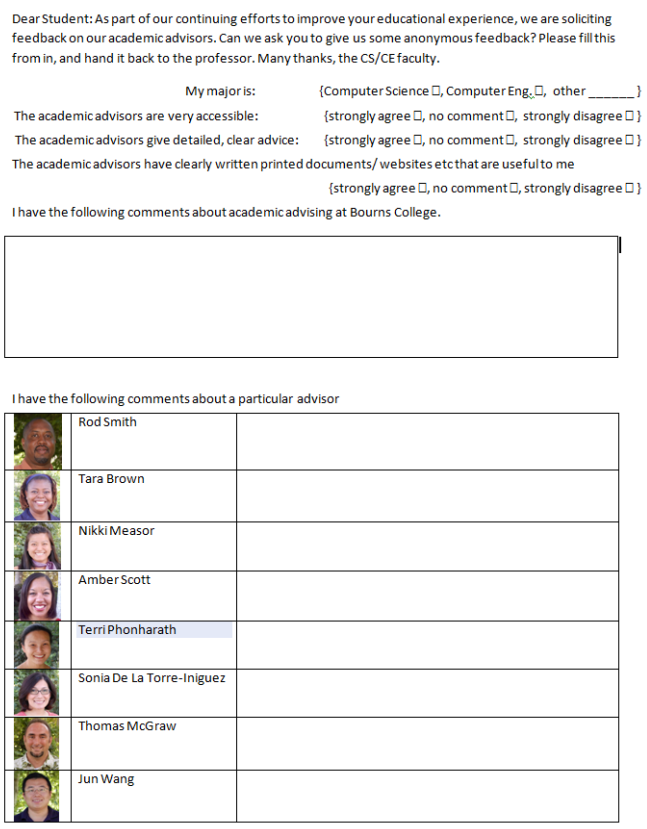
	Rod Smith	M.B.A., Business Administration, University of California Irvine, June 1994. 15 years in student affairs, 6 of those at BCOE.
	Tara Brown	Master of Science in Counseling, College Counseling/Student Affairs. California State University, Northridge, May 2002, 9 years in student affairs, 5 of those at BCOE.
	Nikki Measor	M.S. in Higher Education and Student Affairs, Indiana University, Bloomington, May 2003. 9 years in student affairs, 2 of those at BCOE.
	Amber Scott	M.S., Counseling & Guidance (Specialization in College Student Personnel), California Lutheran University, June 2007. 10 years in student affairs, 2. 5 of those at BCOE.
	Terri Phonharath	B.A., Political Science/Admin Studies, UCR, June 1998. 12 years in student affairs, 5 of those at BCOE.
	Sonia De La Torre-Iniguez	M.S., Educational Counseling and Guidance with Pupil Personnel Services Credential, CSU San Bernardino, June 2010. 9 years in student affairs, 8 of those at BCOE.
	Thomas McGraw	M.S., Sport Management, California Baptist University, June 2006. 14 years in student affairs, 9 of those at BCOE.
	Jun Wang	M.B.A., Business Administration, University of California Riverside, June 2007. 5 years in student professional development at BCOE

Note that the Computer Engineering program recognizes the importance of the highest quality student advising and career guidance. With this in mind we conduct annual informal

surveys of our *lower* division students (note that this is *in addition* to the college level surveys, discussed below). We do this because the exit survey only measures *senior* students, and thus we would have a significant time lag to correct problems in lower division advising if we *only* consider exit surveys.

Our survey is conducted by giving every lower division student a copy of the *anonymous* feedback form shown in Figure 3, and asking him/her to fill it in and return to the faculty. All such forms are then tabulated and summarized, and presented at the next faculty meeting. This takes place in the middle of the Spring quarter. The results of the 2012 survey are shown Table 5.

In addition to numerical data, the survey allows the students an opportunity for a free text narrative of issues, concerns and criticisms.



Dear Student: As part of our continuing efforts to improve your educational experience, we are soliciting feedback on our academic advisors. Can we ask you to give us some anonymous feedback? Please fill this from in, and hand it back to the professor. Many thanks, the CS/CE faculty.

My major is: {Computer Science ☐, Computer Eng. ☐, other _____ }

The academic advisors are very accessible: {strongly agree ☐, no comment ☐, strongly disagree ☐ }

The academic advisors give detailed, clear advice: {strongly agree ☐, no comment ☐, strongly disagree ☐ }

The academic advisors have clearly written printed documents/ websites etc that are useful to me {strongly agree ☐, no comment ☐, strongly disagree ☐ }

I have the following comments about academic advising at Bourns College.

I have the following comments about a particular advisor

Rod Smith	
Tara Brown	
Nikki Measor	
Amber Scott	
Terri Phonharath	
Sonia De La Torre-Iniguez	
Thomas McGraw	
Jun Wang	

Figure 3: The form used to gather feedback on our advisors.

In general, the 2012 survey overwhelming contained positive statements about advising, and praise for particular staff members. One minor criticism that appeared on two responses noted a problem with an out-of-date webpage, giving dated advice. This problem was fixed within 24 hours of the survey being collected.

Table 5: The results of the Spring 2012 Survey on Academic Advising

Spring 2012: Total of 52 Responses	Agree	Neutral	Disagree
The academic advisers are very accessible	41	9	2
The academic advisers give detailed clear advice	35	15	2
The academic advisers have clearly written, useful documents/websites	36	15	1

In addition to this somewhat informal survey taken in lower division classes, we also take the opportunity of the exit survey to poll the students on advising by both faculty and non-faculty. Figure 4 shows that with the 2011 numbers we compare *very favorably* with other respected institutions.

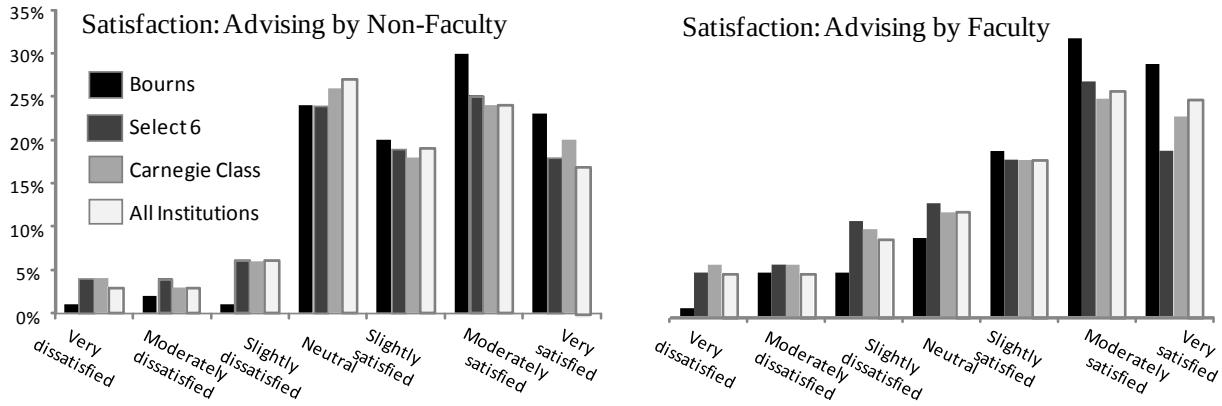


Figure 4: The BCOE students satisfaction with advising by Non Faculty (*left*) and Faculty (*right*), contrasted with other amalgamations of institutions.

Finally, we show in Figure 5 the results of a more general survey of student satisfaction with advising. Note that this is for all of BCoE majors, not just computer engineering majors.

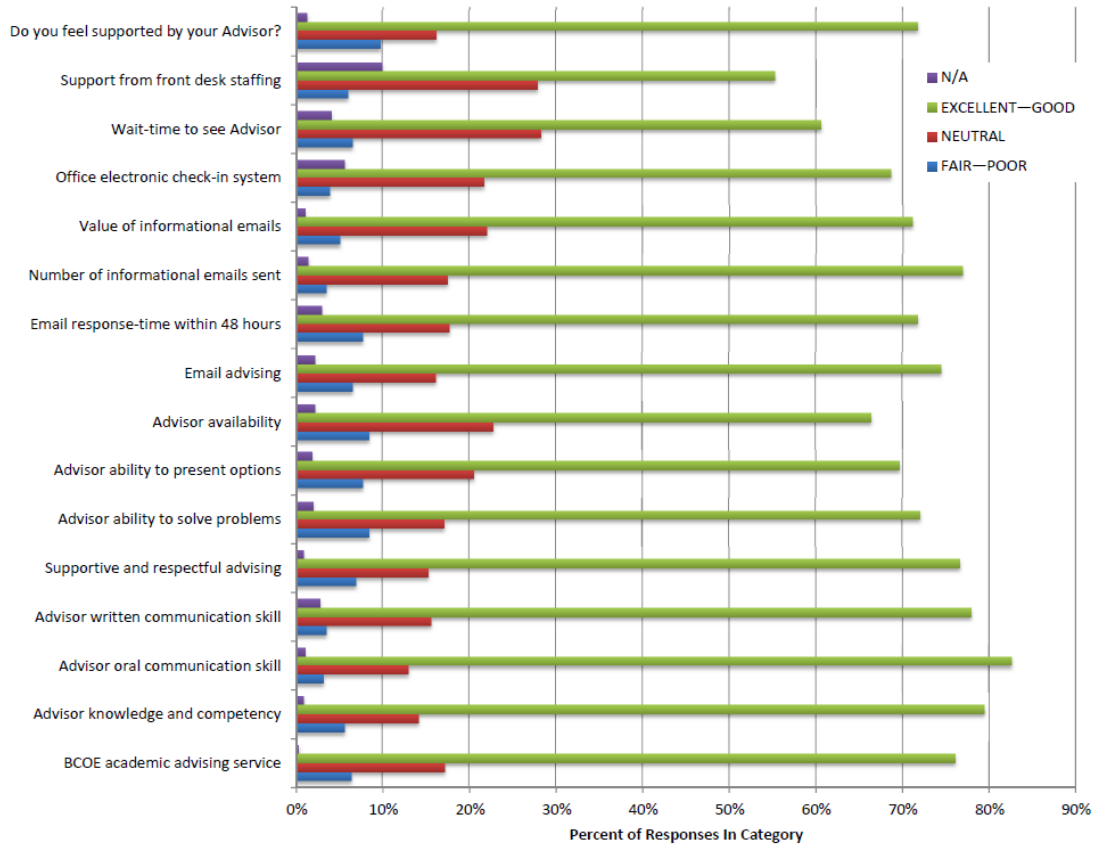


Figure 5: BCoE Advising Satisfaction Survey (May 2012)

We appear to be doing well on every question except "*Support from front desk staffing*". This is due to the fact that this position was eliminated in the last year due to funding cuts. Associate Dean, Prof Ravishankar is currently looking into ways to address this.

Summary for this Section:

The computer engineering program strongly believes that high quality student advising is critical to attracting, retaining and serving our diverse student body. We take great care to measure how well we are serving the students, and take immediate action if problems or weaknesses are spotted.

The mechanisms by which students receive academic advice have already been outlined in **Section B: Evaluating Student Performance**. Here, we will describe the mechanisms for providing Career and Professional guidance.

Professional guidance and mentoring is provided by staff (particularly, the Director of Student Professional Development), the faculty, and the Career Center. The overall College philosophy that guides all interactions with students is to ensure that they are both academically and professionally prepared to become leaders in their chosen fields. This goal is especially challenging to meet in engineering colleges.

As is typical for undergraduate programs in engineering, our students spend the first two years of their undergraduate work completing prerequisite coursework in mathematics, the sciences, and the humanities and social sciences. Unfortunately, instructors in these areas are unfamiliar with any of the engineering disciplines, and unable to motivate or mentor our students in their early years here. Consequently, our students fail to develop a clear sense of academic direction or a sense of professional pride, having no role models or mentors, either at home or on campus. Another consequence of this lack of engagement in the early years with BCoE is that it is harder for students to build effective working relationships with their peers, so they can begin to see them as technically strong, and as effective partners.

We are addressing these issues in several ways. The first of these is a series of 1-unit classes intended to promote engagement with BCoE in the early years and to help the student's professional development in later years. This series of classes are numbered ENGR 1 (freshmen), ENGR 2 (sophomores), ENGR 101 (juniors), and ENGR 102 (seniors). These courses are intended to provide our students with involvement in Professional Development activities. Activities to be performed are program-specific, and will include projects, industry overviews and interactions, involvement with professional societies and clubs, team building, career guidance, and coverage of ethics and lifelong-learning issues. The specific list of topics in these courses includes the following:

- Participate in peer-group building activity.
- Understand Engineering as a creative process for solving real-world problems.
- Understand current and future trends in the student's major discipline.
- Understand some analysis tools, and their use in design and practice.
- Understand the stages of development of an Engineer as a Professional
- Participate in individual and group projects.
- Participate in Professional Clubs.
- Participate in the Career Path Milestones program.
- Understand the role and importance of Ethics in the Engineering profession.
- Understand the importance of engaging in life-long learning.
- Participate in Industry visits.

These topics are presented in workshops and discussion-style activities. A suite of activities supported by the college under the Professional Development Milestones program complement the program-specific content in these courses. Examples of such activities are academically-oriented workshops on time management and study-skills, as well as professionally-oriented activities such as mock interviews, resume writing, as well as research and industrial internships. Figure 6 summarizes these milestones.

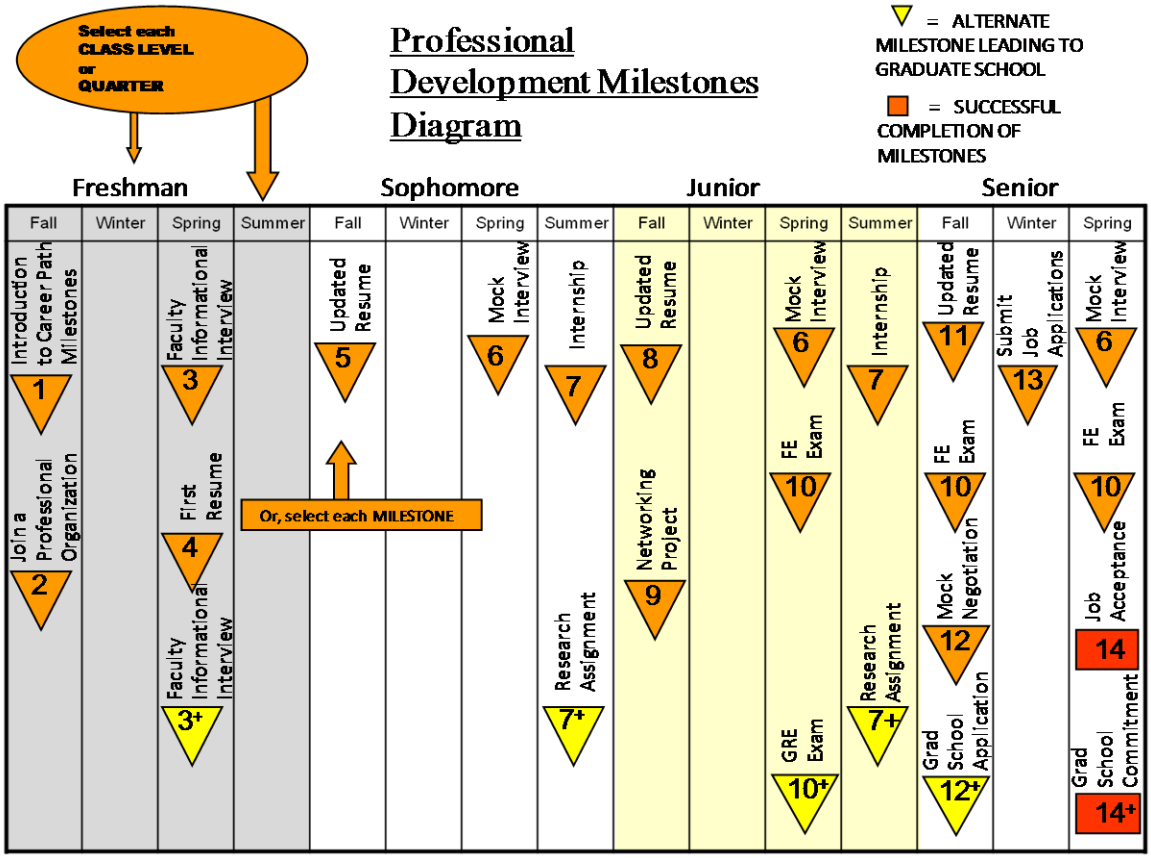


Figure 6: Professional Development Milestones Program guides students on key activities they should be undertaking during their undergraduate years to assure that they are ready for careers or graduate school.

A total of 18 Student Professional Organizations exist in BCoE, and are supported financially by the College. These organizations are student-led, and are very active. Just over 800 students are active members of these organizations (roughly 40% of the students in College).

1. BCOE SLC (Student Leadership Council)
2. ACM (Association of Computing Machinery)
3. AIChE (American Institute of Chemical Engineers)
4. ASME (American Society of Mechanical Engineers)
5. ASQ (American Society of Quality)
6. BMES (Biomedical Engineering Society)
7. EWB (Engineers Without Border)
8. IEEE (Institute of Electrical and Electronics Engineers)
9. IEEE EDS (Electron Devices Society)
10. ION (Institute of Navigation)
11. MRS (Material Research Society)
12. NSBE (National Society of Black Engineers)
13. OSA (Optical Society of America)
14. SACNAS (Society for Advancement of Chicanos and Native Americans in Science)
15. SHPE (Society of Hispanic Professional Engineers)
16. SAE (Society of Automotive Engineers)
17. SWE (Society of Women Engineers)
18. TBP (Tau Beta Pi) – Honors Society

These organizations, under the mentorship of the Director of Student Professional Development, participate in a broad range of activities during the year. A summary appears in Table 6.

Table 6: BCOE Professional Development Milestones Program

BCOE Professional Development Milestones Program 2,102 participants total					
Date	**Event**	**Students**	**Date**	**Event**	**Students**
10/5/2010	Technical Job Search Workshop	27	1/19/2011	Preparing for Engr. Technical Career Fair/Fashion Show	72
10/11/2010	Making Professional Connections with Western Digital	21	1/20/2011	Careers in Video Game & Animation Design	30
10/11/2010	Careers in Pharmaceutical Industry	36	1/26/2011	Google Info Night with Alumni	155
10/12/2010	Beginning Resume Writing	15	1/26/2011	Information Session with CIA	43
10/14/2010	Advanced Resume Writing	17	1/26/2011	Information Session with National Oilwell Varco	44
10/18/2010	Google Careers Info Session & Resume Workshop	146	1/27/2011	Women in STEM Careers	37
10/19/2010	EPA Careers Info Session & Interview Workshop	65	2/9/2011	Engineering, Science, & Metrology in Defense Industries	54
10/19/2010	Northrop Grumman Tech Talk	45	2/15/2011	From Internship to Career Alumni Panel	32
10/19/2010	CIA Information Session	56	2/23/2011	Making Professional Connections	40
11/3/2010	Advanced Resume Workshop with Western Digital	24	3/1/2011	Interview Skills Featuring Western Digital	35
11/8/2010	Careers in Sustainability	26	3/2/2011	NAVY Day at Bourns College of Engineering	160
11/8/2010	INROAD Mixer	58	4/6/2011	Engineering Careers in Pharmaceutical & Medicine Manufacturing	120
11/15/2010	Internships, What, Why & How	40	4/12/2011	Interview Skills, featuring: The Aerospace Corporation	41
11/16/2010	Phoenix Motorcars on Electronic Vehicles Industry	66	4/12/2011	Resumania, Featuring: Northrop Grumman	35
11/18/2010	Careers in Water Resources and Quality	62	4/14/2011	Coffee Chat: featuring: consolidated electrical distributors	30
12/1/2010	Engn Presentation Skills	28	4/20/2011	Student Intern Panel	28
1/1/2011	Resume Writing with Skanska Constructions	35	4/21/2011	A Day in the Life of the EPA – What we do	48
1/10/2011	Careers in Aviation featuring Marine Corps	32	4/21/2011	Work Green, Earn Green: Careers that save the planet	23
1/12/2011	UG Research Internships with NSF	70	4/25/2011	Internship: What, Why, & How?	23
(Over one hundred and forty similar events have been deleted for brevity, full list available on request)					
5/1/2012	Interview Skills, Featuring: Consolidated Electrical Distributors	42	5/1/2012	Yikes! I'm Graduating!	35
5/2/2012	Advanced Resume Writing, California Steel Industries	29	5/1/2012	Jump Start to Law School, Featuring: Kaplan	12
5/2/2012	Career Station		5/3/2012	Job Search Skills	12

In addition, the College has a very active Undergraduate Research program. Faculty are very active participants in undergraduate research. Last year, 60 of the 83 faculty in BCoE were research mentors for undergraduates. Over 250 undergraduates worked with faculty on research projects. This research has resulted in a significant number of publications and research presentations. For example, in the 2010 Southern California Conference on Undergraduate Research, 18 of the 24 research presentations from UCR were by BCoE students. For the second year in a row, BCoE students made more presentations at SCCUR than students from any other engineering college in Southern California. See Section 6.C.1 (*An Overview of our Efforts and Achievements in Undergraduate Research*) for more details on undergraduate research.

A summary of the range of Professional Development, Mentoring, and Success program in BCoE appears in Figure 7.

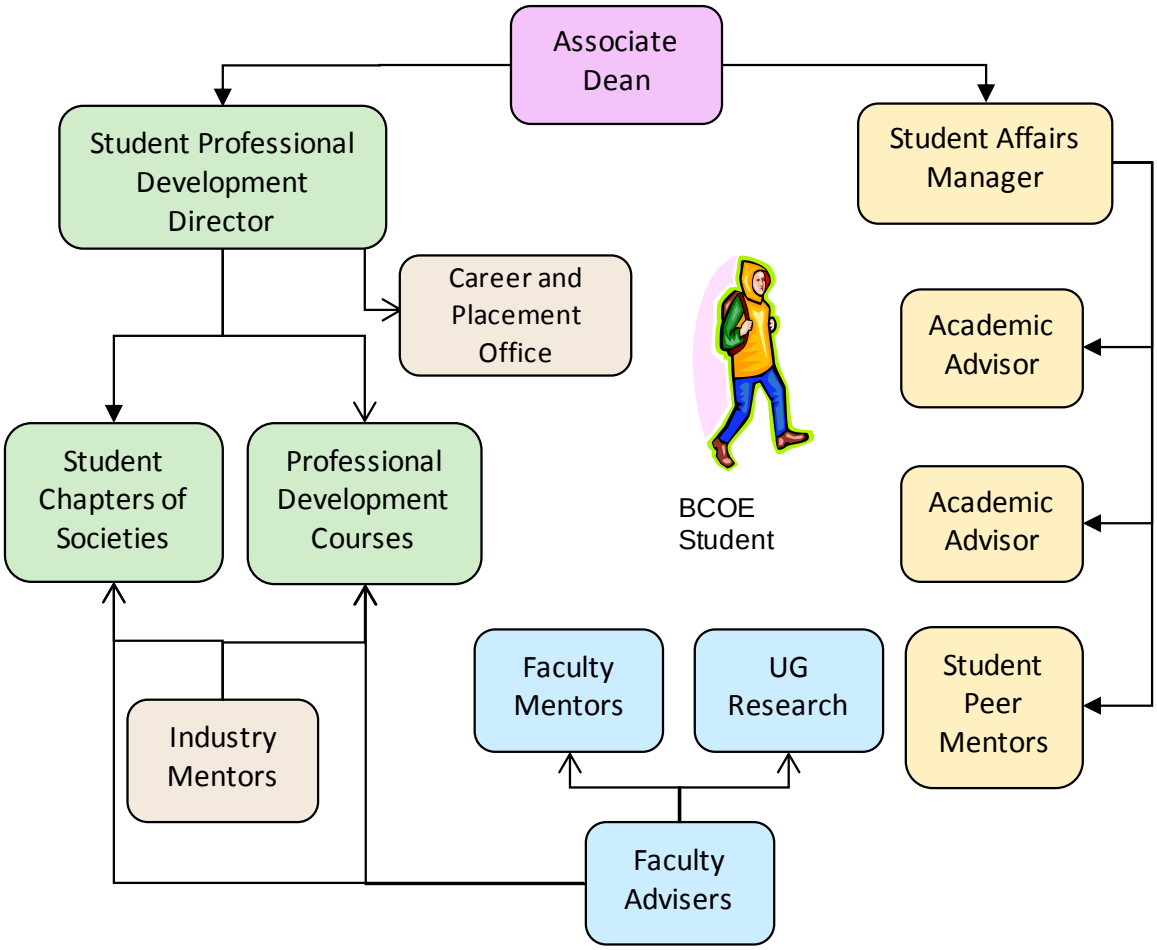


Figure 7: Professional Development, Placement, and Success Programs offered to BCOE undergraduate students.

E. Work in Lieu of Courses

Credit is awarded for selected International Baccalaureate Advanced Placement courses taken in high school, in accordance with the charts on pages 28—31 in the General Catalog for the University of California, Riverside.

Internships and independent study courses may not be used to satisfy College subject requirements, as per the following College regulation:

- **ENR3.2.8.** Internships and independent study courses may not be used to satisfy College subject requirements. (En 25 May 95) (Renumbered & Am 25 May 00)

Credit by Examination is awarded subject to the following College Regulations:

- **ENR2.5.1.** A student who wishes to have the privilege of examination for degree credit must be in residence and not on academic probation.
- **ENR2.5.2.** Arrangements for examination for degree credit must be made in advance with the student's faculty adviser. The approval of the Faculty adviser, the Dean of the college, and that of the instructor who is appointed to give the examination, are necessary before the examination can be given.
- **ENR2.5.3.** The results of all examinations for degree credit are entered on the student's record in the same manner as for regular courses of instruction.

F. Graduation Requirements

Students must meet campus general education requirements. See Undergraduate Studies section.
Computer engineering has the following requirements for the B.S. major. CEN students will follow the given course plan for their selection of courses for each quarter with the help of the CEN student affair officer and the CEN undergraduate advisor to ensure that they meet all the requirements before the graduation.

CEN Major Requirements

1. Lower-division requirements (68 units):

   a) ENGR 001G
   b) CS 010, CS 012 or CS 013, CS 014, CS 061
   c) CS 011/MATH 011
   d) EE 001A, EE 01LA, EE 001B
   e) MATH 008B or MATH 009A, MATH 009B, MATH 009C, MATH 010A, MATH 046
   f) PHYS 040A, PHYS 040B, PHYS 040C
   g) One course of 4 or more units in Chemistry to be selected in consultation with a faculty advisor.

2. Upper-division requirements (85 units minimum)

a) CS 100, CS 141, CS 161, CS 161L; one course from CS 153 or CS 160
b) CS 120A/EE 120A, CS 120B/EE 120B; one course from CS 122A or EE 128
c) CS 111
d) EE 100A, EE 100B, EE 110A, EE 110B
e) ENGR 180W
f) MATH 113
g) EE 114 or STAT 155
h) Five courses (at least 20 units) as technical electives from the following set of Computer Science and Engineering, and Electrical Engineering upper-division courses

CS 122A, CS 122B, CS 130,
CS 133, CS 150, CS 152, CS 153,
CS 160, CS 162, CS 164, CS 165,
CS 166, CS 168, CS 169, CS 170,
CS 177, CS 179 (E-Z), CS 180, CS 181,
CS 183, CS 193
EE 105, EE 115, EE 128, EE 132, EE 140,
EE 141, EE 144, EE 146, EE 150, EE 151,
EE 152, EE 175A, EE 175B

The technical electives selected from h) must include CS 179 (E-Z) or both EE 175A and EE 175B. The selection of the remaining technical electives must be planned, in consultation with a faculty advisor, to include at least one coherent sequence of two classes from either Computer Science and Engineering or Electrical Engineering. The technical electives must be distinct from those used to satisfy the upper-division requirements specified in items a) and b) above.

Students may petition for exceptions to the above degree requirements. Exceptions to Computer Science course requirements must be approved by the Computer Science and Engineering undergraduate advisor or chair, and exceptions to Electrical Engineering course requirements must be approved by the Electrical Engineering undergraduate advisor or chair. Exceptions to other requirements require the approval of the undergraduate advisors or chairs of both departments.

G. Transcripts of Recent Graduates

The CEN program will provide transcripts from some of the most recent graduates to the visiting team along with any needed explanation of how the transcripts are to be interpreted.

H. Diversity in the Bourns College of Engineering

As we noted earlier, the Bourns College of Engineering is proud to be one of the most diverse engineering colleges in America. The number of domestic undergraduates from underrepresented backgrounds jumped 95.6% from the fall of 2006 to the fall of 2010 (the most recent academic year for which full data are available, see Table 7). As shown in Figure 8, in recognition of our efforts to recruit and retain students from diverse backgrounds to engineering, ABET awarded the Bourns College of Engineering the 2009 Claire Felbinger Award for Diversity. Our citation read: "*In recognition of extraordinarily successful initiatives for recruiting undergraduate and graduate students from diverse and disadvantaged backgrounds, retaining them though the bachelor's degree, and advancing them to graduate studies and careers in engineering*." Our faculty and staff truly appreciate this recognition of their efforts by ABET.

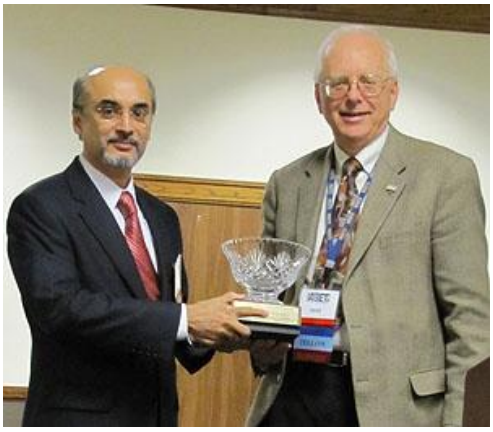


Figure 8: Associate Dean C.V. Ravishankar, left, accepts the 2009 Claire Felbinger Award from ABET President-Elect David Holger.

Table 7: The number of domestic undergraduates from underrepresented backgrounds in the Bourns College of Engineering has nearly doubled since 2006.

	Fall 2006	Fall 2007	Fall 2008	Fall 2009	Fall 2010
Undergraduate: % domestic underrepresented	27%	29%	31%	31%	33%
Undergraduate: # domestic underrepresented	340	377	449	521	665
Undergraduate: % domestic female	12%	12%	15%	17%	17%
Undergraduate: # domestic female	151	156	222	291	348
Graduate: % domestic underrepresented	16%	21%	18%	16%	17%
Graduate: # domestic underrepresented	14	24	27	24	32

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

The University of California, Riverside serves the needs and enhances the quality of life of the diverse people of California, the nation and the world through knowledge – its communication, discovery, translation, application, and preservation. The undergraduate, graduate and professional degree programs; research programs; and outreach activities develop leaders who inspire, create, and enrich California's economic, social, cultural, and environmental future.

With its roots as a Citrus Experiment Station, UC Riverside is guided by its land grant tradition of giving back by addressing some of the most vexing problems facing society. Whether it is assuring a safe, nutritious, and affordable food supply; stimulating the human mind and soul through the humanities and arts; or finding solutions to the profound challenges in education, engineering, business, healthcare, and the environment, UC Riverside is living the promise.

The mission of the Bourns College of Engineering is to:

- Produce engineers with the educational foundation and adaptive skills to serve rapidly evolving technology industries;
- Conduct nationally recognized engineering research focused on providing a technical edge for the United States;
- Contribute to knowledge of both fundamental and applied areas of engineering;
- Provide diverse curricula that will instill in our students the imagination, talents, creativity, and skills necessary for the varied and rapidly changing requirements of modern life;
- Enable our graduates to serve in a wide variety of other fields that require leadership, teamwork, decision-making and problem-solving abilities; and
- Be a catalyst for industrial growth in Inland Southern California.

The vision of the Bourns College of Engineering is to become a nationally recognized leader in engineering research and education.

B. Program Educational Objectives

Before listing our program educational objectives, we will take a moment to state the vision and mission of the College of Engineering, and vision and mission of the Computer Engineering program, since both of these *informed* the creation of our PEOs.

The vision of the College of Engineering is to *become a nationally recognized leader in engineering research and education.*

Its mission is to:

- *Produce engineers with the educational foundation and the adaptive skills to serve rapidly evolving technology industries*.
- *Conduct nationally recognized engineering research focused on providing a technical edge for the U.S.*
- *Contribute to knowledge in both fundamental and applied areas of engineering*.

- *Provide diverse curricula that will instill our students with the imagination, talents, creativity and skills necessary for the varied and rapidly changing requirements of modern life and to enable them to serve in a wide variety of other fields that require leadership, teamwork, decision making, and problem solving abilities*.
- *Be a catalyst for industrial growth in the Inland Empire*[2].

The vision of the Computer Engineering program at UC Riverside is to provide students with the knowledge and skills needed to:

- *Pursue the two primary alternatives after graduation, which are to obtain employment in industry or pursue graduate studies*.
- *Succeed in a career involving a lifelong learning process*.
- *The curriculum is also designed to provide the breadth and the intellectual discipline required to enter professional careers in fields outside engineering such as business and law*.

This vision of the Computer Engineering program led us to define the following Program Educational Objectives (PEOs):

Graduates of UCR's BS degree program in Computer Engineering will meet high professional, ethical, and societal goals as demonstrated by:

success in *post-graduation studies as evidenced by*:

- satisfaction with the decision to further their education
- advanced degrees earned
- professional visibility (e.g., publications, presentations, patents, inventions, awards)
- professional responsibilities (e.g. professional mentoring, professional society membership and offices, reviewing and editorial work for professional journals)

success in *a chosen profession or vocation as evidenced by*:

- career satisfaction
- promotions/raises (e.g. Management leadership positions or distinguished technical positions)
- professional visibility (e.g., publications, presentations, patents, inventions, awards)
- professional responsibilities (e.g. professional registration, professional mentoring, professional society membership and offices)
- entrepreneurial activities
- consulting activities

contributions *to society as evidenced by*:

- Leadership roles
- Public service
- Mentoring / outreach activities
- Volunteer service

[2] The term "*Inland Empire*" is most commonly used in reference to the U.S. Census Bureau's federally defined Riverside-San Bernardino-Ontario metropolitan area, which covers more than 27,000 square miles (70,000 km^2). Informally it includes Palm Springs and Palm Desert.

These PEOs are a change from the last ABET accreditation, and were changed in response to feedback from ABET after the 2006 site visit. Before adoption of these PEOs, a draft was circulated to all constituents, who were invited to give feedback. They were presented for review to the Board of Advisors Meeting at the Computer Science & Engineering Department at UC Riverside on November 8th, 2007, and formally adopted by a unanimous vote at a faculty meeting on November 14th, 2007.

The above mission, vision and program educational objectives are published in the college catalog and are available online at the following URL:

http://cen.ucr.edu/education/objectives/

The Computer Science and Engineering Department and the Electrical Engineering Department, the two departments participating in the Computer Engineering Program, consult regularly with their constituencies (see Section **D. Program Constituencies**), particularly their advisory boards, to review their Program Educational Objectives and those of the Computer Engineering Program and update them as appropriate. Computer Science most recently updated its own objectives in 2005, and Electrical Engineering in 2006.

Naturally, the University and College of Engineering missions are much broader and more general than the Computer Engineering PEOs. However, we note that all are directed toward preparing our students to make an impact in their professional careers and all share the vision of developing leaders in industry, government, academia and society. Moreover, the PEOs articulate elements of the Computer Engineering curriculum that will enable our graduates to apply their knowledge, to communicate effectively, and to exercise creativity through problem-solving and to prepare our graduates for a variety of careers in industry, and academia.

C. Consistency of the Program Educational Objectives with the Mission of the Institution

Table 8 below illustrates the correspondence of the institutional objectives to the CEN objectives. This mapping is shown to the entire faculty at least once a year (most recently on March 5th 2012) who are invited to openly discuss it and offer revisions.

Table 8: Program Educational Objectives and the Mission of the Institution

UCR CEN Mission / CEN PEOs (abridged)	..educational foundation and the adaptive skills to serve rapidly evolving technology industries.	..nationally recognized engineering research ...	Contribute knowledge fundamental and applied areas of engineering.	instill .. skills ..to enable .. a wide variety of other fields that requires leadership, teamwork, decision making, and problem solving abilities.	Be a catalyst for industrial growth in the Inland Empire.
success in *post-graduation studies*					
success in *a chosen profession or vocation*					*
contributions to society					

* We note that an unusually large fraction of our students are from the Inland Empire, and choose to stay in the area after graduation. For example ESRI in Redlands (the largest GIS company in the world) has hired dozens of our students, and ISCA Tech, a startup in Riverside (chemical and biological sensors) has hired six of our graduates etc.

Our program objectives are designed to produce graduates who will be well educated in the fundamental concepts of computer engineering and mathematical principle. Moreover, they will have an appreciation of the need *for*, and the skills *to* be able to continue professional development throughout their lives. Due to a progressively more globalized economy interdisciplinary teaming and communication skills are becoming increasingly important, and as such we prepare graduates to function responsibly in such diverse environments.

D. Program Constituencies

The constituencies of the Computer Engineering program are the students, faculty, employers, alumni, the Advisory Board of both CSE and EE, and the community at large. The faculty has primary responsibility for educating the students and to effect the program's educational objectives. The current students in the program and Computer Engineering alumni are essential constituencies. The Computer Engineering degree program is supported by two departments: Computer Science and Engineering and Electrical Engineering. Both departments have Advisory Boards, which are listed in Table 9 and Table 10 respectively. Given that a large fraction of the Advisory Board members are associated with industry, the Advisory Board serves as an important bridge to our graduates' employer constituency.

Table 9: Electrical Engineering Department Board of Advisors

Name	Affiliation
Mr. Anil Agarwal	Skyworks Solutions, Incorporated
Mr. Stephen Badgett	Riverside Public Utilities
Mr. Howie Chu	Zyxel Communications, Incorporated
Ms. Jean M. Easum	Naval Surface Warfare Center
Dr. Hossny El-Sherief	Northrop Grumman Corporation
Mr. Tom Kaboly	Broadcom Corporation
Mr. Kumaran Krishasamy	Broadcom Corporation
Dr. Bin Lu	Seagate Technology
Dr. William H. Luebke	NAVSEA Warfare Center Corona Division
Dr. Meya Meyyapan	NASA Ames
Dr. Sani Nassif	IBM Austin Research Lab
Mr. J.R. Richardson	Raytheon, Highway Transportation Systems
Dr. Patrick M. Sain	Raytheon Electronics Systems
Dr. Joel Schulman	The Aerospace Corporation
Dr. Allyson Yarbrough	The Aerospace Corporation
Mr. Ron Young	GM ATV
Professor Paul Yu	University of California, San Diego
Dr. Bin Zhao	Fairchild Semiconductor, Incorporated

Table 10: Computer Science Department Board of Advisors

Name	Affiliation
Dr. Amit Agrawal	Auryn, Inc
Mr. Flavio Bonomi	Cisco Systems
Dr. Michael Campbell **(Chair)**	The Aerospace Corporation
Mr. Son K. Dao	HRL Laboratories, LLC
Mr. Don Dye	Acorn Technology Corporation
Petros Efstathopoulos	Symantec Corporation
Mr. Vikram Gupta	Qualcomm Inc.
Dr. John Harrell	The Aerospace Corp.
Mr. Arman Hovakemian	Naval Surface Warfare Center
Mr. Erik Hoel	Environmental Systems Research Institute
Mr. Yu-Chin Hsu	Novas Software, Inc.
Mr. Mark Jeffrey	CTO Serial Entrepreneur/ Mahalo.com
Dr. Ram Keralapura	Office of CTO, Narus Inc.
Mr. Ravi Kumar	Yahoo! Research
Mr. Joachim Kunkel	Synopsys, Inc.
Dr. Bill Luebke	Naval Surface Warfare Center
Dr. James R. McGraw	Lawrence Livermore National Lab
Dr. Scott Morehouse	Environmental Systems Research Institute
Dr. Ravi Iyer,	Intel Corporation
Mr. Sibabrata Ray	Google Inc.
Dr. Prabhakar Raghavan	Yahoo! Labs
Mr. Doug Rosen	Microsoft
Mr. Anthony Sarris	Unisys Corporation
Ms. Pat Thaler	Agilent Technologies, Inc.
Mr. Geoffrey O. Thompson	Nortel Networks, Inc.
Mr. Kees Vissers	Xilinx Research, Inc.
Dr. Ghaleb Abdulla	LALN
Dr. Ravi Iyer	Intel
Dr. Jim Larus	Microsoft

Being a recently created Program, CEN does not have its own Advisory Board. It relies on the evaluation and feedback of the EE and CSE Boards. Since CEN does not have it own set of courses, the need for a separate advisory board is not yet clear.

The Computer Engineering Program is particularly sensitive to the needs of employers of our students. These employers are a diverse group, including (considering only students that graduated in 2012) defense contractors such as Raytheon Space and Airborne Systems, Rockwell Collins Inc and Boeing, communication/information heavyweights such as Ebay, Hewlett Packard, Microsoft, Google, Verizon Wireless, Environmental Systems Research Institute and SBC Communications, financial services companies including Farmers Insurance Group, and Ameriquest Mortgage Company, and numerous start-ups such as Fetch Technologies, LunarPages (Add2Net, Inc) and ACMS inc.

Table 11 illustrates how our program educational objectives meet the needs of our constituents. This mapping is shown to the entire faculty at least once a year (most recently on March 5th 2012) who are invited to discuss it and offer revisions.

Table 11: How Program Educational Objectives meet the needs of our Constituents

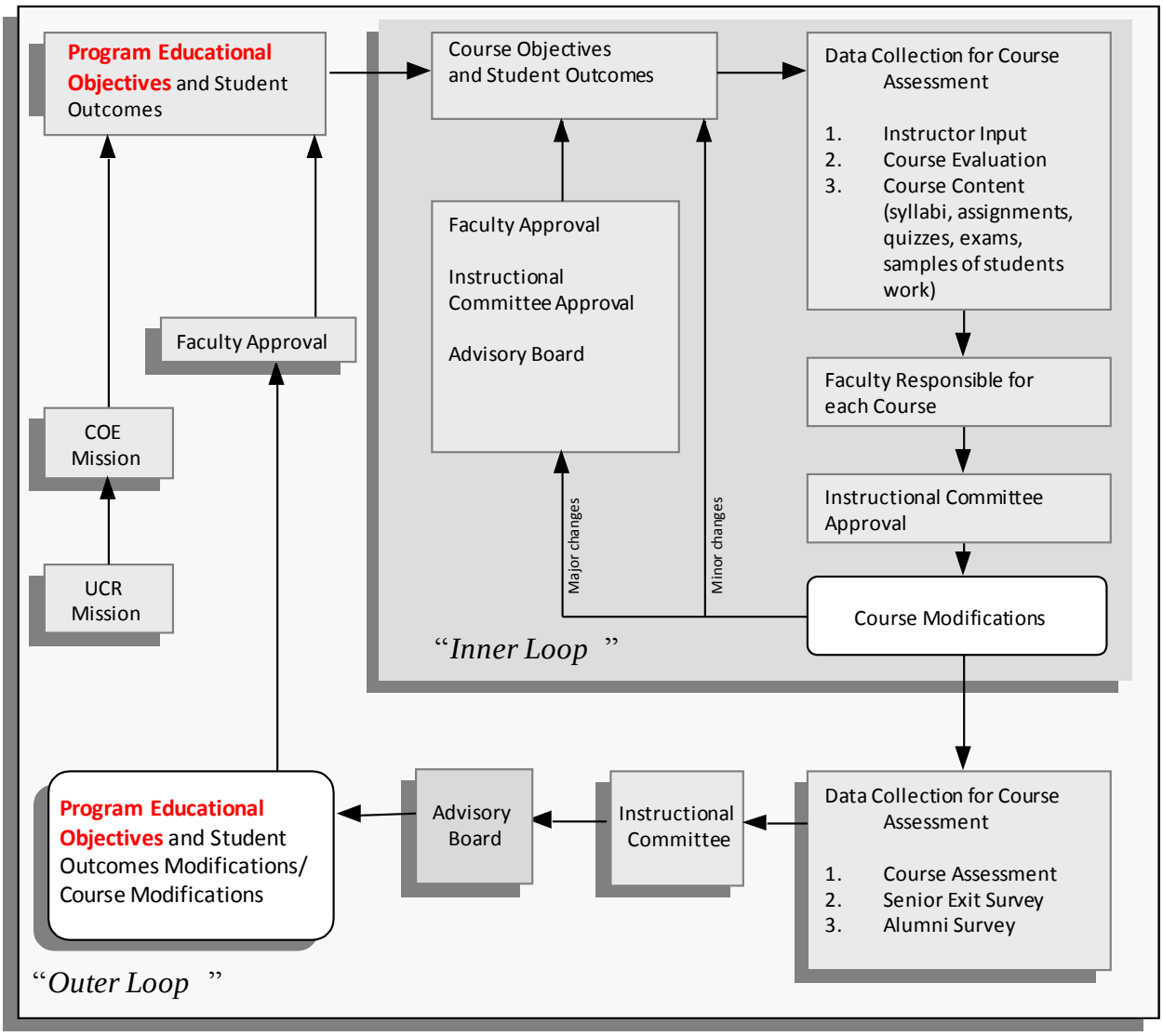
Constituents / PEOs (abridged)	**Students**	**Faculty**	**Employers**	**Alumni**	**Advisory Boards**	**Community at large**
success in *post-graduation studies*	students clearly benefit, financially and otherwise from going on to higher education	faculty care deeply about the reputation of UCR, and our students are our most important ambassadors to other universities	many employers need employees with advanced degrees and significant networking skills	alumni benefit from a halo effect when our current students, become fellow alums and are successful in post-graduation studies and/or a chosen profession or vocation , and make significant contributions to society	note that our Advisory Boards have high overall with Alumni and Employers. They have offered their valuable time and expertise for free, and naturally wish to see the maximum benefit extracted from it. Our students success in post-graduation studies and/or a chosen profession or vocation , and their contributions to society, are the metrics they have suggested as a measure of the success of their input	students with post graduate degrees earn significantly more, boosting tax revenues for the community
success in *a chosen profession or vocation*	students clearly benefit from high career satisfaction and obtaining promotions/raises	faculty care deeply about the reputation of UCR, and our students are our most important ambassadors to industry	employers and our students mutually benefit when students have satisfying careers and are promoted/ recognized			entrepreneurial activities in a community increase the tax base
contributions to society	students benefit from even the *possibility* of public/volunteer service	faculty care deeply about the reputation of UCR, and our students are our most important ambassadors to society at large	employers benefit from the halo effect when they have employees that are engaged in public/volunteer service			the community clearly benefits from citizens anxious to engage in public/volunteer service

E. Process for Revision of the Program Educational Objectives[3]

Table 12 outlines the general process by which we use data to improve our program. Note that *this process itself is examined once a year for meta-improvements*, and it is this meta-process that is the driving process for Revision of the Program Educational Objectives. The process can be seen as an "*inner loop*", which is conducted once a quarter, and an "*outer loop*", which is conducted once a year. The former process focus on *course objectives*, the latter on *Program Educational Objectives*.

[3] We note that the assessment and improvement processes are very similar for both the *PEOs* and for program learning *outcomes*, and these two processes run in parallel. This is a deliberate decision to simplify the process and ensure compliance from all parties. The *assessment* part of this process is described in more detail in Criterion 4.

Table 12: The Program Iterative Improvement Process. Note that one item that is considered once a year in this process are the Program Educational Objectives (*top left*)



The Inner Loop: Individual Course and Course Sequence Level

The inner loop is discussed in exhaustive detail in Section 4.B, so we avoid a detailed discussion here. Suffice it to say that each quarter, for each course offering, a great deal of empirical information regarding the coverage and performance on program educational objectives are gathered, analyzed and discussed at faculty meetings.

The Outer Loop: Curriculum and Program Level

Important note: In this context, we are asking if our PEOs appropriate—do they meet constituent needs? (Are we doing the *right thing*?). We also ask ourselves are our graduates attaining the PEOs? (Are we doing *things right*?), but this is discussed in Criterion 4, not here.

At the end of each year, the following data are collected:

- Senior Exit Surveys. The survey allows the graduating seniors to rank how well the program met the objectives and outcomes. The senior Exit Surveys are distributed to the faculty and analyzed. The Undergraduate Committee then drafts an action plan for improvement. Naturally, since this information is recorded just as students graduate, it has more implications for student outcomes (discussed later in the relevant section), than PEOs. Nevertheless, there are implications for PEOs to questions of the nature "*how well do you think you are prepared to..."*.
- Board of Advisors surveys. Each year, the departments organize meetings with industry advisory boards. The Undergraduate and ABET Committees are tasked with collecting and analyzing the BOA feedback on the courses content, program objectives, etc.
- Quantitative assessment of the EE 175 and CS 179 Senior Design projects.
- Alumni Surveys. These surveys are collected from the set of alumni and analyzed with the goal of determining the importance and relevance of the program objectives and outcomes, as well as their achievement.

The assessment process itself has been continually revised and improved since 2003 to incorporate more quantitative assessment elements. For example, the student Exit Surveys were originally administered in the last session of the senior design course (CS 179 or EE 175), but we realized that this allowed students to graduate without filling out a survey. We now administer it through the Office of Student Academic Affairs. Students must complete the exit survey when they file their applications for graduation. Graduation applications are not accepted without the survey. This assures 100% participation in the survey.

The instructor for each undergraduate course is required to keep a course file, documenting important information such as syllabus, course matrix (i.e. course objectives vs. Student Outcomes), testing/measurement information, course assessments, report, and recommendations for future improvements. While the instructor is *responsible* for this, in practice the TAs actually do most of the paperwork. They are trained for this task in the first two weeks of CS 302, Apprentice Teaching. The loop is "closed" each time a new instructor teaches the course by a mechanism we call instructor "sign-on," a procedure whereby each new instructor reads and signs off on the recommendations made by the previous instructor (which could be the same person) for the improvements in the course curriculum.

The information in the course files is integrated and analyzed by the CEN ABET committee at the end of each academic year. Additional data obtained from the industry Board of Advisors (BOA), students, and alumni, is analyzed. Based on this analysis and in consultation with the Undergraduate Instructional Committee, recommendations may be made to the faculty for changes and/or improvements in the PEO, outcomes, or any aspect of the program. If the faculty approves, the improvement actions are then propagated forward to make the recommended changes in the program.

Changes Made to PEOs since Last ABET Accreditation

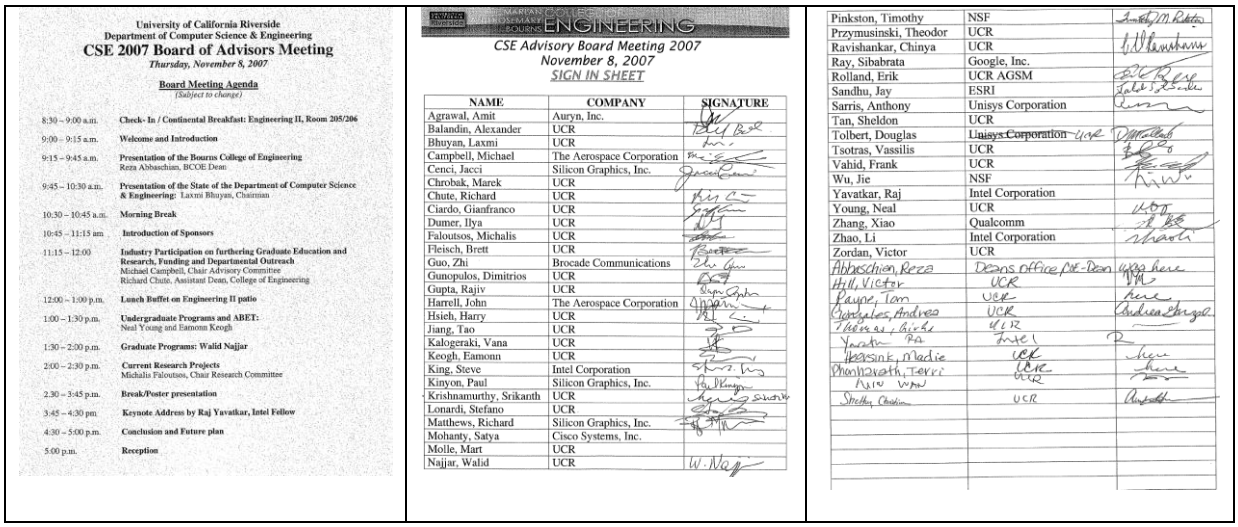
The last time the PEOs were changed was in 2007, below we describe this change in detail: Note that this change does not exactly follow the process describe above for (mostly *minor*) revisions of PEOs, since it reflects a *complete rewriting* of the PEOs inspired by ABET concerns.

After the 2006/07 ABET evaluation, we received feedback that the evaluators had some concerns about our PEOs (we will not repeat them here, as this is extensively documented elsewhere, we will just document the process for *revision of PEOs*).

In late October 2007, the two faculty members from the ABET Committee, Dr. Eamonn Keogh and Dr. Tom Payne, had a series of meetings with the interested parties, including the CS ABET committee, the EE ABET committee (at the time, Dr. Amit K. Roy-Chowdhury and Dr Roger Lake), the CEN Undergrad education committee, the Chair of CS/CE, Dr. Laxmi Bhuyan, some of the most frequent employers of our students (ISCA Tech in Riverside, ESRI in Redlands), and (by phone) some of our BOA, including Dr. Mark Campbell of The Aerospace Corp.

On November the 3rd to 6th 2007, Dr. Eamonn Keogh and Dr. Tom Payne wrote new PEOs. They based them very closely on the EE PEOS. The Electrical Engineering department was consulted and asked for feedback at this stage.

On November 8th 2007, Dr. Eamonn Keogh presented the new PEOs to the Board of Advisors, from 1:00pm to 1:30pm. Each member received a take home copy, and was invited to discuss the PEOs both at the meeting, and offline by email at a later date. Dr. Keogh also discussed ABET more generally, and with Dr. Neal Young they discussed the undergraduate program in general. Almost all the faculty were in attendance. Ms. Andrea Gonzales took minutes. Figure 9 shows supporting documentation for this, the original documents are available on request.



University of California Riverside
Department of Computer Science & Engineering
CSE 2007 Board of Advisors Meeting
Thursday, November 8, 2007

Board Meeting Agenda
[Subject to change]

8:30 – 9:00 a.m.	**Check- In / Continental Breakfast: Engineering II, Room 205/206**
9:00 – 9:15 a.m.	**Welcome and Introduction**
9:15 – 9:45 a.m.	**Presentation of the Bourns College of Engineering** Reza Abbaschian, BCOE Dean
9:45 – 10:30 a.m.	**Presentation of the State of the Department of Computer Science & Engineering:** Laxmi Bhuyan, Chairman
10:30 – 10:45 a.m.	**Morning Break**
10:45 – 11:15 am	**Introduction of Sponsors**
11:15 – 12:00	**Industry Participation on furthering Graduate Education and Research, Funding and Departmental Outreach** Michael Campbell, Chair Advisory Committee Richard Chute, Assistant Dean, College of Engineering
12:00 – 1:00 p.m.	**Lunch Buffet on Engineering II patio**
1:00 – 1:30 p.m.	**Undergraduate Programs and ABET:** Neal Young and Eamonn Keogh
1:30 – 2:00 p.m.	**Graduate Programs: Walid Najjar**
2:00 – 2:30 p.m.	**Current Research Projects** Michalis Faloutsos, Chair Research Committee
2:30 – 3:45 p.m.	**Break/Poster presentation**
3:45 – 4:30 pm.	**Keynote Address by Raj Yavatkar, Intel Fellow**
4:30 – 5:00 p.m.	**Conclusion and Future plan**
5:00 p.m.	**Reception**

MARLAN AND ROSEMARY BOURNS COLLEGE OF ENGINEERING
CSE Advisory Board Meeting 2007
November 8, 2007
SIGN IN SHEET

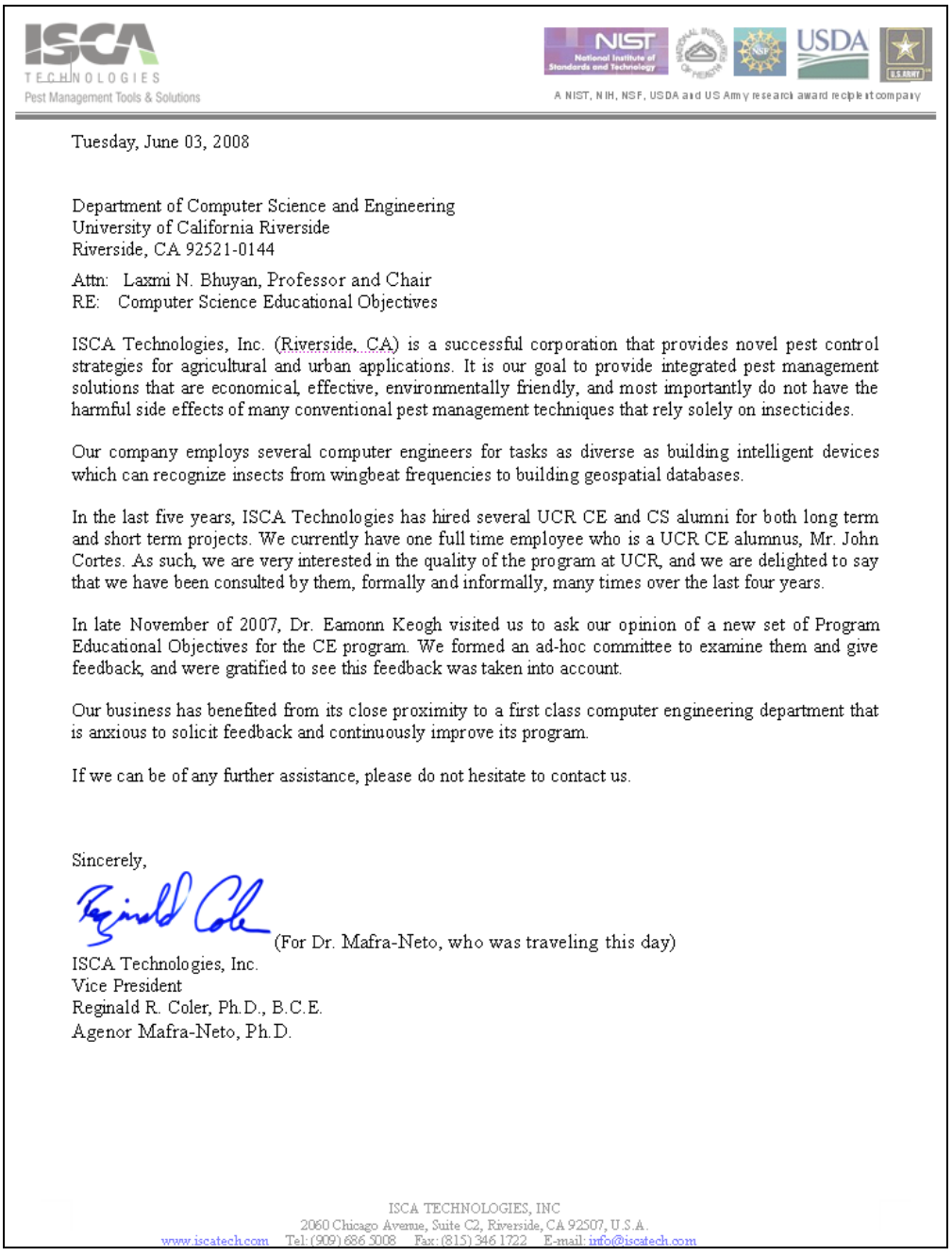
NAME	COMPANY	SIGNATURE
Agrawal, Amit	Auryn, Inc.	
Balandin, Alexander	UCR	
Bhuyan, Laxmi	UCR	
Campbell, Michael	The Aerospace Corporation	
Cenci, Jacci	Silicon Graphics, Inc.	
Chrobak, Marek	UCR	
Chute, Richard	UCR	
Ciardo, Gianfranco	UCR	
Dumer, Ilya	UCR	
Faloutsos, Michalis	UCR	
Fleisch, Brett	UCR	
Guo, Zhi	Brocade Communications	
Gunopulos, Dimitrios	UCR	
Gupta, Rajiv	UCR	
Harrell, John	The Aerospace Corporation	
Hsieh, Harry	UCR	
Jiang, Tao	UCR	
Kalogeraki, Vana	UCR	
Keogh, Eamonn	UCR	
King, Steve	Intel Corporation	
Kinyon, Paul	Silicon Graphics, Inc.	
Krishnamurthy, Srikanth	UCR	
Lonardi, Stefano	UCR	
Matthews, Richard	Silicon Graphics, Inc.	
Mohanty, Satya	Cisco Systems, Inc.	
Molle, Mart	UCR	
Najjar, Walid	UCR	

Pinkston, Timothy	NSF	
Przymusinski, Theodor	UCR	
Ravishankar, Chinya	UCR	
Ray, Sibabrata	Google, Inc.	
Rolland, Erik	UCR AGSM	
Sandhu, Jay	ESRI	
Sarris, Anthony	Unisys Corporation	
Tan, Sheldon	UCR	
Tolbert, Douglas	~~Unisys Corporation~~ UCR	
Tsotras, Vassilis	UCR	
Vahid, Frank	UCR	
Wu, Jie	NSF	
Yavatkar, Raj	Intel Corporation	
Young, Neal	UCR	
Zhang, Xiao	Qualcomm	
Zhao, Li	Intel Corporation	
Zordan, Victor	UCR	
Abbaschian, Reza	Deans office Pst-Dean	
Hill, Victor	UCR	
Payne, Tom	UCR	
Gonzales, Andrea	UCR	
Theresa + Girls	UCR	
Yavatkar, Raj	Intel	
Haarsink, Madie	UCR	
Phonnavath, Terri	UCR	
Strelley, Christian	UCR	

Figure 9: The Agenda for the BOA Meeting held on 11/8/07. *center*) and *right*) the attendance Roster at the BOA Meeting held on 11/8/07

The ABET committee then solicited feedback and approval for our new PEOs from employers of our CEN students. This process was conducted by phone, email and when

possible, by an onsite visit by a delegation from our department. Figure 10 documents this process with one company that has hired four Computer Engineering students, similar documentation for other companies is available on request.



ISCA TECHNOLOGIES
Pest Management Tools & Solutions

A NIST, NIH, NSF, USDA and US Army research award recipient company

Tuesday, June 03, 2008

Department of Computer Science and Engineering
University of California Riverside
Riverside, CA 92521-0144

Attn: Laxmi N. Bhuyan, Professor and Chair
RE: Computer Science Educational Objectives

ISCA Technologies, Inc. (Riverside, CA) is a successful corporation that provides novel pest control strategies for agricultural and urban applications. It is our goal to provide integrated pest management solutions that are economical, effective, environmentally friendly, and most importantly do not have the harmful side effects of many conventional pest management techniques that rely solely on insecticides.

Our company employs several computer engineers for tasks as diverse as building intelligent devices which can recognize insects from wingbeat frequencies to building geospatial databases.

In the last five years, ISCA Technologies has hired several UCR CE and CS alumni for both long term and short term projects. We currently have one full time employee who is a UCR CE alumnus, Mr. John Cortes. As such, we are very interested in the quality of the program at UCR, and we are delighted to say that we have been consulted by them, formally and informally, many times over the last four years.

In late November of 2007, Dr. Eamonn Keogh visited us to ask our opinion of a new set of Program Educational Objectives for the CE program. We formed an ad-hoc committee to examine them and give feedback, and were gratified to see this feedback was taken into account.

Our business has benefited from its close proximity to a first class computer engineering department that is anxious to solicit feedback and continuously improve its program.

If we can be of any further assistance, please do not hesitate to contact us.

Sincerely,

(For Dr. Mafra-Neto, who was traveling this day)
ISCA Technologies, Inc.
Vice President
Reginald R. Coler, Ph.D., B.C.E.
Agenor Mafra-Neto, Ph.D.

ISCA TECHNOLOGIES, INC
2060 Chicago Avenue, Suite C2, Riverside, CA 92507, U.S.A.
www.iscatech.com Tel: (909) 686 5008 Fax: (815) 346 1722 E-mail: info@iscatech.com

Figure 10: A Letter from an Employer of Several Computer Engineering Students, Discussing the PEO Feedback Solicitation

We also solicited comment and approval for our new PEOs from our students, this is documented elsewhere in this report, and omitted here for brevity.

On November 14th 2007, Dr. Keogh presented the new PEOs with notes from the Board of Advisors to the entire faculty, 40 minutes were spent discussing the PEOs and they were adopted by a majority vote. The minutes of this meeting are detailed in Figure 11.

Faculty Meeting Minutes from November 14, 2007

The meeting commenced at 12:00 p. m. by Chair Laxmi Bhuyan. The following faculty were present: Laxmi Bhuyan, Rajiv Gupta, Tao Jiang, Mart Molle, Walid Najjar, Chinya Ravishankar, Vassilis Tsotras, Michalis Faloutsos, Eamonn Keogh, Srikanth Krishnamurthy, Stefano Lonardi, Thomas Payne, Neal Young, Harry Hsieh, and Christian Shelton.

(A) Announcements were made by Laxmi regarding:
(1) The faculty meeting will be held every two weeks from 12-1 p. m.
(2) No corrections were suggested for the October 24th meeting minutes.
(3) Intel will be sending from $10,000-$20,000 to support the distinguished lecture series and their logo will appear on the series posters.
(4) Mike Carrey has been recommended by Reza for an Eminent Scholar position at UCR- Discussion took place as to where he is interested in applying for a position and what we can do to make an attractive offer to him. Mike will be back to Riverside December 7th for a visit.
(B) **Eamonn presented the proposed ABET program educational objectives and their need to be measurable and explicit. Discussion ensued as to whether or not they should be published in the general catalogue. A vote was taken and the faculty voted for the Program Educational Objectives as presented.**
(C) Debate was held about the Advisory Board and what their role is in relation to the Department; their interest is in graduate and undergraduate programs. Laxmi suggested that perhaps there should not be an Advisory Board meeting every year. He stated that he had presented the agenda to faculty for feedback and received none. Perhaps the agenda should be different next year and change it to an Industry Day. Or perhaps have a separate Industry Day and keep the Board of Advisors for ABET purposes. It was suggested that if the department held an industry day there could be more research and poster presentations which would feature graduate student research. The population of the board of advisors was discussed and that most were high level managers. It was suggested that perhaps it would be better to target industry affiliates who are mid level managers and would be the managers of the people who would actually hire our students. The department could form a committee to update the list (which hasn't been reviewed and updated since 2001) by deleting old inactive names and inviting new people. Due to time constraints it was suggested that this discussion be continued at another meeting.
(D) Christian Shelton's merit was discussed and ballots were distributed for voting.
(E) Vassilis said it would be good to have 4:00 p. m. meetings on Fridays for students to meet with the faculty.
The meeting was adjourned at 1:40 p.m.

Figure 11: Computer Science and Engineering Faculty Meeting Minutes from Nov 14, 2007

In summary, we created new PEO's after soliciting input and approval from all our constituents, our Board of Advisors, employers of our students, faculty, and the students themselves. Furthermore we have *carefully documented* this process at every step.

Summary for this Section

As illustrated in Table 12, we have a detailed and rigorous process for revision of the Program Educational Objectives. This process takes place once a year, and input is obtained from *all* constituents. At least two hours a year (at the faculty retreat in September) are reserved for *the entire* faculty to discuss the PEOs face-to-face.

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

After consulting with all our constituents, the faculty decided to adopt the ABET a-k as our student outcomes in 2007. We revisit this issue at least once a year at the faculty retreat (September), however thus far we have found no reason to change or augment the outcomes.

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

We note that our department has a culture of openness to new ideas, and constantly researches and discusses our student outcomes. We do this not only using the formal process we design for this task (cf. Table 15 in Criterion 5), but also by including ad-hoc information from new reports, white papers, proceedings of journals and conferences on engineering education etc. As a representative example, at the May 9th 2012 faculty meeting we discussed at length the findings of a 2009 national survey by the Association of American Colleges and Universities, "*Raising The Bar: Employers Views On College Learning In The Wake Of The Economic Downturn*"[4]. This report provided us with useful information indicating our student outcomes are relevant to employers. Quoting from the survey: ―*The areas in which employers feel that colleges most need to increase their focus include*

1) *written and oral communication*

2) *critical thinking and analytical reasoning*

3) *the application of knowledge and skills in real-world settings*

4) *complex problem-solving and analysis*

5) *ethical decision-making*

6) *teamwork skills*

7) *innovation and creativity*

8) *concepts and developments in science and technology*

[4] *www.aacu.org/leap/documents/2009_EmployerSurvey.pdf*

Table 13 maps these employer responses to our student outcomes, an exercise we completed at the faculty meeting on May 9th 2012 to spur further discussion of our student outcomes.

Table 13: The Relationship of Student Outcomes to Association of American Colleges and Universities Employer Survey

AACU survey / Student Outcomes	1	2	3	4	5	6	7	8
(a) an ability to apply knowledge of mathematics, science, and engineering			■					■
(b) an ability to design and conduct experiments, as well as to analyze and interpret data		■						
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability			■					
(d) an ability to function on multidisciplinary teams				■		■		
(e) an ability to identify, formulate, and solve engineering problems		■					■	
(f) an understanding of professional and ethical responsibility					■			
(g) an ability to communicate effectively	■							
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context			■					
(i) a recognition of the need for, and an ability to engage in life-long learning							■	
(j) a knowledge of contemporary issues			■					
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.				■				

One outcome of this discussion was a consensus that we need to redouble our efforts in *measuring* the student's teamwork skills. Currently the assessment of this skill is limited to peer-assessments by the team, observation by the instructor, and how well the team performs on the given task. It was decided that a committee would be formed to attempt to find additional metrics for teamwork skill that could be incorporated into various instruments.

B. Relationship of Student Outcomes to Program Educational Objectives

Table 14 shows the relationship of student outcomes to Program Educational Objectives. This mapping was created in late October 2007 by the ABET Committee, and shown to the full faculty for comments and discussion on November 14th 2007.

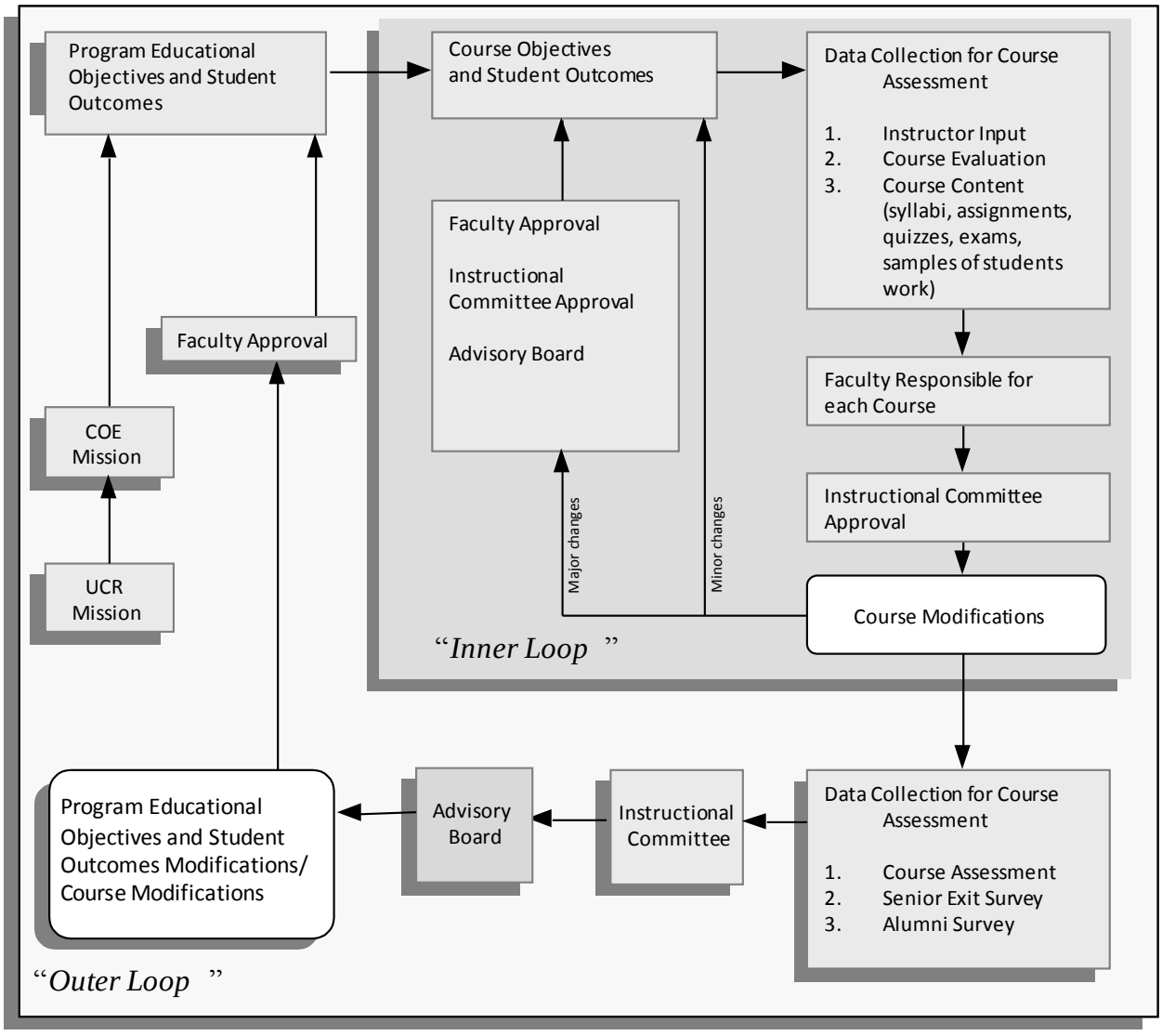
Table 14: The Relationship of Student Outcomes to Program Educational Objectives

PEOs (abridged) / Student Outcomes	**Success in post-graduation studies *as evidenced by*:**	**Success in a chosen profession or vocation *as evidenced by*:**	**Contributions to society *as evidenced by*:**
(a) an ability to apply knowledge of mathematics, science, and engineering	advanced degrees earned	career satisfaction/ promotions & raises	
(b) an ability to design and conduct experiments, as well as to analyze and interpret data		career satisfaction/ promotions & raises	
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability		career satisfaction/ promotions & raises	public service
(d) an ability to function on multidisciplinary teams	professional responsibilities	entrepreneurial activities	leadership roles
(e) an ability to identify, formulate, and solve engineering problems		entrepreneurial activities / consulting activities	
(f) an understanding of professional and ethical responsibility			volunteer service/ mentoring / outreach activities/ public service
(g) an ability to communicate effectively	professional visibility	promotions & raises / professional visibility / consulting activities	mentoring / outreach activities
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	professional responsibilities		
(i) a recognition of the need for, and an ability to engage in life-long learning	satisfaction with the decision to further their education/ professional visibility	professional visibility	
(j) a knowledge of contemporary issues		entrepreneurial activities / consulting activities	
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	professional visibility	entrepreneurial activities / consulting activities	

CRITERION 4. CONTINUOUS IMPROVEMENT

We begin with Table 15 which shows a visual overview of the process that we use to assess and evaluate the extent to which the program educational objectives and student outcomes are being attained, and make improvements. While both processes are holistic, the "*inner loop*" focuses on the student outcomes and the "*outer loop*" focuses on the program educational objectives.

Table 15: The Continuous Improvement Process. Note that this table is similar to Table 12, however there we consider the process for revision of Program Outcomes, but here we are considering how we assess and evaluate the extent to which the *program educational objectives* and *student outcomes* are being attained.



The Inner Loop: Individual Course and Course Sequence Level

At the end of each quarter, the following data are collected:

- Grades in homework assignments, lab reports, short tests and examinations. Review of the student performance (grade received) for feedback on whether the course/program objectives are met. All the material is archived in a standardized format (see "*the ABET Binder*" in Section 4.B below), to simplify inspection (by ABET evaluators) and analyses (by faculty).
- Student Evaluation of Teaching. Evaluations administered near the end of each quarter allow students to provide the instructor with anonymous feedback on the effectiveness of the course. The questions in the evaluation forms include questions relevant to the stated program objectives like "*Have you learned something you consider valuable*?"
- End-of-course student assessments/surveys. Course surveys are distributed at the end of each course. The course survey is based on the course objectives, and Student Outcomes (a)→(k) from the course objective matrix. Students are asked how well the course learning objectives, and Student Outcomes were achieved.

Note: All required CEN major courses are offered by either the EE or CSE Departments. The CEN Program relies on these departments for the collection of course data and the management of the Continuous Improvement Process.

The Outer Loop: Curriculum and Program Level

At the end of each year, the following data is collected:

- **Senior Exit Surveys**. The survey allows the graduating seniors to rate how well the program met the objectives and outcomes. The senior Exit Surveys are distributed to the faculty and analyzed. The Undergraduate Committee then drafts an action plan for improvement.
- **Board of Advisors Surveys**. Each year, both the departments organize meetings with industry advisory boards. The Undergraduate and ABET Committees are tasked with collecting and analyzing the BOA feedback on the courses content, program objectives, etc.
- **Senior Design Projects** quantitative assessment of the EE 175 and CS 179 Senior Design projects, tied to the a-k outcomes.
- **Alumni Surveys**. These surveys are collected from of alumni and analyzed with the goal to determine the importance and relevance of the Program Education Objectives and Student Outcomes, in addition to their achievement. The last two surveys were conducted in Spring 2008 and Spring 2012. The ABET Chair sends out the surveys by email to the alumni based on their latest contact information that is available. This cycle we began to explore using social media to further improve our response rate. The survey consists of questions that directly measure different aspects of the PEOs (e.g., whether the alumni has completed a graduate degree, whether the alumni has

completed a professional certification), as well as more indirect questions such as how well they were prepared for their career choice.

- **Faculty Input**: Inputs received from the Alumni and EE/CSE Board of Advisors are analyzed by the undergraduate committee, in the context of the other sources of information listed above. A summary is then presented to the faculty with a list of modifications that should be implemented for better achievement of the PEOs.

Having seen an overview of the entire process, in the next two sections we will consider the PEOs (*outer loop*) and course objectives (*inner loop*) in great detail.

A. Program Educational Objectives

We use several mechanisms to measure how well the program is achieving the PEOs. These include employer surveys, employer visits and interviews, alumni surveys, and industrial advisory committee meetings. Below we consider each in turn.

4.A.1 Consulting with both the CSE and EE Board of Advisors on PEOs

The CEN program maintains a close relationship with both the CSE and EE board of advisors. Our faculty meets with them formally once a year (typically early in the winter quarter) for a full day, and we also correspond with them on faculty visits and through informal email and phone surveys. The last meeting with our CSE board of advisors took place on April 2nd 2012. While seventy-five minutes was allotted to undergraduate education, the discussion of undergraduate issues spilled into the heavily attended working lunch / dinner sessions. Figure 12 shows the unedited notes taken at the meeting were further discussed at a faculty meeting that took place on April 4th 2012.

(*unedited*) Minutes of the discussion during the Board of Advisors, Dept of Computer Science and Eng, April 2nd 2012. Scribe: Prof. Stefano Lonardi, Vice Chair and Professor. Discussion started from the Board of Advisors raising the issue of the need for undergrad students of having Calculus in their curriculum for CS and CEN degree. Someone in BOA mentioned that perhaps more discrete math (concept of proof, induction, correctness) would be more appropriate than Calculus. Others in BOA mentioned that Statistics, Logic, Communication Theory (Information Theory) or even Economics would be more appropriate: perhaps broadening the range of course undergraduate could take would be beneficial for some students (e.g. replacing Calculus+Physics with other options).

A discussion about the "problem" with the quality of teaching for math and physics at UCR followed: often for math these course are taught by visiting professor, that are not very interested in offering a high quality learning experience for students (Prof. Neal Young and Frank Vahid).

Some advisors mentioned that we should incorporate in the math background skills that allow student to "turn data into knowledge" -- i.e., probability and statistics.

These days many disciplines are, or are becoming computational. The next topic of discussion was about retention. Someone in the BOA mentioned that broadening the experience in the math series by offering alternatives to Physics + Calculus could help increasing retention. Someone said that "perhaps not all CS students are interested in learning about nuts and bolts".

The last topic was about our choice of the programming language used to teach freshmen introduction to programming, which is C++. Some BOA member felt that C++ is not the best language to learn as the first programming language: too unforgiving and frustrating due to its syntax. Prof. Neal Young explained the rationale behind C++, that we have discussed alternatives, but some upper division classes (OS, networks, etc) need C++.

Faculty that participated in the discussion: Prof. Neal Young, Prof. Frank Vahid, Prof. Marek Chrobak, Prof. Tao Jiang, Prof. Laxmi Bhuyan, Prof. Tamar Shinar, Prof. Michalis Faloustos, Prof. Stefano Lonardi, Prof Eamonn Keogh.

Computer Science & Engineering
Advisory Board Meeting

CSE THE MARLAN AND ROSEMARY BOURNS COLLEGE OF ENGINEERING

WHEN: Monday, April 2, 2012
Engineering Building II, Room 205/206
TIME: 8:30am-5:00pm
Continental Breakfast: 8:30am – 9:00am

Welcome and State of the Department:	
Chair Laxmi Bhuyan	**9:00 am - 9:30 am**
Program Discussion and Feedback:	
Graduate Program: Prof. Tao Jiang	**9:30 am – 9:45 am**
U/G Program: Prof. Neal Young	**9:45 am - 10:15 am**
ABET: Prof. Eamonn Keogh	**10:15 am - 10:30 am**
Program Discussions and Suggestions (over Coffee)	**10: 30am – 11.00 am**
Distinguished Lecture:	**11:00 am - 12:00 pm**
"The Cloud will Change Everything"	
James Larus, Microsoft Research	
Lunch: 12:00pm – 1:15pm	
Introduction of New Faculty:	
Harsha Madhyastha	**1:15 pm - 1:30 pm**
Tamar Shinar	**1:30 pm - 1:45 pm**
Vagelis Hristidis	**1.45 pm - 2.00 pm**
Workshop:	**2:00 pm – 4:30 pm**
High Performance Architecture and Embedded System	
Ravi Iyer, Director, SoC Platform Architecture, Intel Corporation	**2:00 – 2:30 pm**
Tony Givargis, University of California, Irvine	**2:30 – 3:00 pm**
Coffee Break	**3: 00 – 3: 15 pm**
Faculty Presentations 15 minutes each	**3:15 – 4:30 pm**
Laxmi Bhuyan, Professor, Philip Brisk, Assistant Professor Rajiv Gupta, Professor, Walid Najjar, Professr Frank Vahid, Professor,	
Concluding Session:	**4:30pm - 5:00pm**
Dinner: 6:00pm (Optional)	

Figure 12: *left*) minutes from the CSE Advisory Board meeting that took place on April 2nd 2012 shows that well over an hour (*right*) was devoted to undergrad education issues.

CSE BOA in attendance for the full day were: Ghaleb Abdulla -LALN, Mike Campbell (chair) - Aerospace Corp, Don Dye - Acorn, Petros Efstathopoulos - Symantec, Vikram Gupta - Qualcomm, John Harrell - Aerospace Corp, Ravi Iyer - Intel, Jim Larus - Microsoft and Kees Vissers - Xilinx.

In Figure 13 we show the notes taken at this meeting by the BOA chair, Dr. Mike Campbell of the Aerospace Corp. These notes with Dr. Lonardi's notes (Figure 12) were discussed at length at a faculty meeting on April 18th 2012.

Chair's opening remarks:

Prof. Bhuyan laid out the Department's current structure, priorities, and goals. This presentation and all the presentations throughout the day showed effective focus on the Department's three primary goals: 1. Continued enhancement of the Department's national ranking; 2. Maintaining high quality faculty, graduate students, & undergrads; and 3. Enhancing Faculty visibility and recognition. In spite of the current budget constraints, the Department is maintaining exceptionally high productivity, especially in terms of PhDs per Faculty per year. The Department seems to be weathering the current budget issues well. This is a credit to the leadership and the willingness of the Faculty and Staff to do whatever it takes.

Graduate Program:

Prof. Jiang's presentation led to a very good discussion of the current balance between the MS and PhD programs. There are many issues, and the discussion provided a very strong rationale for the current structure. In particular, the Chair and the Faculty made a very strong case that the current MS/PhD balance is appropriate in support of the Department's three most important goals, above. (This is independent of the current State budget issues.) It appears that increasing the number of MS degree students would only be advisable as a very long-term goal and may require structural changes in the way funding is allocated to Departments for teaching resources.

Undergraduate Program Discussion Topics:

Undergrad retention:

The statistic "30-40%" may be misleadingly low. Need to present that statistic with enough definition, context, and benchmarking vs. other institutions. That said, undergrad retention is still an important metric of the Department's success.

Undergrad core curriculum:

Advisory Board members questioned the six-course Math requirement. The number of courses may be appropriate; however, on the surface it appears to be heavily weighted towards continuous mathematics and Calculus in particular. The rationale for this is that the students need to learn mathematical rigor and how to construct a formal proof.

There was a consensus by the Board that the requirement for learning rigor and how to write proofs is an important and relevant goal. Our discussions revealed that the overall course content is actually more balanced than it first appeared and does include coverage of discrete math and statistics, especially in the latter required courses and in the recommended electives. It was widely noted that this breadth of mathematical course work is a very positive thing. However, there was a near consensus that there are other lower division Math courses besides Calculus that could fulfill the goal of teaching theorem proving. It may be beneficial for this required core Math sequence to place even greater emphasis on discrete math, statistics, probability, and quantitative analysis. This might require decreased emphasis on Calculus, and it may be beneficial to give students more options for how to meet the course requirements aimed at teaching theorem proving.

There were also questions re. the one-year Physics requirement. It is understood that this course requirement reflects the relatively heavy emphasis on hardware in this Department. The Board supports this emphasis. In fact, the basic science requirement can serve two purposes: 1) understanding physical computer hardware, and 2) strengthening the students' ability to apply computational technology to scientific applications. However, several Board members questioned whether three quarters of basic Physics is the best complementary coursework to support an understanding of computer hardware. There was a near-consensus that this Physics sequence requirement should be broadened to allow for other areas of science, including both physical sciences (biology,

chemistry, environmental) as well as behavioral & social sciences (psychology, economics). Broadening the science requirement in this way would also serve many of the Department's other goals for their undergrads. It was noted that there are aspects re. the instruction of the current Physics sequence by outside faculty that influence the implementation of this requirement. If the suggestion to broaden the science requirement is implemented, it is understood that these concerns with instruction by outside faculty will have to be addressed again & again for each new area, which will require additional University resources and significant collaboration with other departments.

ABET:

Prof. Keogh's presentation on the ABET process gave a good introduction for those Board members that were new to the topic, and provided a valuable update for those of us that have been on the Board since before the last accreditation. The thoughtful planning that has gone into this by Prof. Keogh and the entire Faculty, Staff, and Administration really shows. I'm sure I speak for all of the Board when I say that we understand the importance of this process, and we are all willing to support your ABET work in any way we can.

James Larus' Distinguished Speaker Lecture:

Dr. Larus' presentation was very well done, and it was clearly very well received by the Advisory Board as well as the general audience of faculty and students. There was some discussion of whether it is best to schedule the DSL during the Advisory Board meeting. The general consensus seemed to be that overall this benefits the goals of the Advisory Board meeting.

Intro. of New Faculty:

Prof. Madhyastha gave a very good presentation on improving understanding of how applications behave in a thin client environment. This research demonstrated very good breadth by addressing the full spectrum from low level behaviors & metrics to the user experience.

Prof. Shinar enthusiastically described her very interesting and timely work on physics-based modeling for both computational science and graphics applications. Also described her work with young people to encourage females (and other under-represented groups) to enter STEM and be successful. This is recognized as a very important long-term goal by the Board members. She is to be commended for dedicating her personal time and energy to it.

Prof. Hristidis' presentation re. his team's work in Databases / Data Mining, one of the Department's traditional strengths, demonstrated very good balance between theory and application.

Figure 13: The CSE BOA Chair, Dr. Mike Campbell, wrote these (unedited) minutes at the Advisory Board meeting that took place on April 2nd 2012

CEN faculty also met with the Electrical Engineering BOA (cf. Table 9) once a year. The last time was on May 10th 2012. The agenda and discussions were similar and thus omitted for brevity (all notes, agenda, attendance rosters etc. will be available for inspection to ABET evaluators). One idea that came out of this year's BOA meeting was that it would be a good idea to either hold a joint meeting of (a subset of) the CSE and EE BOA every second year, or for CEN to have its own BOA. These ideas are under review, and will be settled by ABETs 2012 visit.

4.A.2 Consulting with Employers on the appropriateness and achievement of PEOs

We begin by noting in passing that our BOAs (discussed in previous section) and our student employers have a large overlap, although we deliberately make sure it is not a perfect overlap.

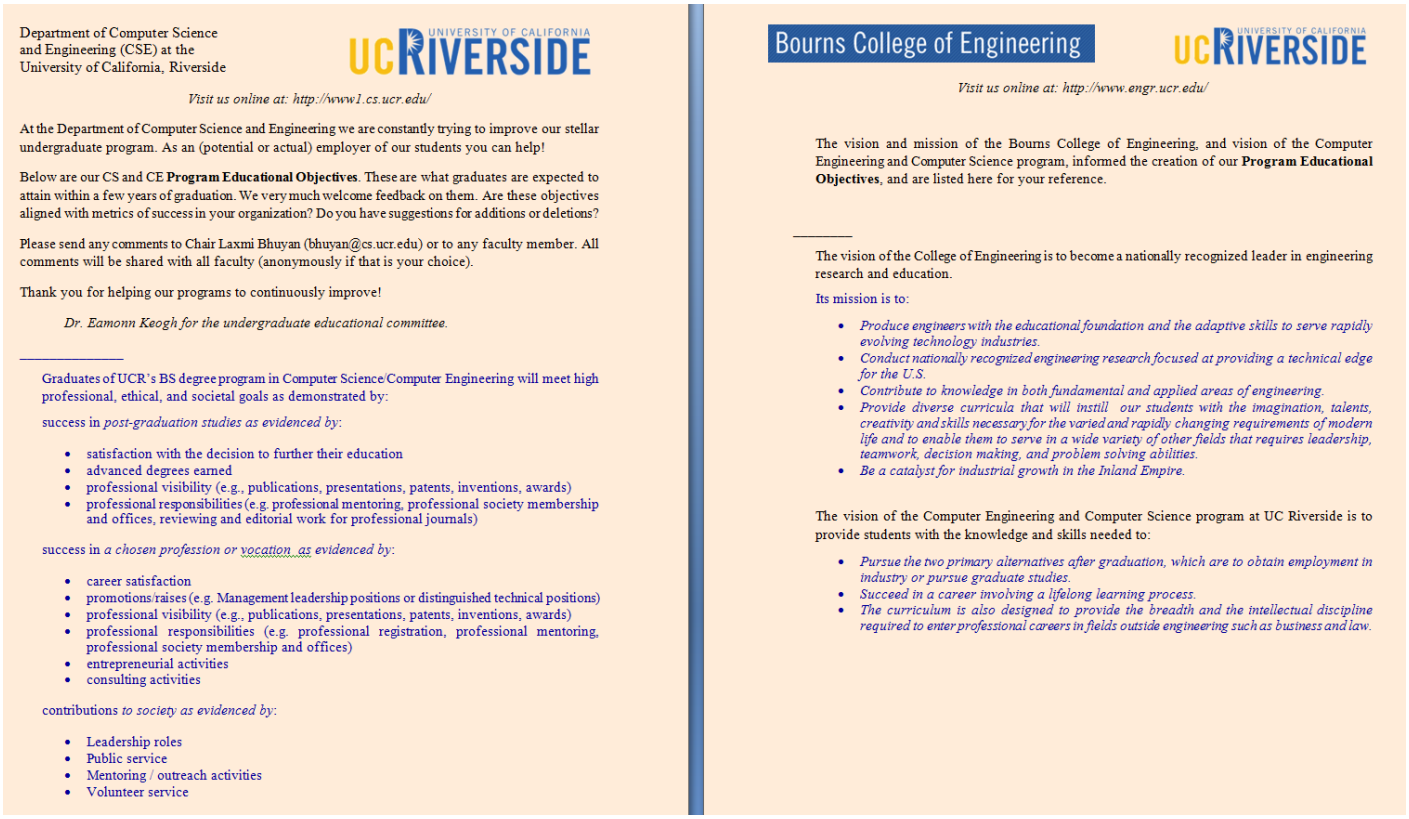
One method we use to gather information on *both*...

1) ..how well are our graduates meeting the program educational objectives...
2) ..how well the current program educational objectives align with employers needs...

...exploits the fact that our faculty frequently visit our graduates' employers.

Some representative examples from the last two years include: Dr. Shelton, NSWC Corona (Naval Surface Warfare Center, Corona), Dr. Faloutsos, The Bourns Company (not to be confused with Bourns College of Engineering)., Dr. Brisk Intel Corp, Western Digital., Dr Payne, Jethead Development, Luminex, Inc, Aerospace Corp., Dr. Najjar, ISCA Technologies, Jacquard Computing., Dr Keogh, ISCA Technologies, Microsoft, Google, ESRI., Dr Vahid, Qualcomm., Microsoft, Google, Altera Corp Western Digital etc.

We have created a one-page (double sided) flyer that we use to prompt conversations with our graduates' employers. Figure 14 shows its contents.



Department of Computer Science and Engineering (CSE) at the University of California, Riverside

UC RIVERSIDE UNIVERSITY OF CALIFORNIA

Visit us online at: http://www1.cs.ucr.edu/

At the Department of Computer Science and Engineering we are constantly trying to improve our stellar undergraduate program. As an (potential or actual) employer of our students you can help!

Below are our CS and CE **Program Educational Objectives**. These are what graduates are expected to attain within a few years of graduation. We very much welcome feedback on them. Are these objectives aligned with metrics of success in your organization? Do you have suggestions for additions or deletions?

Please send any comments to Chair Laxmi Bhuyan (bhuyan@cs.ucr.edu) or to any faculty member. All comments will be shared with all faculty (anonymously if that is your choice).

Thank you for helping our programs to continuously improve!

Dr. Eamonn Keogh for the undergraduate educational committee.

Graduates of UCR's BS degree program in Computer Science/Computer Engineering will meet high professional, ethical, and societal goals as demonstrated by:

success in *post-graduation studies as evidenced by*:

- satisfaction with the decision to further their education
- advanced degrees earned
- professional visibility (e.g., publications, presentations, patents, inventions, awards)
- professional responsibilities (e.g. professional mentoring, professional society membership and offices, reviewing and editorial work for professional journals)

success in *a chosen profession or vocation as evidenced by*:

- career satisfaction
- promotions/raises (e.g. Management leadership positions or distinguished technical positions)
- professional visibility (e.g., publications, presentations, patents, inventions, awards)
- professional responsibilities (e.g. professional registration, professional mentoring, professional society membership and offices)
- entrepreneurial activities
- consulting activities

contributions *to society as evidenced by*:

- Leadership roles
- Public service
- Mentoring / outreach activities
- Volunteer service

Bourns College of Engineering

UC RIVERSIDE UNIVERSITY OF CALIFORNIA

Visit us online at: http://www.engr.ucr.edu/

The vision and mission of the Bourns College of Engineering, and vision of the Computer Engineering and Computer Science program, informed the creation of our **Program Educational Objectives**, and are listed here for your reference.

The vision of the College of Engineering is to become a nationally recognized leader in engineering research and education.

Its mission is to:

- *Produce engineers with the educational foundation and the adaptive skills to serve rapidly evolving technology industries.*
- *Conduct nationally recognized engineering research focused at providing a technical edge for the U.S.*
- *Contribute to knowledge in both fundamental and applied areas of engineering.*
- *Provide diverse curricula that will instill our students with the imagination, talents, creativity and skills necessary for the varied and rapidly changing requirements of modern life and to enable them to serve in a wide variety of other fields that requires leadership, teamwork, decision making, and problem solving abilities.*
- *Be a catalyst for industrial growth in the Inland Empire.*

The vision of the Computer Engineering and Computer Science program at UC Riverside is to provide students with the knowledge and skills needed to:

- *Pursue the two primary alternatives after graduation, which are to obtain employment in industry or pursue graduate studies.*
- *Succeed in a career involving a lifelong learning process.*
- *The curriculum is also designed to provide the breadth and the intellectual discipline required to enter professional careers in fields outside engineering such as business and law.*

Figure 14: The PEO feedback solicitation flyer ("The Orange Sheet")

This flyer is printed on bright orange paper (to make it visually memorable) and placed in every faculty member's physical mailbox twice a quarter. Faculty are encouraged to take the flyer with them on visits to employers and use it as a conversation starter on PEOs. While this flyer considers "*How well the current program educational objectives align with employers needs."* it

also invariably spurs some conversation on "*How well are our students meeting the program educational objectives*.". The information gleaned by this direct contact, either face to face with the visiting faculty, or sent offline to the chair, is discussed at the next faculty meeting, and all such feedback is summarized by the ABET chair (in this cycle, Dr. Keogh) at the annual faculty retreat.

4.A.3 Alumni Survey

We conduct an alumni survey every two years, the last survey was conducted in Spring 2012. The number of responses was only nine, which makes it difficult to make any statistically significant claims about the results. To mitigate this we also examine the surveys from Computer Science and Electrical Engineering (For clarity, *not* in this document. Available upon request). This is possible to (judiciously) do as all three have the exact same set of questions (we designed this feature in 2007, exactly for this reason) and more than 50% of classes in CEN are in common with CS and/or EE. Note that CS and EE both have more than 35 responses.

In Table 16 we show the results of the 2012 survey, compared to the 2007 survey, which is the last survey that was seen by ABET evaluators.

Table 16: The CEN Alumni Survey, annotated by relevance to our Program Educational Objectives and to the Student Outcomes, contrasting the results of the 2008 survey and the 2012 survey.

Key	Questions answered by students that have gone to grad school	Questions answered by students that have *not* gone to grad school

1. What year did your earn your bachelor's degree in Computer Engineering?

2007(**4**), 2006(**0**), 2005(**8**), 2004(**1**), 2003(**1**), 2002(**3**):

2012(**0**), 2011(**2**), 2010(**3**), 2009(**0**), 2008(**1**), **2007** or before(**3**):

Note that the response rate seems to have slightly decreased, suggesting we need to do more aggressive tracking of alumni.

2. Have you pursued or completed any degrees beyond your bachelor's degree in engineering from UCR? Yes, No

56.3% said **yes**: (2008)

66.6% said **yes**: (2012)

It is very satisfying that 2/3rds of respondents have pursued or completed advanced degrees.

3. If you have completed another degree, please indicate all degrees completed.
M.S., Ph.D., MBA, J.D., M.D. Other (please specify)

(This question maps onto ABET (i) directly, and to directly onto PEO "*satisfaction with the decision to further their education*" and "*advanced degrees earned*")

MS 57%, Other 43%. (2008)

MS 75%, Other 25% (2012)

4. If you are pursuing another degree, please indicate the degree you are pursuing.
M.S., Ph.D., MBA, J.D., M.D.

(This question maps onto ABET (i) directly, and to directly onto PEO "*satisfaction with the decision to further their education*" and "*advanced degrees earned*") As choices are not mutually exclusive, they may sum to <100%

MS 66.7%, PhD 50.0% (2008)

MS 20%, PhD 80% (2012)

While we recognize that possibility of selection bias, we are delighted to find that fully 4/5ths of our students are pursuing PhDs

5. Have you published articles and/or made presentations at conferences in your field? Yes, No

(This question maps onto ABET (g)(j)(a)(b) and (c) directly, and to directly onto PEO "*success in post-graduation studies as evidenced by professional visibility*")

44.4% **Yes** (2008)

33.3% Yes (2012)

This number has stayed flat. We suspect it has a recency bias, as most grad student do not begin publishing until their 3rd or 4th year, and the majority of our respondents graduated less than four years ago.

6. Have you been named on any patents or patent applications?
Yes, No
(This question maps onto ABET (c)(g)(j)(a) and (k) directly, and to directly onto PEO "*success in post-graduation studies as evidenced by professional visibility-patents*")

0% **Yes.** (2008)
33.3% Yes (2012)

7. Have you received any awards for professional achievement?
Yes, No, If yes, please describe
(This question maps onto ABET (a) and (e) directly, and to directly onto PEO "*success in post-graduation studies as evidenced by professional visibility-awards*")

22% **Yes** (2008)
33.3% Yes (2012)

8. Have you engaged in any international research or collaborations (e.g., presented at international conferences, worked with international collaborators)? Yes, No, If yes, brief description of international activities
(This question maps onto ABET (d)(g) and (i) directly, and to directly onto PEO "*success in post-graduation studies as evidenced by professional visibility*")

22% **Yes** (2008)
33.3% Yes (2012)

9. Have you been a program committee member or organizing committee member of a conference? Yes, No
(This question maps onto ABET (f)(g)(i)(h) and (j) directly, and to directly onto PEO "*success in post-graduation studies as evidenced by professional visibility-reviewing and editorial work for professional journals*")

22% **Yes.** (2008)
0% Yes (2012)
This number has stayed decreased. We suspect it has a recency bias, as most grad students do not begin serving on PC until their 4th or 5th year, and the majority of our respondents graduated less than four years ago.

10. Have you been a reviewer for any journals? Yes, No, If yes, approximately how many times?
(This question maps onto ABET (f)(g)(i)(h) and (j) directly, and to directly onto PEO "*success in post-graduation studies as evidenced by professional visibility-reviewing and editorial work for professional journals*")

11% **Yes** (2008)
33.3% Yes (2012)

11. Have you engaged in other professional service such as scientific or technical review panels, serving as an expert witness, or consulting? Yes, No
(This question maps onto ABET (f)(d)(g)(i)(h) and (j) directly, and to directly onto PEO "*Public service, leadership roles*" and "*consulting activities*")

22% **Yes** (2008)
33.3% Yes (2012)

12. At this point of your career and education, what is the level of your satisfaction with your career choice and success in each of the following?

2008 Very satisfied - 5 4 3 2 1- Not satisfied
The field you work in: 66% scored a '5', and 33% scored a '4'
The academic institution/lab you work in: 75% scored a '5', and 25% scored a '4'
Recognition of your work: 22% scored a '5', 44% scored a '4' and 33% scored a '3'

2012 Very satisfied - 5 4 3 2 1- Not satisfied
The field you work in: 50% scored a '5', and 16.6% scored a '4', 16.6% scored a '3'
The academic institution/lab you work in: 50% scored a '5', and 16.6% scored a '4', 16.6% scored a '3'
Recognition of your work: 33.3% scored a '5', 16.6% scored a '4' and 50% scored a '3'

(This question maps onto ABET (i) directly, and to directly onto PEO "*Satisfaction with the decision to further*

their education" and "*professional visibility*")
This is somewhat of a mixed bag for us. The scores have decreased slightly, but not statistically significantly given the fairly small number of respondents. Moreover, graduates today are facing a different economic climate to graduates in 2008, a confounding factor that is hard to control.
On the other hand, on all three measures, at least 50% of students report being satisfied or very satisfied.

13. While pursuing an advanced degree, have you also been working professionally?
I have only been a student -- skip to Professional and Community questions
I have worked professionally
(Mostly a bookkeeping question, to bifurcate the following questions into those that have had graduate education and those that have not)

62.5% of the students responded "*I have worked professionally*" (2008)
100% of the students responded "*I have worked professionally*" (2012)

14. From the options below, please choose the one that best describes your current work.
Engineering support, Engineering development, Engineering management, Engineering research, Technical sales/marketing, Other (please specify)
(This question maps onto ABET (i) directly, and to directly onto PEO "*Satisfaction with the decision to further their education*" and "*leadership roles*", and "*public service*")
(2008)
Engineering support 0%, Engineering development 53%, Engineering management 15%, Engineering research 15%, Technical sales/marketing 7% Other (please specify) 15%.
(2012)
Engineering support 0%, Engineering development 15.4%, Engineering management 7.6%, Engineering research 0%, Technical sales/marketing 0% Other (please specify) 10%.

15. At this point of your career, what is the level of your satisfaction with your career choice and success in each of the following? The field you work in, The organization you work in, Your salary, Recognition of your work

(This question maps onto ABET (a) *indirectly*, and to directly onto PEO "*Satisfaction with the decision to further their education*" and "*leadership roles*", and "*professional visibility*")
(2008)
The field you work in: 54% scored a '5', and 23% scored a '5,' and 15% scored a '3', and 7% a '2'
The organization you work in: 54% scored a '5', and 33%, scored a '4' and 7% scored a '3' and '1'
Your salary: 23% scored a '5', and 30%, scored a '4' and 30% scored a '3', and 15% scored a '1'
Recognition of your work: 30% scored a '5', and 30%, scored a '4' and 23% scored a '3', and 7% scored a '2', and 7% scored a '1"
(2012)
The field you work in: 25% scored a '5', and 75% scored a '4,' and 0% scored a '3', and 0% scored a '2'
The organization you work in: 50% scored a '5', and 50%, scored a '4' and 0% scored a '3', '2' and '1'
Your salary: 25% scored a '5', and 25%, scored a '4' and 25% scored a '3', and 25% scored a '2'
Recognition of your work: 25% scored a '5', and 75%, scored a '4' and 0% scored a '3', and 0% scored a '2', and 0% scored a '1'
These numbers seem to have improved, with significantly less alumni reporting lower numbers.

16. Have you had promotions and/or raises since beginning your professional career?
Yes, No, If yes, how many times?
(This question maps onto ABET (a)(b)(c) *indirectly*, and to directly onto PEO "*Satisfaction with the decision to further their education*" and "*promotions raises*")

67% **Yes** (2008)
25% **Yes** (2012)
This is the most disappointing number in the survey. However, as noted elsewhere, Moreover, today are facing a different economic climate to graduates in 2008, a confounding factor that is hard to control

17. Have you published articles or made presentations in your organization or in your profession?
Yes, No
(This question maps onto ABET (g)(i)(j) directly, and to directly onto PEO "*Professional visibility-presentations-publications*")

41% **Yes** (2008)
0% **Yes** (2012)
The low number here reflects that the majority of respondents did not answer this question, as they are students in grad school that answered a similar question above.

18. Have you engaged in international activities such as participation in international conferences, collaborative research, or employment abroad?
Yes, No
(This question maps onto ABET (i)(g)(d) directly, and to directly onto PEO "*Professional visibility*")
16% **Yes** (2008)
50% **Yes** (2012)

19. Have you made inventions and/or been listed on patents or patent applications?
Yes, No
(This question maps onto ABET (c)(g)(j)(a) and (k) directly, and to directly onto PEO "*success in chosen profession or vocation as evidenced by professional visibility-patents*")
0% **Yes** (2008)
0% **Yes** (2012)

20. Have you been nominated for any professional or academic awards?
Yes, No, If yes, please describe. How many? Did you win?
(This question maps onto ABET (a) and (e) directly, and to directly onto PEO "*success in chosen profession or vocation as evidenced by professional visibility-awards*")
25% **Yes** (2008)
20% **Yes** (2012)

21. Have you mentored others, either inside or outside your organization? Yes, No
(This question maps onto ABET (g)(d)(f) and (j) directly, and to directly onto PEO "*mentoring/outreach services*" and "*Volunteer services*")
75% **Yes** (2008)
20% **Yes** (2012)
This numbers decline (again with the caution of generalizing from a small sample) is worrisome, and was discussed at length at the faculty meeting following the survey.

22. Have you led groups or teams on projects or new initiatives? Yes, No
(This question maps onto ABET (g)(h) and (d) directly, and to directly onto PEO "*entrepreneurial activities*", "*professional visibility*" and "*leadership roles*")
50% **Yes** (2008)
33.3% **Yes** (2012)

23. Have you engaged in any start-up businesses or been involved in any new ventures in your organization? Yes, No, If yes, please describe
(This question maps onto ABET (e) and (h) directly, and to directly onto PEO "*entrepreneurial activities*", "*leadership roles*")
33% **Yes** (2008)
16.6% **Yes** (2012)

24. In the past year, have you attended any workshops, conferences, symposia, etc., related to your profession? Yes, No
(This question maps onto ABET (i) directly, and to directly onto PEO "*professional responsibilities*")
50% **Yes** (2008)
33.3% **Yes** (2012)

25. In the past year, have you taken any classes/courses related to your profession? Yes, No.
(This question maps onto ABET (i) directly, and to directly onto PEO "*professional responsibilities*")

50% **Yes** (2008)
50% **Yes** (2012)

26. In the past year, have you read any books related to your profession? Yes, No
(This question maps onto ABET (i) directly, and to directly onto PEO "*professional responsibilities*")

91% **Yes** (2008)
66.6% **Yes** (2012)
The decline in this number may be due to the confusion between "books" and "ebooks" (or professional blogs such as spectrum.ieee.org/blogs/). We will discuss changing the wording of this question at the faculty retreat in Fall 2012, and poll our BOA for advice.

27. Do you subscribe to any periodicals related to your profession? Yes, No
(This question maps onto ABET (i) directly, and to directly onto PEO "*professional responsibilities*" and indirectly to PEO "*professional society membership*")

75% **Yes** (2008)
16.6% **Yes** (2012)
Again the decline in this number may be due to the confusion between periodicals and web-based materials such as professional blogs (spectrum.ieee.org/blogs/). We will discuss changing the wording of this question at the faculty retreat in Fall 2012, and poll our BOA for advice.

28. Are you a member of any professional societies? IEEE, ACM, SAE, Other (please specify)
(This question maps onto ABET (i) directly, and to directly onto PEO "*professional responsibilities*" and indirectly to PEO "*professional society membership*")

100% IEEE, 40% ACM, 0% SAE, and 10% ASQ (American Society of Quality) (2008)
36.36% IEEE, 27.27% ACM, 0% SAE, and 36.36% other (2012)

29. Have you obtained Professional Engineer certification? Yes, No, If no, are you pursuing PE certification.
(This question maps onto ABET (i) directly, and to directly onto PEO "*professional responsibilities*" and "*satisfaction with the decision to further their career*")

0% **Yes** (2008)
11.1% **Yes** (2012)

30. Have you been involved in any of the following activities?
Public service, Community leadership roles, Volunteer activities, Mentorship and outreach activities
(This question maps onto ABET (f)(i) and (g) directly, and to directly onto PEO "*professional responsibilities*" and "*Volunteer service/outreach activities/public service*")

Public service: 64% **Yes** (2008)
Community leadership roles: 57% **Yes**
Volunteer activities: 57% **Yes**
Mentorship and outreach activities: 61% **Yes**

Public service: 66.6% **Yes** (2012)
Community leadership roles: 55.5% **Yes**
Volunteer activities: 66.67% **Yes**
Mentorship and outreach activities: 50% **Yes**

31. How would you rate the importance of the following items on your career path?
Very satisfied- 5 4 3 2 1- Not satisfied

- **Basic math and science** 71% (**5**), 21% (**4**), 0.0% (**3**), 0% (**2**), 7% (**1**) (2008)
- **… beyond math and science** 28% (**5**), 14% (**4**), 35% (**3**), 14% (**2**), 7% (**1**)
- **Core curriculum in your major** 35% (**5**), 57% (**4**), 7.0% (**3**), 0.0% (**2**), 0.0% (**1**)
- **Technical electives** 64% (**5**), 28% (**4**), 0.0% (**3**), 0.0% (**2**), 7% (**1**)
- **Senior Design Project** 57% (**5**), 21% (**4**), 14% (**3**), 0.0% (**2**), 7% (**1**)

- **Basic math and science** 66.6% (**5**), 11.1% (**4**), 11.1% (**3**), 11.1% (**2**), 0% (**1**) (2012)
- **… beyond math and science** 33.3% (**5**), 55.5% (**4**), 0% (**3**), 11% (**2**), 0% (**1**)
- **Core curriculum in your major** 55.5% (**5**), 22.2% (**4**), 22.2% (**3**), 0.0% (**2**), 0.0% (**1**)
- **Technical electives** 66.6 (**5**), 22.2% (**4**), 11.1% (**3**), 0.0% (**2**), 7% (**1**)
- **Senior Design Project** 55.5% (**5**), 11.1% (**4**), 22.2% (**3**), 0.0% (**2**), 11.1% (**1**)

(Note that this is a subjective measure, hence it is not used as part of our formal ABET study. Nevertheless, this question maps onto ABET (h) indirectly, and to indirectly onto PEO "*satisfaction with the decision to further their education*")

32. How would you rate UCR's effectiveness in preparing you in the following areas?

Very satisfied- 5 4 3 2 1- Not satisfied

- **Basic math and science** 50% (**5**), 43% (**4**), 0.0% (**3**), 7% (**2**), 0% (**1**) (2008)
- **… beyond math and science** 42% (**5**), 50% (**4**), 7.0% (**3**), 14% (**2**), 0% (**1**)
- **Core curriculum in your major** 21% (**5**), 50% (**4**), 28% (**3**), 0.0% (**2**), 0% (**1**)
- **Technical electives** 28% (**5**), 57% (**4**), 14% (**3**), 0.0% (**2**), 0% (**1**)
- **Senior Design Project** 36% (**5**), 36% (**4**), 21% (**3**), 7% (**2**), 0% (**1**)

- **Basic math and science** 44.4% (**5**), 44.4% (**4**), 11.1% (**3**), 0% (**2**), 0% (**1**) (2012)
- **… beyond math and science** 33.3% (**5**), 55.5% (**4**), 11.1% (**3**), 0% (**2**), 0% (**1**)
- **Core curriculum in your major** 44.4% (**5**), 33.3% (**4**), 11.1% (**3**), 11.1% (**2**), 0% (**1**)
- **Technical electives** 44.4% (**5**), 33.3% (**4**), 11.1% (**3**), 11.1% (**2**), 0% (**1**)
- **Senior Design Project** 44.4% (**5**), 33.3% (**4**), 11.1% (**3**), 0% (2), 11.1% (**1**)

(This is a subjective measure, it is not used as part of our formal ABET study. Nevertheless, this question maps onto ABET (h) *indirectly*, and to *indirectly* onto PEO "*satisfaction with the decision to further their education*")

33. If you participated in research as an undergraduate, how much did that contribute to your preparation for further pursuits?

Highly positive - 5 4 3 2 1- Highly Negative

25.0% (2)50.0% (4)25.0% (2)0.0% (0)0.0% (0) (2008)

14.3% (1)42.8% (3)28.6% (2)14.3% (1)0.0% (0) (2012)

(This question onto ABET (d)(e)&(i) directly, and to *indirectly* onto PEO "*success in post-graduation studies*")

34. Our program is designed to enable a Bourns College of Engineering alumnus to be successful either in pursuing a higher degree or in starting a career in engineering or a related field. Based on your experience, what comments do you have on our program and our objectives?

(This is a generic "catch all" question, the answers to which *may* have implications for ABET criteria and PEOs)

(2008) Annotations:

"*It needs to be much, much harder to prepare them for the real world and so employers will value UCR candidates more highly.*"

"*Great experience, has literally given my life a new focus and meaning, I highly recommend.*"

(2012) Annotations:

"*It's as good as it realistically could be. As long as the program care enough to try and improve it will do well*"

This survey was discussed at length by CEN faculty on May 9th 2012. Several issues were identified, and a sub-committee was assigned to investigate these and report on them at the Fall 2012 faculty retreat. These issues are detailed in the minutes of the meeting, which are available for inspection.

Preamble to Sections "4.B Student Outcomes" and "4.C Continuous Improvement"

Before introducing these two sections we take the time to address the following two issues:

1) How does the CEN program evaluate *student outcomes* and *continuous improvement* given that their courses are hosted by two different departments, CSE and EE?

2) More pragmatically, how do we present the two relevant sections in this document?

In fact, as hinted at earlier in this document, the first item is not a significant issue. Recall that in 2007, both the CSE and EE departments decided to *jointly* write a set of PEOs that would cover CS, CEN and EE. Moreover, each of these programs has a process for the revision of PEOs that includes the step of consulting the other programs.

In addition to PEOs, the CEN, CSE and EE programs also heavily consulted with each other when writing their Student Outcomes. Once again, the CEN and EE programs deliberately decided to use the same set of SOs (The CS program uses a *superset* of the CEN outcomes; this need not concern us here).

Thus, as the reader will appreciate, with *identical* Student Outcomes and *identical* Program Education Objectives in EE and CSE, the task of evaluating the *student outcomes* and our efforts at *continuous improvement* are greatly simplified. For example, a professor in EE department, that happens to teach a course hosted by the CSE department and used by the CEN program, could write an email to all EE/CSE/CEN faculty saying: "*the students are underperforming on Student Outcome g and I am worried this will affect our on 'Mentoring / outreach activities' PEO. I think we should...*". This email would be completely understood by all EE/CSE/CEN faculty without the need for re-mapping or "translation".

As for the second issue: While the end-product of evaluating *student outcomes* and *continuous improvement* are identical and commensurate for both the CSE and EE departments, some of the internal details are different. One of the most obvious differences is that the EE department archives their course reports digitally, whereas the CSE department archives the course outcomes on paper[5], using the "ABET Binders" discussed below in great detail.

There are several reasons for these minor differences. Some are simply legacy issues within the departments. Another is that the CSE department also uses a subset of CEN courses as a subset of its CS program (and, for the next ABET cycle, its Business Informatics program). We emphasize again that these are minor internal "bookkeeping" differences, and have no impact on the measurement or interpretation of either the SOs or the continuous improvement process for CEN. Nevertheless, this does present us with a minor difficulty in the presentation of the next two sections. It would be very confusing to the reader to present both internal processes, and, moreover it would significant lengthen this already very long section. We have therefore decided for clarity to present a detailed discussion of the process from the point-of-view of the CSE department, and only present details from the point-of-view of the EE department in the handful of minor cases were they differ. We remind the reader that all supporting files will be available during the site visit (and beforehand, upon request).

[5] The student's scores on the final in CS courses *are* digitally archived to allow analyses and summarization.

B. Student Outcomes

We consider the student outcomes at multiple levels of granularity and at multiple time scales. The core tool we use to do this called the **Student Outcomes Binder**. However over the years it became known colloquially as the **ABET Binder**, and to avoid confusion we will simply use this shorter term below.

The ABET Binder is a physical and logical record of each course offering. The binders for a given quarter are color coded for ease of reference. For example Fall 2011 Binders are yellow etc. They are kept in a secure room, and they are available for inspection by ABET evaluators during sites visits (or at any other time).

The binders are created by the TAs for the offering, under the supervision of the course instructor. The TAs are trained to create the binders in the first two weeks of CS 302 (Apprentice Teaching), which is taught by the ABET coordinator. All TAs must enroll in CS 302 for every quarter in which they TA. In the rare cases in which there is no TA for an offering, the course instructor creates the binder. This situation almost never happens. They only way it can happen is if a class has such a low enrollment that it would normally be canceled, but the Chair decides to offer the class anyway, as a service to the students who need that particular class.

At the end of each quarter, the TAs for each offering must present their binder to the ABET coordinator (currently Dr. Keogh) and have it inspected and "signed off" on. They cannot get credit for CS 302 unless the binder is complete. Thus over the last four years we have had 100% compliance, and the ABET binders form a detailed and carefully annotated archive which we use to assess student outcomes (details below).

The ABET binder contains:

- **Course Information**: This includes the full course syllabus, name of the professor and teaching assistants.
- **Handouts**: A copy of every item *physically* handed from the professor to the students, including notes, hard copies of slides, copies of newspaper articles etc. In some cases these may be non-paper items, such as a "fifteen puzzle" used for *CS170 Introduction to Artificial Intelligence*. For non-physical "objects" such as a suggested URL, the binder either includes the full text/screen dump of the contents of the URL, or in the case of a large resource, just the link and a description of the content.
- **Exams**: A copy of the final exam used in the class, annotated and cross-referenced by its relevance to the student's outcomes (this is described in great detail below). For some offerings, the midterm(s) are also annotated and recorded in this fashion. *The binder also includes a spreadsheet containing the student's performance on the exam at a question by question level.* It is this information that allows us to do a fine-grained assessment of student outcomes. Note that this paper copy is just for backup, the detailed analysis of this data is done electronically.
- **Quizzes**: A copy of every quiz given (if any), together with one annotated example of "A", "B" and "C" quality work handed in by (randomly chosen) students. For quizzes that have a binary score, an annotated example of "Credit" and "No-Credit" are kept. Since in most cases the students quizzes are returned to them as a study aid, the binder contains a *copy*.

- **Project**: A copy of every project assigned (if any), together with one annotated example of "A", "B" and "C" quality work handed in by (randomly chosen) students. If the project involved so much coding that a print-out is not feasible, a CD-Rom or USB stick is included.
- **Homework**: A copy of every homework assigned (if any), together with one annotated example of "A", "B" and "C" quality work handed in by (randomly chosen) students.
- **Labs**: A copy of every lab assigned (if any), together with one annotated example of "A", "B" and "C" quality work handed in by (randomly chosen) students.
- **Special notes**: This section is optional, but can be used to make note of any unusual occurrences during the quarter. For example "*Midterm was canceled due to flooding, grade weight on final was increased to 30%*", or "*Dr. Smith had medical problems in week 6 and, Dr. Keogh finished teaching the class*" etc.

The ABET binders form a tangible, permanent and easy to understand record of every course offering. Faculty members teaching a class for the first time are encouraged to view the relevant binders from previous offerings. When discussing possible changes to a course at a faculty meeting, the relevant binders are brought to the faculty meetings for reference.

Minor difference in EE hosted Courses:

The above section, written from the perspective of the CSE department also largely reflects the process of the EE department. There are a few minor differences.

- The courses hosted by the CSE department use the *physical* binders as discussed above. The courses hosted by the EE department use *digital* course folders, which contain essentially identical information. The CEN faculty examines *both* as part of their continuous improvement process (as discussed below). As noted above, these course reports are designed to consistent and commensurate across both departments.
- For the quantitative analysis of Student Outcomes (discussed in the next section) there is a minor difference in the philosophy of mapping course objectives to student outcomes. As shown in the sample in Table 17 the CSE department maps all course objectives to *any* student outcomes it feels are covered by that outcome. In contrast, EE department the program decided to focus on the top 2-3 most closely related outcomes in each lecture courses. The reasoning behind this decision was based on the fact that although some outcomes may be somewhat related, it is hard to directly measure more than 2-3 outcomes in most courses.
- For courses hosted by the CSE department, the measurement of the Student Outcomes is confined to the final (or the final *project*, if there is no traditional final). Courses hosted by the EE departments may use other instruments (e.g., homework problems, quizzes, exam questions, projects), and may use one instrument for one outcome, and another instrument for a different outcome.
- For courses hosted by the EE department, the mapping from course objectives to Student Outcomes is done a binary scale. However the CSE department hosted courses use a 0-to-3 scale. As we explain in the next section, the quantitative analysis algorithms normalize away these differences and are invariant to these choices.

4.B.1 Quantitative Analysis of Student Outcomes

The CEN programs continuous improvement process attempts to optimize two goals. The first is performance on the *course objectives*, which specify the concepts that a specific course strives to teach its students. For example, the introductory CS10 course has "*Use variable to store computer program data*" as one of its course objectives. The second goal is to optimize the performance on the higher level Student Outcomes. The relationships between the course objectives and the Student Outcomes are critical in our assessment process, and have been the subject of significant discussion and adjustment over the years. Although the department largely converged on these mappings by 2005/06, we occasionally revisit the mappings during course revisions and as part of the process for revision of the Program Educational Objectives (c.f. Section 2.E)

While *all* these course objectives, with their mapping to our Student Outcomes, are detailed in Appendix A, below we show a random representative example for concreteness. In Table 17 we show the mapping of course objectives to student outcomes for CS 153: *Design of Operating Systems*.

Table 17: Course Objectives with Mapping to Student Outcomes for CS 153

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Study basic principles underlying the design of operating systems with a focus on principles and mechanisms used throughout the design	1	0	1	0	1	0	0	0	0	0	3
An understanding of CPU scheduling storage management: memory management virtual memory and file systems	1	0	0	0	0	0	0	0	0	0	3
Study of concurrency control and synchronization classical algorithms for synchronization and concurrency management	1	0	1	0	0	0	0	0	0	0	3
Study Deadlocks Devices device management and I/O systems	1	0	0	0	0	0	0	0	0	0	3
Study dynamic binding	0	0	0	0	0	0	0	0	0	0	3
An understanding of protection access control and security	1	0	0	0	0	1	0	1	0	0	3
Improve skills in concurrent programming and introduce kernel programming	3	2	0	0	0	0	0	0	0	0	3

The last major revision of these mapping happened in 2006/07, using the following process. For each course, a committee was formed consisting of everyone that had ever taught the course, everyone that *might* teach it in the future (i.e., new hires in that area) and any interested party. The committee drafted the mapping, after viewing the previous syllabi, teaching materials, and examples of graded instruments (exams/quizzes/homeworks/projects). The draft mappings were presented and discussed at several faculty meetings in the fall of 2005 and voted on by the full faculty.

Below we provide a detailed work explanation of how we analyze the student's achievements on the final (and sometimes, *midterm*) for both *coverage* and *performance* on course objectives.

- *Coverage* measures the extent to which we are teaching and testing the course objectives.
- *Performance* measures the student's knowledge of the course objectives.

Note that our decision to measure these metrics on only the final (and sometimes, *midterm*) exam was a conscious choice made at the faculty retreat in fall 2007. The final and midterm exams are

always conducted in a controlled environment under the professor's direct supervision, with 100% attendance, and thus avoid the difficulty of confounding factors such as absent students (quizzes), or students cheating (homeworks) etc.

In the table below, the term course objective has been shortened to *objective*, and the term Student Outcome has been shortened to *outcome*. Table 18 shows a running example we will use to explain our process. The student outcomes are shown as **A**, **B**, & **C** in the table.

Table 18: A worked example of how we determine *coverage* and *performance* on course objectives and student outcomes.

Exam Scores	Q1	Q2
John Doe	1	1
Jane Smith	0	1
Normalized Question Performance	0.5	1

Question-To-Objective	Q1	Q2		Objective Performance	Objective Coverage
Objective 1	3	3		0.75	1
Objective 2	0	3		1	0.5

Objective-To-Outcome	**A**	**B**	**C**
Objective 1	3	3	3
Objective 2	0	0	0
Outcome Performance	0.75	0.75	0.75
Outcome Coverage	0.5	0.5	0.5

The numbers in white cells are entered by faculty for each course offering; whereas all the numbers in gray cells are calculated (by automatic scripts) as part of our evaluation process, two weeks after finals week.

The performance data here is being calculated from two students' scores on a single, two-question exam, as seen in the "Exam Scores" table. In our running example, John Doe answered two questions perfectly (1 out of 1 on both questions), whereas Jane Smith got zero credit on the first question, but aced the second question.

The "Question-To-Objective" table gives a weight to each objective-question pair, which states how related the question subject is to the objective. These weights are determined and recorded by the course instructor, as he/she writes the exam.

The "Objective-To-Outcome" table gives a weight (i.e. mapping) to each objective–outcome pair. Recall (as discussed above) these weights are relatively static, and have been essentially unchanged for 5 years. This is important, since it allows us (with appropriate statistical caution) to compare offerings of the same course offered in different quarters, and to plot and consider trends.

We wish to calculate how well a course covers its own objectives as well as the student outcomes. We also calculate how well students of the course perform with respect to each objective/outcome. The steps to produce the derived data are as follows.

1. **Normalized Question Performance**: Each question's score is normalized by dividing it by the maximum possible number of points for that question. Then the average score across students is found for each exam question. In the example above, in the "Exam Scores" table, the max question point value possible is 1.

2. **Objective Performance**: The relevance of each exam question to each class objective is given as input, as seen in the "Question-To-Objective". To determine the performance of an objective we first multiply the Normalized Question Performance of a question by the objective-to-question weight for that objective, for each exam question. We then divide the sum of the sum of the objective-to-question weights for that objective. Table 19 shows an example of how this formula is used for the running example. Note that the performance for objective 2 is perfect since question 1, which had imperfect performance, is not relevant to objective 2 and thus not used in its calculation. Thus, if the faculty reviewed this data they would be happy to discover perfect performance on Objective 1, but would worry about the relatively poor performance on Objective 2.

Table 19: The Calculation of the Objective Performance

Exam Scores	Q1	Q2
Normalized Question Performance	0.5	1

Question-To-Objective	Q1	Q2		Objective Performance
Objective 1	3	3		[(0.5*3) + (1*3)] / (3+3) = 0.75
Objective 2	0	3		[(1*3) + (1*3)] / (0+3) = 1

3. **Objective Coverage**: Knowing the *performance* on the course objectives is of little use without an understanding of the *coverage*. If nothing else, with very low coverage, the performance results are likely to be unreliable. To determine the coverage of an objective we first sum the question-to-objective weights for that objective. We then divide by the maximum possible coverage value, which is the number of questions multiplied by the max possible weight, which in this example is 3. Table 20 shows the relevant calculations for our running example.

Table 20: The Calculation of the Objective Coverage

Question-To-Objective	Q1	Q2		Objective Coverage
Objective 1	3	3		(3+3) / (2*3) = 1
Objective 2	0	3		(0+3) / (2*3) = 0.5

4. **Outcome Performance**: To determine the performance of an outcome, we first multiple each objective's performance value by its objective-to-outcome weight for that outcome, and sum over all objectives. We then divide by the maxium possible achievable value, which is just the sum of all of the objective-to-outcome weights for that outcome. Table 21 shows an example of this calculation. Note that since only objective 1 relates to each outcome (**A**, **B**, **C**), the outcome performance draws only upon objective 1's performance, and thus are all the same.

Table 21: The Calculation of the Outcome Performance

Question-To-Objective	Objective Performance
Objective 1	0.75
Objective 2	1

Objective-To-Outcome	A	B	C
Objective 1	3	3	3
Objective 2	0	0	0
Outcome Performance	[(0.75*3) + (1*0)] / (3+0) = 0.75	0.75	0.75

5. **Objective Coverage**: To determine the coverage of an outcome, we first multiply each objective's coverage value by its objective-to-outcome weight for that outcome, and sum over all objectives. We then divide by the maximum possible coverage value, which is the number of objectives multiplied by the max possible weight, which in this example is 3. In Table 22 each outcome is fully covered by objective 1, which is in turn fully covered on each question. However since each outcome is missing coverage by objective 2, their final coverage is only 0.5.

Table 22: The Calculation of the Objective Coverage

Question-To-Objective	Objective Coverage
Objective 1	1
Objective 2	0.5

Objective-To-Outcome	A	B	C
Objective 1	3	3	3
Objective 2	0	0	0
Outcome Coverage	[(1*3) + (0.5*0)] / (3*2) = 0.5	0.5	0.5

6. **Multiple Exams**: Our method can also handle the case of multiple exams. The summation of values is taken over all exams and then metrics are computed, rather than metrics being computed per exam and then averaged by number of exams. Below you can see a simple example with one student, one question, and two exams. The "*Exam 'x' Objective Performance*" tables show the performance metric for each exam individually. The "False Objective 1 Performance" table shows the result if the per-exam values are simply averaged. The problem with this is that the relative weight of the question-to-objective is lost between the same objective across exams. The "*Actual Objective 1 Performance*" shows the correct way to calculate across exams, where the summations are carried out across exams, and the objective-to-question weighting is preserved.

Table 23: Combining Results of Two Exams

Exam 1	Q1		
John Doe	0		
			Exam 1 Objective Performance
Objective 1	1		(0*1) / 1 = 0

Exam 2	Q1		
John Doe	1		
			Exam 2 Objective Performance
Objective 1	3		(1*3) / 3 = 1

ABET **Course** Metric

False Objective 1 Performance
(0 + 1) / 2 = 0 .5

Actual Objective 1 Performance
(0*1 + 1*3) / (1+3) = 0 .75

7. **Zero Coverage Case**: Using the objective/outcome performance calculation given before would give you a value of 0 performance if the coverage was also 0. The problem is that in this case, because the objective did not relate to any questions, we do not have any information as to how the students would perform on that objective. We handle this as a special case, as indicated by the -1 performance value for objective 1 seen below. When summing the product of each objective performance / objective-to-outcome pair to find outcome performance, we ignore any objectives which have -1 performance. The outcome's performance, just like objective performance, is given a -1 if that outcome's coverage is 0.

Table 24: How the Pathological Zero Coverage Case is Handled

Question-To-Objective	Q1	Q2		Objective Performance	Objective Coverage
Objective 1	3	3		xxx	1
Objective 2	0	3		-1	0

Objective-To-Outcome	**A**	**B**	**D**
Objective 1	3	0	0
Objective 2	3	0	3
Outcome Performance	xxx	-1	-1
Outcome Coverage	0.5	0	0

This section has been very long and technical. However the reader is now in a position to appreciate the following section, where we show how we use these formulas to produce intuitive visual summaries of student outcomes at multiple granularities, in order to support and direct our efforts in continuous improvement.

4.B.1.a Course Reports

Using the analytical algorithms discussed in the previous section, for *every* quarter, for *all* course offerings, we produce a visual report summarizing the *coverage* and *performance* on the course outcomes, together with the *coverage* and *performance* on the PEOs. Figure 15 shows a randomly chosen example.

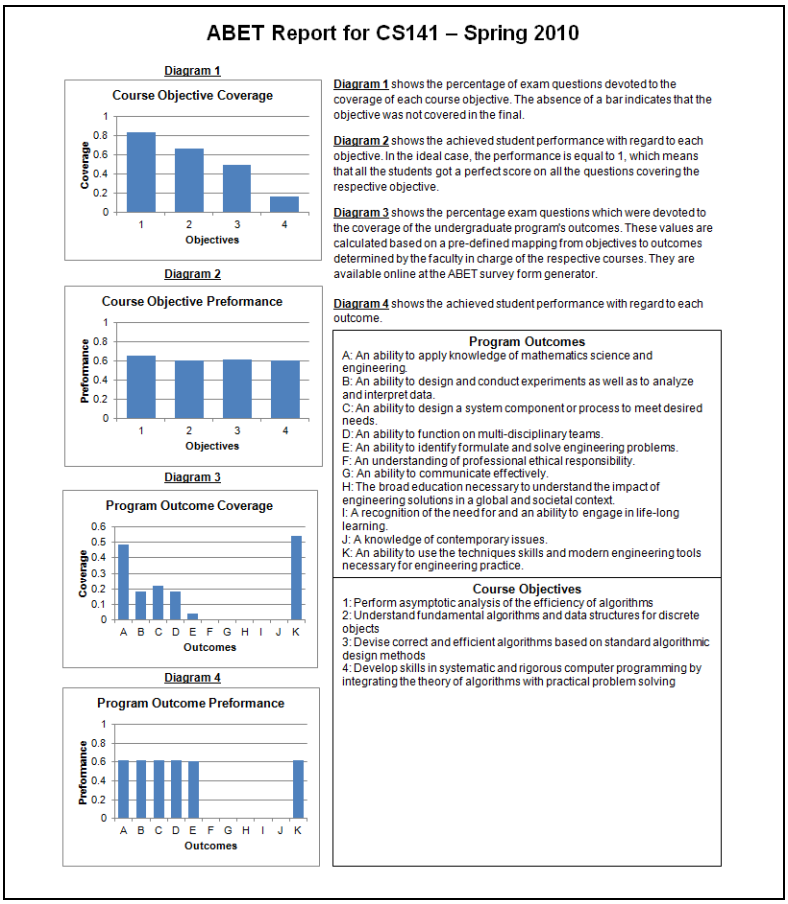


Figure 15: A Sample Course Report, from the spring 2010 offering of CS141: *Intermediate Data Structures and Algorithms*

This report is produced within a week of the final grades being submitted, and is then sent to the course instructor, who compares it with the reports from previous offerings. The course instructor is encouraged to annotate the report. For example, a recent report was annotated: "*The earlier introduction to the Relational Model does seem to have had the desired effect, however, the student's performance on query evaluation and the internals of query optimization seems to have stalled...* ". The annotated reports are archived with the ABET binders (C.F Section 4.B), and are discussed at faculty meetings, and at the annual faculty retreat.

More critically, an instructor teaching an offering of a course is required to view the course report for at least the most recent offering (*all* reports are available if desired) and to contact the previous instructor (if a different person) to be briefed on the course. It is this step that is codified in Step 1 of Table 15, *Data Collection for Course Assessment*.

4.B.1.a Course Difference Reports

The course reports shown in the previous section allow the instructor an intuitive review of the coverage and performance on course objectives. Suppose an instructor spots an area of concern, perhaps the course is not covering an objective adequately (alternatively, an objective is being *taught*, but not adequately *tested*), or an objective is being covered, but the students are testing poorly on it. As shown in the "inner loop" of Table 15, the instructor in consultation with his/her colleagues that have experience/interest in teaching the class, and the undergraduate instruction committee, will attempt to find a remedy for the next course offering. How can we tell if that remedy is successful? For this purpose we generate a special *course difference report*, which uses the formula introduced in Section 4.B.1 to produce a side-by-side comparison of two offerings. Figure 16 shows an example of such a report, contrasting the Winter/Spring 2010 offerings of *CS010: Introduction to Computer Science*.

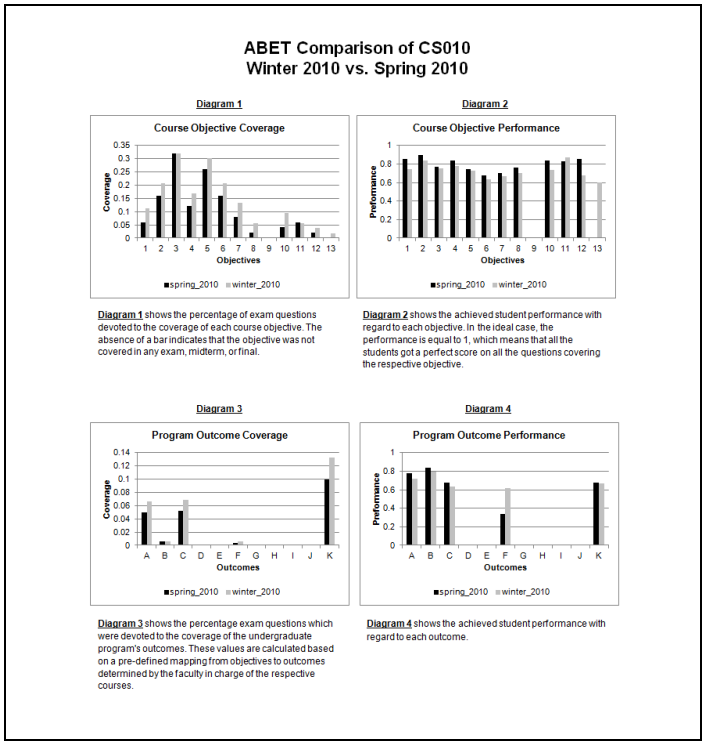


Figure 16: A Sample Course Difference Report

The courses in question were taught by Kris Miller. Below are his unedited notes on this course difference report:

> *One reason I believe scores for almost all course objectives went up in Spring 2010 versus Winter 2010 is that we switched from teaching the students to use the editor emacs to the IDE Code::Blocks starting with the Spring 2010 quarter. Brian, Victor, and I had actually been discussing this change for several quarters. We saw that students struggled mightily with tool shock the first couple of weeks. Many students in fact never really became comfortable with emacs. We felt that if we could find a program editor that more closely resembled the types of text editors students were used to coming from a Windows background this would reduce some of the tool shock, allowing the students to more quickly focus on the programming concepts rather than the programming tools.*

The TAs reported after the first week of labs that they noticed the students were definitely struggling less with the programming tools and the course reports appear to support the case that this had a beneficial effect on the entire quarter.

Note that the detailed information captured in the course reports and course difference reports is useless unless it is examined and acted on. As hinted at in Figure 17 the *entire* faculty does examine these reports, together with the contents of the ABET binder, at faculty meetings.

Figure 17: ABET course reports are regularly examined at faculty meetings when discussing undergraduate education, curriculum changes, effectiveness of teaching (for promotion and tenure cases) etc.

Expected level of attainment for achievement of all Student Outcomes

The CEN Steering Committee has decided on an expected level of attainment for achievement of all Student Outcomes to be 70%. The rational for this number is:

- The attainment numbers will invariably include students that choose to quit the major. As these are generally the poorest performing students, they are "*pulling down*" the averages. Thus the attainments numbers we see in our reports are in essence lower bounds for the students that actually graduate.
- The ABET committee has consulted with other UC campuses with similar programs, and our chosen value is not significantly different from theirs.
- Dr. Keogh has done significant data analyses on the amount of uncertainly in our measurement system (and how to reduce it). For example he has extensively studied the variance in attainments when everything else is fixed (Same instructor, same course, approximately same class size, same exam questions (with values changed and other anti-cheating devices)). Given the amount of inevitable uncertainly in our measurement system, a threshold higher than 75% is very likely to produce many Type II errors (we appear to miss our attainment goals, but we actually are meeting them). Our 70% goal, is much less likely to produce such errors, but still holds us to a high level of attainment.

We revisit these expected levels of attainment for achievement at least once a year, the last occasion they were discussed was May 23th 2012.

In Table 25 we show the results of aggregating the *coverage* of student outcomes at a quarter by quarter level. In the upper table we show a binary table, which simply tells us if each student outcome was covered or not in a particular quarter. Note that in most quarters all outcomes are covered, but it is possible that in a given quarter we may not cover all outcomes, depending on the courses offered that quarter. In the lower table we show the *relative* coverage (that is to say, the columns sum to one).

Table 25: The Student Outcomes Coverage Aggregated for each Quarter

Binary Outcome Coverage

	Win 2010	Spr 2010	Fall 2010	Win 2011	Spr 2011	Fall 2011
a	1	1	1	1	1	1
b	1	1	1	1	1	1
c	1	1	1	1	1	1
d	0	1	1	1	1	0
e	1	1	1	1	1	1
f	1	1	1	1	1	1
g	1	1	1	1	1	0
h	0	1	1	1	1	0
i	0	1	1	1	1	0
j	0	1	1	1	1	0
k	1	1	1	1	1	1

Normalized Outcome Coverage

a	0.27	0.20	0.17	0.17	0.24	0.23
b	0.07	0.05	0.10	0.10	0.05	0.13
c	0.11	0.08	0.12	0.12	0.09	0.17
d	0.00	0.17	0.16	0.16	0.06	0.00
e	0.06	0.03	0.05	0.05	0.05	0.14
f	0.02	0.03	0.02	0.02	0.02	0.01
g	0.03	0.01	0.00	0.00	0.03	0.00
h	0.00	0.06	0.04	0.04	0.01	0.00
i	0.00	0.02	0.05	0.05	0.03	0.00
j	0.00	0.05	0.04	0.04	0.04	0.00
k	0.44	0.29	0.24	0.24	0.37	0.32

This table was last shown to the faculty on May 2nd 2012. The faculty noted that relatively sparse *coverage* of some outcomes (i.e. *g*, *h*, *j*) makes the determination of performance of the outcomes (see below) more difficult. It was decided that the ABET committee and the undergraduate education committee investigate the issue and report to faculty at the Faculty retreat in Fall 2012.

In Table 26 we show the results of aggregating the *performance* of student outcomes at a quarter by quarter level. Note the handful of missing entries correspond to outcomes that were not tested in that quarter (at least by an instrument that was recorded in our system, the outcomes were almost certainly measured by other instruments used to determine the students grade).

Table 26: The Student Outcomes Performance Aggregated for each Quarter

Outcome Performance

	Win 2010	Spr 2010	Fall 2010	Win 2011	Spr 2011	Fall 2011
a	0.62	0.64	0.69	0.69	0.69	0.72
b	0.51	0.63	0.71	0.71	0.68	0.67
c	0.58	0.69	0.70	0.70	0.67	0.74
d	0.00	0.62	0.75	0.75	0.75	
e	0.58	0.69	0.67	0.67	0.56	0.63
f	0.55	0.64	0.75	0.75	0.61	0.89
g	0.41	0.66	0.78	0.78	0.46	
h		0.81	0.55	0.55	0.59	
i		0.96	0.54	0.54	0.70	
j		0.80	0.63	0.63	0.63	
k	0.62	0.63	0.69	0.69	0.68	0.72

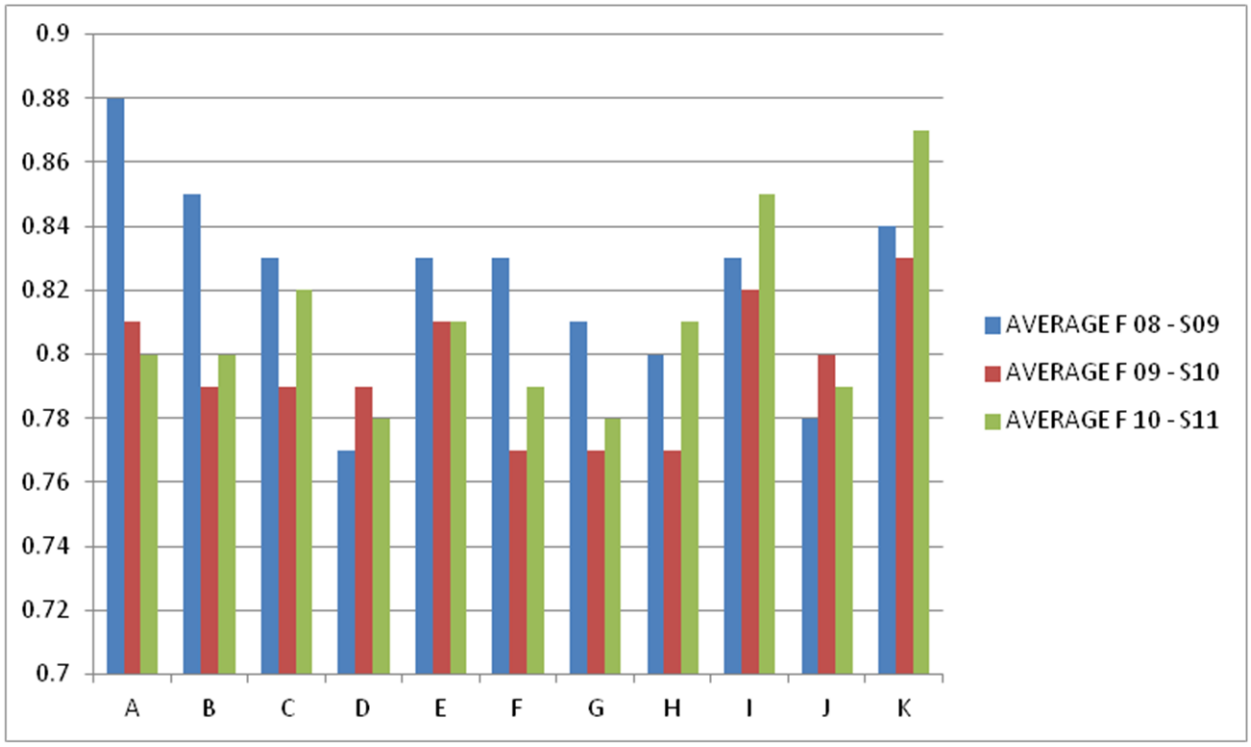
Max Outcome Performance

a	0.79	0.96	0.82	0.82	0.85	0.78
b	0.79	0.96	0.83	0.83	0.85	0.73
c	0.71	0.96	0.82	0.82	0.84	0.83
d	0.00	0.62	0.75	0.75	0.75	
e	0.73	0.96	0.81	0.81	0.78	0.63
f	0.62	0.80	0.78	0.78	0.85	0.89
g	0.41	0.66	0.78	0.78	0.68	
h		0.96	0.57	0.57	0.59	
i		0.96	0.54	0.54	0.70	
j		0.96	0.78	0.78	0.63	0.00
k	0.79	0.96	0.81	0.81	0.85	0.81

As noted above, we examine the Student Outcome data in multiple granularities and in multiple ways. Below we show an example of this.

In Table 27 we consider the Student Outcomes performance aggregated for each AY from 08/09 to 10/11, for *just* the courses hosted by the EE department. Our ability to "*slice and dice*" the data by instructor, by quarter, by year, by hosting department and by Student Outcomes, allows us to spot potential problems and test the effect of curriculum or instructional changes.

Table 27: The Student Outcomes Performance Aggregated for each AY from 08/09 to 10/11, for just the courses hosted by the EE department



In the next section we give numerous examples of *continuous improvement*. Note that most of these examples were driven by a need noted in the course reports (among other methods), and almost all improvements are measured by changes in the outcomes in the course reports (among other ways).

Note that for clarity of presentation here we have omitted values or graphics that show the *variance* of these measurements. However as scientists we recognize the importance of consider variance while assessing the potential significance of any apparent changes in performance. This extra information is available and considered at every step.

C. Continuous Improvement

Without claiming to be exhaustive, below we list some *representative* examples of how the results of evaluation processes for the program educational objectives and the student outcomes and other available information have been used as input in the continuous improvement of the program.

Note that many of these changes are rather small; we feel that we had converged on an excellent program by 2006. Nevertheless the faculty is encouraged to, and rewarded for, fine-tuning any aspect of the curriculum.

Improvements to AI offerings based on discussions with constituents (Outer Loop, Table 15)

In 2011/2012, we significantly restructured our artificial intelligence offerings. Our inspiration to do so came from a variety of sources. The most significant of these were meetings between the two faculty most responsible for AI (Dr. Shelton and Dr. Keogh), meetings with the Board of Advisors, and Dr. Keogh's meetings with several student employers, including Microsoft, ESRI and ISCA technologies (each of these companies have hired at least four of our students in the last five years). Moreover, Dr. Shelton spoke at length with instructors at other UC campuses about their experiences with undergraduate AI courses. Finally, Dr. Keogh interviewed several alumni who had taken CS 170: Intro to AI with him, and had gone on to work in a position that might reasonably use these skills (including Shruti Kasetty, Microsoft, Isaac Espinoz, PricewaterhouseCoopers etc).

Our findings from these constituents included:

- **Need**: We needed to offer an *information retrieval* course, as a very significant fraction of our students end up working in a related field (text retrieval at Microsoft Bing, Spatiotemporal information retrieval at ESRI, multimedia retrieval at ISCA technologies etc.) **Action**: We designed a new course (cf. Section 6.E), CS 172: *Introduction to Information Retrieval*. Moreover, when making hiring decisions in the 2010/11 cycle, the need for an instructor for this course was weighted. While (at least) Dr. Shelton, Dr. Keogh and Dr. Tsotras can teach this class, it was felt it would be good to have a specialist help develop the curriculum, and teach the first offering. **Result**: In fact, we did hire Dr. Hristidis, an information retrieval specialist, and he did lead the charge in developing the curriculum, and he is teaching the first offering in spring 2012.

- **Need**: Our BOA questioned the need for us to have CS 171: *Introduction to Expert Systems* on the books, as this is now seen as a dated and unused technology, and many of its applications have been subsumed into other areas (Bayesian Networks etc). As it happens, that course had not been offered in over a decade. **Action**: In winter 2010, a committee of AI professors met to discuss this, and they proposed to the faculty that this course be removed from the curriculum. This was unanimously approved by the faculty.

- **Need**: Our BOA and (some of) our employers suggested that our AI class focus less on "classic AI" (search, logic, constraint satisfaction etc), and more on modern statistical/probabilistic learning techniques, as these are more pragmatic skills for companies such as Facebook, Microsoft etc. However, the faculty felt that the "classic AI" material was important to keep because it offered an opportunity for projects where students could both gain significant experience in coding, and formally prove certain

properties of their programs (completeness, optimality etc). **Action**: We restructured the course offerings. Beginning in 2012/2013, CS 170 will be a "classic AI" course on search, logic, constraint satisfaction, and the like. CS 171 will be a "machine learning / data mining" course that will consider statistical/probabilistic learning techniques. We feel these changes update the curriculum to a more modern standard and allow better coverage of the relevant topics. **Result**: As we roll out the first offerings of these courses in 2012/2013 a committee consisting of Dr. Shelton, Dr. Keogh, Dr. Hristidis, and Dr. Tsotras will carefully evaluate the effects of these changes, both by using the classic measure of our course reports, and by more explicit surveying of the students that take the classes.

Improvements to CS180 based on viewing course reports (Inner Loop, Table 15)

In winter 2010 Dr. Neamtiu taught CS 180: *Introduction to Software Engineering*. The course report for the offering is shown in Figure 18.

Notes: This is necessarily a low-resolution view of the course report. The original high resolution version, together with all the original raw data is available for inspection.

This report only reflects the course final, which was not cumulative. The midterm *does* reflect coverage on course objective 3. Nevertheless, based on a review of this report with the undergrad committee Dr. Neamtiu has decided that future offerings will have a cumulative exam, in order to allow a more meaningful comparison between different offerings of the class.

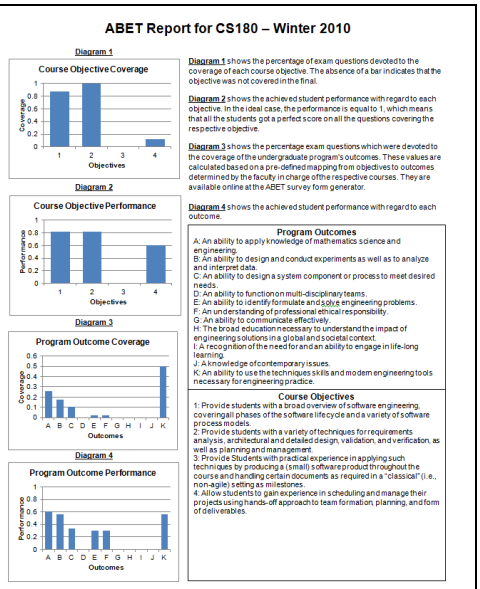


Figure 18: The Course Report for CS180-Winter 2010

Dr. Neamtiu noted several things from the course report which prompted him to make changes.

- **Need**: First, he noted that we were poorly assessing how well the students understand the ethics of software engineering and the societal implications of software errors. Moreover, from what little assessment we were doing the students' performance was lacking. **Action**: Dr. Neamtiu added contents to the lecture material to illustrate the consequence of software-induced disasters: the explosion of the Ariane 5 rocket, the 2003 Northeastern Blackout, the Marc Climate Orbiter explosion, avionics software. Also he added the following essay-like question on the final exam: "*In engineering disciplines such as civil engineering, a product (e.g., bridge) failure might lead to the product designers and makers being prosecuted. However, in software engineering, product designers and makers are not only not held responsible, but the product itself usually comes with no warranty whatsoever, even though, as illustrated in class, software failures puts lives and livelihoods at risk. Why do you think software*

engineering is held to a lower responsibility standard than other engineering disciplines?".

- **Need**: As per Course Objective #3, practical experience in building a small software product and handling documents in a milestone-setting is deemed important. Moreover, at the department's Board of Advisors meeting in March 2010, leaders from industry, e.g., Yahoo! Research have noted that one of the best improvements we can make to our students' preparation was to turn them into *software engineers*, rather than *programmers*. Briefly, the difference between the two categories is that programming essentially an individual activity, whereas software engineering involved multi-person construction of multi-version software. **Action**: In CS 180, for the project part of the course, Dr. Neamtiu has moved to an approach that emphasized flexibility in team formation and implementation strategy, while adhering to strict documentation and schedule guidelines; this approach has the role of exposing students to realistic software development practices, as well as issues and solution that appear in the development of large projects in a multi-person team (this also addresses Course Objective #4). Moreover, projects change each quarter and topics are highly relevant to what students will work on after graduation. For example, recent team projects included implementing "lite" versions of LinkedIn, Facebook, YouTube, Twitter. Other projects involved developing Android and iPhone applications for augmented reality and time management. Finally, students have to construct their project in a succession of two milestones, to simulate the incremental delivery approach standard in real-world development. Projects are graded on requirement completion as well as documentation and a project demo presentation. **Result**: The approach has already started to bear fruit. Apart from observing numerical improvement on course reports, Dr. Neamtiu has personally followed up by contacting both alumni, finding that they indicate they have been able to find jobs and internships based on the large, team-oriented, highly-relevant-to-employers project in the class, and student employers, who report increased satisfaction with our students' performance.

Improvements to CS111 based on viewing course reports (Inner Loop, Table 15)

Dr. Chrobak frequently teaches *CS111: Discrete Structures*. A sample report for a recent offering of this course is shown in Figure 19.

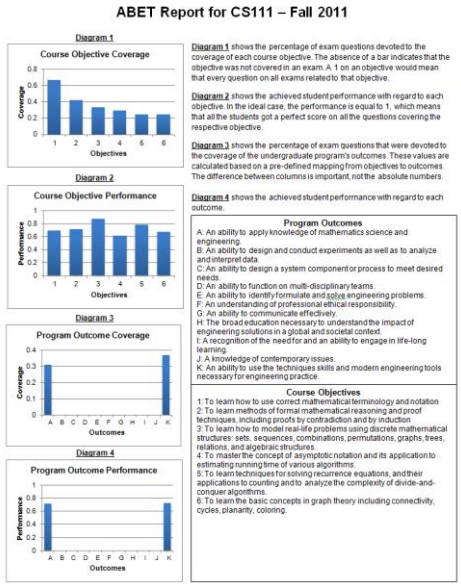
Notes: This is necessarily a low-resolution view of the course report. The original high resolution version, together with all the original raw data is available for inspection.	

Figure 19: The Course Report for CS111-Winter 2010

Dr. Chrobak noted several things from the course reports which prompted him to make changes to the course.

- **Need**: Dr. Chrobak noticed that students were scoring relatively poorly on outcome 1, his annotation of course reports included text such as "*I noticed that many students, even those with solid understanding of the material, had difficulty presenting their solutions in a clear and rigorous fashion.*". **Action**: After discussion with the other faculty that teach this course, and with the undergraduate education committee, Dr. Chrobak took action to address this problem: "*To address this, I introduced several changes to the way CS111 is taught. I provide students with strict guidelines for preparing homework assignments. At the beginning of the course students are required to read several articles on writing mathematical text. In lecture, I put more emphasis on rigorous formulations and reasoning. For example, when presenting Kuratowski's theorem "*A graph is planar if and only if it does not contain a subgraph that is a sub-division of K5 or K3,3*", I would discuss common mistakes, like replacing "*if and only if*" by "*if*" or by "*only if*" weakens the statement, or why writing "*does not contain K5 or K3,3*" (that is, omitting the sub-division part) makes the statement incorrect. Questions to formally state definitions or theorems are now included on tests.*" The results in the most recent offering of the course, are shown in Figure 21 and they strongly suggest that this process is helpful, the outcome 1 scores have risen to be on par with other outcomes.
- **Need**: Dr. Chrobak made changes the syllabus for CS111 to address students' difficulties with the material (after consulting the entire faculty, at a faculty meeting in winter 2010). In earlier offerings of CS111, we covered *generating functions*. That topic caused

significant difficulties for the students, partly because it requires solid background in calculus. Dr. Chrobak consulted with our BOA and several employers who note that *generating functions* are of limited educational value to students that major in computer science or computer engineering. **Action**: In more recent offerings of CS111 we now instead cover *counting integer partitions*, a topic that is mathematically equally sophisticated, but does not require background outside of discrete mathematics, and is more relevant to mathematical problems students are likely to encounter in their future study.

Improvements to curriculum based on alumni surveys (Outer Loop, Table 15)

Dr. Zordan was, until 2010, the only faculty in computer graphics, and as such anxious to improve the graphics part of our curriculum. He combed over the 2009 alumni survey, visited employers of our students with an interest in graphics (Dreamworks, Sony, THQ, and Electronic Arts.) and did personal one-on-one phone follow up interviews with alumni. Based on these efforts, he noted:

- **Need**: Students interested in video games and graphics as freshmen had no way to pursue their interest until their junior to senior year because there was a long list of requirements before they could take CS130 *Intro to graphics*. Many students seemed discouraged and unsure of their choice to invest several years in a discipline they saw as only peripherally related to their interests. **Action**: Dr. Zordan led the charge in modifying the curriculum to add CS66 *Introduction to Three-Dimensional Digital Modeling* and CS67 *Three-Dimensional Digital Modeling and Animation*, as courses with no prerequisites that teach both about the topic and software as well as programming via a games industry scripting language. These courses are in their first complete run this academic year (11-12) so there are no hard measurements, but we will track to see if these students appear to yield higher retention rates over the average. We anticipate this as a result of their satisfaction and engagement in taking such courses earlier in their undergraduate experience. Anecdotal evidence shows that students appear more confident and satisfied after taking CS66. Their confidence is both in their choice of studies (computer science as a discipline that leads to pursuits in computer game development) as well as their sense of proficiency and experience in their field of choice (as programmers and masters of a suite of software that is used ubiquitously in the game industry).

Improvements to CS120B based on viewing course reports (Inner Loop, Table 15)

Dr. Frank Vahid frequently teaches CS120B Introduction to Embedded Systems. Note that this course is listed as EE/CE 120B and is co-taught by EE and CS. This course has lab involving hardware (breadboards, chips, components, wiring, troubleshooting tools) and software (C programming, compilation/debug tools, downloading).

- **Need**: based on a careful analysis of the course reports, and interviews with the students, Dr. Valid noted that on the midterm and homework, students from EE did very well on hardware questions, but less well on software questions, and the opposite was true for students from CE. Afraid that this observation might have been a fluke, Dr. Valid asked other faculty that teach this course, including Dr. Najjar (CE) and Dr. Zhu (EE) to test to see if this was true in their offerings. They confirmed the finding, anecdotally at first, and then numerically using the course reports. Together they hypothesized the following cause: Students work in pairs and share a hardware lab kit that they purchase, as well as a

lab PC, as is standard in most universities offering embedded systems courses. However, a drawback of this approach that was observed was that commonly one partner (typically an EE student) would do most of the hardware work and the other partner (typically a CS student) all of the software work, leading to an imbalanced learning experience.

Action: Dr Vahid tried several methods to encourage all students to learn both HW and SW elements, such as practical exams. However, this had limited success (as measured by course reports), were hard to manage and anecdotally seem stressful for students. Dr. Vahid takes up the story in a report he wrote as a briefing to the faculty...

For Winter 2012, we decided to try the approach of requiring every student to have their own lab kit (which is more feasible than 5 years ago due to dropping costs for the kits). Thus, in Fall 2011, we spent about 100 hours upgrading the lab materials with detailed explanations, extensive photographs, and some videos, so that CS people could be successful with learning the hardware kit, and EE people successful with learning the software tools. Then, with each student having their own kit, we had students rotate partners for the first 5 weeks of the course. For the last 5 weeks they could choose their partner. For the final project, each partner did his/her own project, but then 15% of the grade was based on their partner's project and interaction, striking a balance between each student learning independently, and students getting help from a partner and learning to work together. The approach was a success, with students doing equally well on their lab assignments and final projects (as measured by the course reports) even though working more independently and having to learn both hw and sw. Thus we are continuing the one-lab-kit-per-student approach this quarter and will do so from now on. I observed that students were having difficulty on the midterm exam capturing synchronous state machines to specify desired embedded systems program behavior. I also noted that students usually did significantly better on concepts that were done on a homework. The problem with the synch SM concept though is that, even though students did them on homeworks, there was no quick way of them knowing if they got the problem right or wrong (in contrast to other types of problems), and students rarely spend time poring over a solution to compare their answer. I also noted that, although we were teaching this disciplined synchSM method in lectures, students in the lab projects would commonly ignore the method and use ad hoc methods (as is done in most universities) -- I believed that more practice in the synch SM methods and perhaps tools to ease use of the method might remedy the issue. Thus, a colleague of mine at UCI and I decided that students needed a "virtual lab" tool that would capture synch SMs and allow for their simulation. We wrote a proposal to NSF's CCLI program (Course, Curriculum, and Lab Improvement) and obtained a joint grant. We hired two undergrads who spent a year developing a synchSM capture tool and a microcontroller simulator tool, which were integrated with one another, called the RI (Riverside-Irvine) tools. These tools are now a centerpiece of the course, with all homeworks done using the tools, and even the first week of lab spent just learning the tools. Student performance has improved tremendously. Students regularly get A/B scores on exam problems for capturing synchSMs. Furthermore, we were able to extend the course content to emphasize capturing concurrent synchSMs. Student final projects in the last two weeks of the course are now impressive 4-5 concurrent synchSM systems running on a single microcontroller with no operating system support -- projects that could never have been completed several years ago before the tools. As part of the NSF project, we also developed an e-book, and will soon begin advertising the book and tools to other universities.

Note that Dr Vahid both noted the need for change, and measured the results of the change using (among other tools) the course reports.

Improvements made by a single faculty member

In the above example we considered data-driven continuous improvement to *individual courses*. In this section we review data-driven continuous improvements created by an *individual* professor. We consider the work of Dr. Philip Brisk, simply to avoid redundancy (he was not mentioned above), however similar remarks could be made for all our faculty. Below we have pasted Dr. Brisk's notes verbatim, with no attempt to edit or "polish".

RATIONALE: I received a grant from the Cyber Physical Systems (CPS) Program of the US National Science Foundation (CNS-1035603, "System support for generally programmable digital microfluidic biochip devices"). One of the criteria for the successful outcomes of NSF grants is "integration of research with education," but the actual methods employed for integration and evaluation are left unspecified.

IMPROVEMENT: I did two things, relating to two different classes that I teach.

CS.120B: This applies to the offering of CS.120B in Spring 2011. Every week, I assigned a paper to the students to read based on CPS. I discussed the paper for 10-15 minutes during each week, and supplanted the discussion with videos whenever possible. CPS-related themes included robotics, wearable computing, MS Kinect, and programmable microfluidics, among others. I asked basic questions on the exams, and occasionally on homeworks, to assess whether the students were reading and understanding the papers that were assigned.

CS.179J: I created specific senior design projects relating to programmable microfluidic technology, which is the core topic of my grant. In the Spring 2010 offering, one group of three students adopted one of these projects; in the Winter 2012 offering, two groups of four students (eight students in total) adopted these projects.

RESULTS:

CS.120B: I monitored the performance of students on homework's and exams on the questions relating to CPS and external readings. Initially, the students did not do particularly well; my interpretation was that the students did not take these readings seriously, as they were somewhat decoupled from the core topics covered in the textbook, lecture, and lab; however, student performance improved significantly as the quarter progressed. I noticed that many topics were too advanced for the students to comprehend in detail, even though they were making an effort. The problematic topics were robotics and computer vision (as applied to the MS Kinect). On the bright side, 6 of the top students in the course approached me about doing independent research during the Summer of 2011, and one approached me later (at the end of the Fall 2011 quarter). All performed independent research in my laboratory successfully, and participated in relevant projects in the CS.179J offering in Winter 2012. Three of the students have applied to the Ph.D. program in Computer Science and UCR. I have offered to be their faculty advisor, and I am in the process of trying to obtain grants to fund their Ph.D. studies over the next 5 years.

CS.179J; In the Spring 2010 quarter, the three students who worked on the project relating to programmable microfluidics identified several problems relating to resource-constrained scheduling. They were able to produce relatively naive solutions, which I was able to later improve upon with one of my graduate students. The work with my graduate student was later accepted for publication at DAC 2012. The undergraduate project was quite successful for a short 10-week capstone senior design.

In the Winter 2012 offering, both projects were even more successful. In one project, my graduate student developed a microfluidic synthesis framework which consists of three key steps to solve: scheduling, placement, and routing. The system was modular, so that algorithms could be developed and plugged in without affecting the rest of the system. All of the students who worked on this project were given papers describing existing algorithms and were asked to implement them. One student implemented two genetic algorithms used for scheduling. A second student implemented a simulated annealing-based placer. The

third and fourth students implemented two routing algorithms each, one simple, and one complicated. The project was quite successful, and we hope to release the framework as open source for the community to use during the Summer of 2012. The student who worked on scheduling has applied to the Ph.D. program at UCR, as discussed above.

The second project developed algorithms to concurrently transport fluids in programmable microfluidic devices. With my help, the students modeled the problem as a vertex-disjoint path problem from graph theory, which is known to be NP-complete. The students developed two heuristics for this problem, which were inspired by the well-known PathFinder algorithm from FPGA routing. The results were quite encouraging, as this is the first significant effort to look at the problem of fluid routing in this particular context. I hope to submit a paper for publication to ICCAD 2012 based on this work, with the four students as co-authors. Three of the students who participated in this project have applied to the Ph.D. program at UCR. One has been working on traffic routing algorithms with another professor at CE-CERT, but has chosen to take an industrial position at ESRI instead; I hope to supervise the other two, as mentioned above.

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RATIONALE: The founder of StopTheHacker.com approached me about my CS.179J course offered in Spring 2010 and suggested that I create new projects based on smart phone programming (Note, UCR CS faculty Dr. Faloutsos is CEO of *StopTheHacker.com*). *He offered to provide the API developed by his company so that it could be ported to smart phones.*

IMPROVEMENT: Initially, enrollment was low for the quarter, and there was some concern that the class would be cancelled. During the first week of class, I sent out an email announcement to the undergraduate student population to promote the class, and mentioned that smart phone programming would be supported.

RESULTS: Almost immediately, the size of the class doubled, and some students mentioned that they switched out of another CS 179J class to take this one because of the smart phone programming component.

Altogether, there were 4 smart phone programming projects, with teams comprised of 3 or 4 students. One of the projects, which was quite successful, ported the StoptheHacker.com API to Android phones, and the results were disseminated to representatives of the company.

Based on student feedback, there was significant satisfaction with the smart phone programming projects. I have encouraged my colleagues who teach other CS.179 courses (e.g. software systems, networking) to incorporate smart phone applications into their projects as well.

Two students who worked on a smart phone project, Richard Ramos and Jacob Leung, stayed at UCR to earn M.S. degrees; I supervised their M.S. project, which was also based on a smart phone; they implemented a tire pressure monitoring system prototype that notified the car owner, via a smart phone application, when the tire pressure moves out of the manufacturer-recommended range. I believe that this project grew out of their experience with smart phones in CS.179J.

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RATIONALE: I received 10 Enforce Atom(™) Development boards from Intel as an equipment donation for use in my CS 179J offering for Spring 2012. At the same time, many students expressed interest in doing projects relating to computer vision using the MS Kinect's 3D camera system and API.

IMPROVEMENT: I created several projects around the development boards, including topics relating to computer vision based on the MS Kinect, and controlling a microfluidic device using a development board.

RESULTS: The microfluidics project was successful; it ran on the development board seamlessly.

The Kinect-oriented projects were not successful. The development boards shipped with an obscure Linux variant (Timesys) that did not provide sufficient driver support. None of the groups working on Kinect-related projects were able to get the Kinect working with the development boards. One group tried a more traditional webcam and also failed. In response, I changed the projects around so that they could use desktop/laptop PCs running Windows instead, and all projects were successfully completed (although a significant amount of time was wasted trying to get the development boards to work).

A secondary problem was that the development boards became dangerously hot, and tended to overheat.

I do not plan to use the development boards again in my classes. I am planning to work with Harsha Madhyastha to integrate them into his cluster to provide a heterogeneous computing platform consisting of Intel Nehalem(™) and Atom(™) processors. This can be used to support research and undergraduate curriculum on operating system support for heterogeneous computing platforms.

If that project fails, I will ask an undergraduate student to assemble the development boards into a RAID array (each board has a 320GB hard drive), and I will use it as a data store/backup system for my laboratory.

I will definitely incorporate Kinect and camera-based projects into my future CS 179J courses; to keep the students' lives simple, I will require that they use Windows, because it is the only platform that has a mainstream and well supported Kinect SDK at the moment; any other operating system is likely to lead to more problems with device drivers, which can be a major time waste during a senior capstone design project class.

End direct quotation of Dr. Brisk's notes.

Curriculum improvements based on discussions with constituents: EE BOA (Outer Loop, Table 15)

Need: At the last EE BOA meeting it was agreed that more exposure should be provided to energy related courses. **Action**: Two courses in the area of power systems, namely EE123 (Power Electronics) and EE153 (Electric Drives) were introduced (EE Faculty Meeting Minutes 10-29-1010). Both the courses were approved at the campus level during 10/11. **Result**: EE123 is scheduled to be offered in 12/13. A new faculty has been hired in the EE dept. in this area. Hamed Mohseian-Rad (Ph.D. 2008) was hired as an Assistant Professor in Fall 2012. His expertise is in energy systems and optimization.

Curriculum improvements based on discussions with constituents: Students (Outer Loop, Table 15)

Need: Students noted in student surveys that they complete their Senior Design Project (EE175AB) close to the final week before graduation and are short of time need to write final report. In the previous two-quarter EE175AB structure in the Winter and Spring quarters, after students submit their final report in the finals week of Spring quarter, they left school and there is no time for the instructors to give back commented final reports to students for clarification, editing, revision, or improvement, which is an important step in design documentation. **Action**: The Senior Design Project course has been changed from a two quarter sequence of EE175AB (4 units each) offered in the Winter and Spring of the senior year to a three-quarter sequence of EE175ABC (3 units, 4 unit and 1 unit respectively) offered in the Fall, Winter and Spring of the senior year. (EE Faculty Meeting Minutes 11-14-2011). **Result**: This change has just been approved by the Faculty and BCOE Executive Committee. It has the support of the BOA. It will be implemented from the 12/13 academic year. In the new three quarter structure, students are still required to complete the project in two quarters; at the end of the second quarter they make the final presentation and demo of the design. They complete and submit a draft final report in the third quarter. The instructor will review and mark up the final report with comments. The

students address the instructor feedback on the draft report and submit a revised report. In this format, the instructors will have sufficient time to comment on the final reports, send feedback and improvement requirements to students. Students will then complete the requirements and re-submit the final reports including any improvements of the design, which will be used for final grading. This completes the feedback loop.

Improvements to EE 175A/B based on viewing course reports: (Inner Loop, Table 15)

Need: Desire to better cover the course objectives of EE175A/B.

Action: The instructors have further updated the lectures and final report requirements. Highlights of the updates are that we introduced:

- A lecture on Systems Engineering (based on NASA material) to introduce the concepts and practice of systems engineering.
- A lecture on data analysis techniques.
- A lecture on lab skills and an exam to gain 24-hour lab access.
- A career center counselor is invited to lecture on resume writing and job search.
- A short essay has been added as part of the final report on how working on the design project helps students recognize the need for and an ability to engage in lifelong learning
- In addition to a lecture and exam on professional ethics, a short essay is required as part of the final report to discuss potential ethics consideration of the project and design process.
- To remind students to practice professional ethics and make ethics a more concrete and measurable requirement, new in 2012, we are introducing ethics evaluation by team members and instructors on professional responsibility, how well a student functions in the team, helping team members, being dependable and honest, etc. The Senior Design Project syllabus with the ethics evaluation form is attached.
- More detailed instructions are given in the final report tem-plate on realistic constraints and industry standards to guide the students in their design considerations.

Result: These changes are introduced this year and there is no data available yet. The CEN undergraduate committee will monitor the results of these changes carefully.

Summary for this Section (*Section 5.C Continuous Improvement*):

Our program has a culture of *data-driven* continuous improvement of undergraduate education. Faculty are rewarded for their efforts in improving the curriculum and in general teaching excellence, by having this aspect of their work be considered a significant factor in promotion and tenure decisions.

D. Additional Information

For the courses hosted by CSE department, the ABET binders (described in detail in Section 4.B) for the last four years will be available for inspection. As noted above and shown in Figure 20, these binders are color coded, labeled on the spine and indexed in a consistent format, allowing rapid inspection. Note that these binders include sample student work (examples of graded high/medium/low quality of written submissions) for all courses. For the courses hosted by EE department, digital versions of the above will be available in an easy to navigate format.

Figure 20: (a subset of) The ABET course reports and copies of all textbooks used in the CEN program (*lower right*)

We will have examples of senior design projects available. A copy of every compulsory or recommend textbook used in the last four years will be available, and finally, typed minutes from both EE and CSE meetings in the last four years will also be available for inspection.

CRITERION 5. CURRICULUM

How our Curriculum Aligns with our Program Educational Objectives

The PEOs are designed to fulfill three main requirements: enable our graduates to pursue higher degrees, be successful in their industrial positions, and be good citizens of the community. The courses are structured to meet all the requirements. As evident from the course plan (see Table 29, Table 30 and Table 31), our students get a broad training in various aspects of CEN that provide the technical foundations for both higher studies and industrial positions requiring such technical skills. Such courses include the basic science and math courses, the core CEN courses, programming expertise, technical electives covering all the areas of the department, and a comprehensive senior design project. They are also required to take language and writing courses that are essential for success. We also prepare our students to be mindful of their ethical responsibilities and the broader role of engineering in society. These are covered in a number of courses, but most thoroughly in the Senior Design Project.

Additional information about how our PEOs align with our curriculum can be derived from considering how our curriculum maps to the student outcomes (Table 28) and how, in turn our student outcomes map to our PEOs (Table 14).

How our Curriculum Supports the Attainment of our Student Outcomes

As shown in Table 28, the required courses in the CEN curriculum support attainment of all of the ABET-defined student outcomes. For each course, an **X** is entered in columns corresponding to the student outcomes for which that course supports attainment. Equivalently, for each student outcome, an **X** is entered in rows corresponding to the courses which support attainment of that outcome. It can be seen that attainment of each student outcome is supported by *at least* two courses.

Table 28: Curriculum Structure Supports Student Outcomes

		Course	A	B	C	D	E	F	G	H	I	J	K
	one of	EE 114	X				X						
		STAT 155	X				X						
		MATH 113	X				X						
		ENGR 180	X	X	X		X	X					X
		EE 100B	X	X									
		EE 100A	X	X									
		EE 110B	X				X						
		EE 110A	X				X						
		CS 111	X										X
		EE/CS 120B	X					X	X			X	X
		EE/CS 120A			X	X							
	one of	CS 122A	X		X		X						X
		EE 128		X	X								
		CS 100	X							X			X
		CS 141	X	X	X	X							X
	taken	CS 161	X		X								X
	together	CS 161L	X	X	X		X						X
	one of	CS 153	X		X								X
		CS 160	X		X		X						X
either this		CS 179	X	X	X	X	X	X	X	X	X	X	X
or this	both	EE 175A	X	X	X	X	X	X	X	X	X	X	X
pair	these	EE 175B	X	X	X	X	X	X	X	X	X	X	X

Note that we do *not* limit our evaluation of student outcomes to just these required classes. We evaluate the student outcomes in *every* technical elective that a CEN student can take. See Appendix A for more details.

Table 29 shows the prerequisite structure of the program's required lower division courses.

Table 29: Prerequisite Structure of Lower Division CEN Required Courses

	Course	Prereq 1	Prereq 2	Prereq 3	Notes
one of	EE 114	EE 110A			
	STAT 155	MATH 009C, or	MATH 009HC		maybe concurrent
	MATH 113				
	ENGR 180	ENGL 001			C or better
	EE 100B	EE 100A			
	EE 100A	EE 001B			
	EE 110B	EE 110A			
	EE 110A	CS 010	EE 001		maybe concurrent
	CS 111	CS 010	CS 011	MATH 009C	
	EE/CS 120B	EE/CS 120A			
	EE/CS 120A	CS 061			C or better
one of	CS 122A	CS 012, or	CS 013	EE/CS 120B	
	EE 128	EE/CS 120A	EE 100B		or instructors consent
	CS 100	CS 014			
	CS 141	CS 014			C or better
taken	CS 161	EE/CS 120B			
together	CS 161L				
one of	CS 153	CS 061	CS 100	CS 111	
	CS 160	CS 061	CS 100	CS 111	
	4 or more units in Chemistry in consultation with a faculty advisor.				
	PHYS 040C	PHYS 040B			
	PHYS 040B	PHYS 040A			
	PHYS 040A	MATH 008B, or	MATH 009A, or	MATH 009HA	maybe concurrent

Table 30 shows the prerequisite structure of the program's required upper division courses.

Table 30: Prerequisite Structure of Upper Division CEN Required Courses

	Course	Prereq 1	Prereq 2	Prereq 3	Prereq 4	Prereq 5	Notes
	CS 100	CS 014					
	CS 122A	CS 012, or	CS 013	EE/CS 120B			C or better in 120B
	CS 122B	CS 122A					
	CS 130	CS 100	MATH 113	may be concurrent or instructor's consent			
	CS 133	CS 100	CS 111	MATH 113			
	CS 150	CS 014	CS 111	MATH 09C or	MATH 09HC		
	CS 152	CS 061	CS 100	CS 111	CS 150		
	CS 153	CS 061	CS 100	CS 111			
	CS 160	CS 061	CS 100	CS 111			
	CS 162	CS 161	CS 161L				C- or better
	CS 164	CS 100	CS 111	CS 153			
	CS 165	CS 141	CS 153				
	CS 166	CS 100	CS 111				
	CS 168	EE/CS 120A					or instructor's consent
	CS 170	CS 100	CS 111				
	CS 177	CS 100	CS 111	and C++ programming proficiency			
one	CS 179E	CS 141	CS 152	ENGR 180W			C- or better
of	CS 179F	CS 153	ENGR 180W				8 additional
these	CS 179G	CS 141	CS 166	ENGR 180W			upper-division
	CS 179I	CS 141	CS 164	ENGR 180W			units in CS
	CS 179J	CS 100	CS 111	CS 122A	CS 161	ENGR 180W	and CS 160
	CS 179K	CS 180	ENGR 180W				are
	CS 179M	CS 100	CS 111	CS 170	ENGR 180W		recommended
or	CS 179N	CS 130	ENGR 180W				
both	EE 175A	ENGR 180W					senior standing
these	EE 175B	EE 175A					
	CS 180	CS 014	CS 100				
	CS 181	CS 061	CS 100	CS 111	CS 150		
	CS 183	CS 100					
	EE 105	CS 010	EE 001A	MATH 046			
	EE 115	110B					
	EE 128	CS/EE 120A	EE 001B				or instructors consent
	EE 132	EE 105 or	ME 103	EE 110A or	ENGR 118		or instructors consent
	EE 133	EE 100A					
	EE 134	CS/EE 120A	EE 001A	EE 001B	EE 100A	EE 133	
	EE 135	EE 001A	EE 001B and A	EE 100B	EE 133	EE 134	
	EE 141	EE 110B					
	EE 144	EE 132					
	EE 146	senior standing in EE or instructors consent					
	EE 150	EE 114	EE 115				
	EE 151	EE 132	EE 141				
	EE 152	EE 110B					

UCR | Bourns College of Engineering

Suggested Course Plan for a UC Riverside Major in

COMPUTER ENGINEERING

Catalog Year: 2011

Fall Quarter	Units	Winter Quarter	Units	Spring Quarter	Units
FIRST YEAR					
CS 010	4	CS 012[1]	4	CS 061	4
C++ Programming I		*C++ Programming II*		*Machine Org. & Assembly Lang. Prog.*	
ENGL 001A	4	ENGL 001B	4	MATH 009C	4
Beginning Composition		*Intermediate Composition*		*First Year Calculus*	
ENGR 001G	1	MATH 009B	4	MATH/CS 011	4
Professional Dev. & Mentoring		*First Year Calculus*		*Intro to Discrete Structures*	
MATH 009A	4	PHYS 040A	5	PHYS 040B	5
First Year Calculus		*Physics (Mechanics)*		*Physics (Heat/Waves/Sound)*	
SECOND YEAR					
CS 014	4	EE 001B	4	CS 100	4
Intro to Data Structures & Algorithms		*Engineering Circuit Analysis II and Lab*		*Software Construction*	
EE 001A and EE 01LA	4	EE/CS 120A	5	CS/EE 120B	5
Engineering Circuit Analysis I and Lab		*Logic Design*		*Embedded Systems*	
MATH 046	4	MATH 010A	4	MATH 113	5
Differential Equations		*Multivariable Calculus*		*Linear Algebra*	
PHYS 040C	5	CS 111	4	Breadth _____	4
Physics (Electricity/Magnetism)		*Discrete Structures*		*Humanities/Social Sciences*	
THIRD YEAR					
CS 141	4	CS 153 or CS 160	4	CS 161 & CS 161L	6
Interm. Data Structures & Algorithms		*Operating Sys. or Concurrent Prog.*		*Design & Arch. of Comp. Sys.and Lab*	
EE 100A	4	EE 100B	4	EE 114[2]	4
Electronic Circuits		*Electronic Circuits*		*Prob., Random Variables & Processes*	
EE 110A	4	EE 110B	4	ENGR 180W*	4
Signals and Systems		*Signals & Systems*		*Technical Communications*	
ENGR 101G	1	Breadth _____	4	Breadth _____	4
Professional Dev. & Mentoring		*Humanities/Social Sciences*		*Humanities/Social Sciences*	
FOURTH YEAR					
CS 122A or EE 128	5	CHEM 1A/LA or CHEM 003	5	Technical Elective**	4
Micro Design or Instrumentation		*General Chem. or Concepts of Chem.*		_____	
Technical Elective**	4	Technical Elective**	4	Technical Elective**	4
_____		_____		_____	
Breadth _____	4	Technical Elective**	4	Breadth _____	4
Biological Sciences		_____		*Humanities/Social Sciences*	
Breadth _____	4	Breadth _____	4		
Humanities/Social Sciences		*Humanities/Social Sciences*			

[1] CS 13 may also be used to satisfy this requirement

[2] STAT 155 may also be used to satisfy this requirement

To earn a B.S., you must complete all College and University requirements. For a complete list: www.catalog.ucr.edu.

ENGLISH COMPOSITION*

A C or better is required in three quarters of English Composition courses to satisfy the graduation requirement. ENGR 180W fulfills the third quarter of English Composition.

BREADTH REQUIREMENTS

For an approved list of Breadth courses: http://student.engr.ucr.edu/policies/requirements/breadth.html.

Humanities: (3 courses)
- A. World History: _____
- B. Fine Arts, Lit., Phil. or Rlst: _____
- C. History of Science: _____

Social Sciences: (3 courses)
- A. Econ. or Posc.: _____
- B. Anth., Psyc, or Soc.: _____
- C. Additional Social Science: _____

Biological Science _____

Ethnicity: (1 course)
1. _____

ABET Upper Division Depth: (2 courses)
1. _____
2. _____

TECHNICAL ELECTIVES **

Please note that Technical Electives may be offered throughout the Academic Year. Consult with your Academic Advisor about potential offerings.

Course Plan is subject to change.

Total Units: 192

Maximum Units: 230

Table 31 shows the suggested course plan for a CEN major.

Table 31: The Suggested Course Plan for a CEN Major

How our program meets the requirements in terms of hours and depth of study for each subject area (Math & Basic Sciences, Engineering Topics, and General Education)

General Education. UCR has defined a set of General Education requirements that all students at UCR must satisfy as part of their baccalaureate (Bachelor's) degree program. This set of courses in the General Education consists of 37 credit hours, and is designed to provide all undergraduates with a balanced, broad and coherent general education, and to promote competence in reading, writing, speaking, listening, critical thinking, computer literacy and mathematics.
The principal goal of the program is to teach students the fundamental knowledge associated with Computer Engineering and hands-on experience that demonstrates how this knowledge is applied to engineering design and problem solving, thereby providing an excellent base for a successful engineering career. This involves building a sufficient knowledge base and analytical capabilities so that graduates can continue to expand their knowledge as the underlying technology and target applications not in Computer Engineering change during their professional career.

The core courses, consisting of EE and CS courses are intended to provide a broad base so that those who terminate their formal education with the Bachelor's degree can continue to grow as professionals throughout their careers. This goal is met by a curriculum in which there is a progression of coursework in which fundamental knowledge acquired in earlier years is applied in later engineering courses. Satisfaction of these goals prepares the students to attain the objectives of the program.

Mathematics & Basic Sciences: Computer Engineering students must take a minimum of 48 hours in this component. Furthermore, some of the Basic Science classes must involve a lab, so that all students in the program are exposed to an experimental science experience. Computer Engineering students are required to take the following

Mathematics courses (28 credit hours):

MATH 009A - 009C	First Year Calculus	12
MATH 011	Introduction to Discrete Structures	4
MATH 046	Differential Equations	4
MATH 10A	Multivariable Calculus	4
MATH 113	Linear Algebra	4

Physics courses (15 credit hours): PHYS 040A-040C, General Physics, 5 credit hours each, including 3 lecture hours, 1 discussion hour and 3 laboratory hours.
Chemistry courses (5 credit hours) chosen from either:

- CHEM 1A (*General Chemistry*) 4 credit hours along with CHEM 01LA (*General Chemistry Lab*) 1 credit hour.
- CHEM 03 (*Concepts of Chemistry*) 4 credit hours.

Engineering Topics. Every Computer Engineering student must take a total of *88 credit hours* in required CS and/or EE courses as described above in detail, this component consists of engineering science and engineering design courses that are at the heart of Computer Engineering. The Engineering Topics courses are shown in Table 32 grouped into three levels with two or three clusters per level.

Table 32: Engineering Topics

	Cluster topic	Courses	#	Focus of class cluster
FOUNDATIONS	Introduction to computing	CS 10, CS 12, CS 14	12	Fundamentals of programming with an introduction to data structures
	Computing structures	CS 061, EE/CS 120A	9	Builds up the computing structures, from wire to register transfer logic and hardware description languages.
BUILDING-UP	Circuit analysis and electronic circuits	EE 01A, EE 01LA, EE01B, EE 100A, EE 100B	16	Building up on the physics foundation, introduces the analysis of electrical circuits using it to represent and model electronic devices and their behavior.
	From algorithm to software systems	CS 100, CS 111, CS 141	16	Design, implementation & evaluation of real software systems based on solid theoretical foundations using modern tools to design and build real applications, such as OS.
	Signals, systems & models	EE 110A, EE 110B, EE 114	12	Building on the foundation in mathematics, probability and statistics, introduces signal and systems, continuous and discrete
ENGINEERING DESIGN	Design aspects of computers	CS 161, CS 161L, EE/CS 120B, CS 153	15	Brings together the hardware and software aspects: processors, OS and applications. Introduces the costs and benefits tradeoffs in the engineering design process.
	Computers in the real-world	CS 122A or EE 128	4 or 5	Brings together the cumulated experience into real-life environments: embedded systems or instrumentation.
	Design, the capstone experience	CS 179 E-Z or, EE 175A and EE 175B	4 or 8	Ties the varied experiences into one design project with emphasis on: team work, real-life relevance, ethics, design and construction methodologies

- The Foundations level introduces programming and data structures (CS 10, CS 12 and CS 14) and the logic and hardware structures that support computing (CS 061 and EE/CS 120A). CS 061 plays a particularly important role: starting from the transistor as a switch it builds up to gates, truth tables, combinational logic, flip-flops, registers, memory devices, state machines, a very simple CPU and its assembly language, terminating with the correspondence between assembly language and C. This course lays the foundation for all future mainline Computer Engineering courses.
- The Building-Up level brings in the electrical and electronic circuits (EE 01A, EE 01LA, EE 01B, EE 100A and EE 100B) as engineering science of Computer Engineering. Based on the programming foundation it develops programming as a science (CS 111 and CS 141) and an art (CS 100). The science of signal and systems is developed in EE 110A, EE 110B and EE 114, giving the student a holistic view of abstract machines and communication systems.
- When they reach the Engineering Design level students are ready to rely on the information and formation received so far to conceive, design and evaluate computing systems. The initial design aspects of computer systems include the design and performance/cost tradeoffs of an ALU, a complete CPU, cache memory and TCAM memory (CS 161 and CS 161L). The hardware/software includes the co-design of embedded systems (CS 120B and CS 122A) and the design and evaluation of operating systems (CS 153). The design of instruments, an art rooted in science, is an option in EE 128. The training of Computer Engineers culminate in the senior design project (CS 179 or EE 175A & B).

Design Experience

CEN students have a choice of doing either a CS179 project, or an EE 175 A/B project. Below we discuss each in turn.

Design Experience: EE 175 A/B Option:

The Senior Design Project (EE175) is a rigorous two-quarter (recently modified to three quarters) course that provides students the experience of designing a real-life project. A group of instructors coordinate the course, providing the lectures and advising the students on the design. Projects are either suggested by the instructors or proposed by students and approved by the instructors. The instructors ensure that all design projects have sufficient level of technical difficulty and make use of knowledge and skills from earlier electrical engineering courses. In fact, each project requires knowledge and skills from multiple EE courses, from circuits, logic design, electromagnetics, microcontroller programming to control, wireless communications, DSP, robotics, etc. We specifically require students to identify engineering standards and design constraints in their design projects. The requirements and an introduction to engineering standards and realistic design constraints are covered in a lecture. They are also required sections in the Final Report. Below we provide more details.

Prerequisites

Senior standing in Electrical Engineering, Engr 180W.

Objectives

The Senior Design Project is the culmination of coursework in the bachelor's degree program in electrical engineering or computer engineering. In this comprehensive two-quarter course, students are expected to apply the concepts and theories of electrical engineering or computer engineering to an engineering design project. Detailed written reports, working demonstration, and oral presentations are required.

The following are the specific course objectives, and their mapping to the Student Outcomes is shown in Table 33.

1. Ability to understand the engineering design process, working in teams.
2. Ability to formulate design specifications and evaluation criteria; determining methodologies and performing solution analyses
3. Develop skills in project management including organization, teamwork, planning, scheduling, and budgeting
4. Develop skills in library techniques such as literature and information searching
5. Develop technical writing and oral communication skills through proposal and report writing, as well as mid-course and final presentations
6. Ability to design and conduct experiments and analyze data
7. Understanding of professional and ethical responsibility
8. Obtain a general understanding of engineering economics, marketing, career strategies, and resume preparation
9. Understand the impact of engineering solutions in a global and societal context.
10. Knowledge of contemporary engineering issues.

Table 33: The course objectives of EE175 and their mapping to the Student Outcomes

Item	OUTCOME-RELATED LEARNING OBJECTIVES	OUTCOMES										
		A	B	C	D	E	F	G	H	I	J	K
1	Ability to understand the engineering design process, working in teams.			1	1	1					1	1
2	Ability to formulate design specifications and evaluation criteria; determining methodologies and performing solution analyses	1	1	1		1						1
3	Develop skills in project management including organization, teamwork, planning, scheduling, and budgeting			1	1	1					1	1
4	Develop skills in library techniques such as literature and information searching							1		1	1	1
5	Develop technical writing and oral communication skills through proposal and report writing, as well as mid-course and final presentations					1		1				1
6	Ability to design and conduct experiments and analyze data	1	1	1								1
7	Understanding of professional and ethical responsibility						1					1
8	Obtain a general understanding of engineering economics, marketing, career strategies, and resume preparation.						1		1	1		1
9	Understand the impact of engineering solutions in a global and societal context								1			1
10	Knowledge of contemporary engineering issues									1	1	1

Credits and Hours

Eight quarter units of engineering design credit are granted for the completed project and other required components listed here. It is expected that approximately twelve hours of laboratory (or field) work will be required weekly for satisfactory completion of the project. The design value of these units has been accounted for in the total number of required science and design units necessary for graduation.

Weekly Class Meetings

The entire class of EE175A and EE175B meets once each week for one hour. These meetings are intended to provide instruction in topics common to all design projects (engineering economics, ethics, etc.). In addition, it is expected that each project team meet with their faculty supervisor on a weekly basis to report and discuss the progress of the project. They may include brief presentations by each team, aimed at improving technical presentation skills. Attendance of the lectures and weekly meetings is mandatory.

Project Participants

Projects are completed in small teams with shared responsibility. If the team option is elected, each student will be held responsible for a distinct component of the total team effort. Team projects will be sufficiently more complex than individual projects so as to allow for an appropriate workload for all team members.

Project Elements

The senior design projects include proposal and report writing, experiment design, hardware and software design, test plan and test, broad impact and ethical issues, among other things. Remember that this is a design course and students must define a ***design*** project, not a research, nor an evaluation or fabrication project. It is a balanced approach to encompass many of the elements stated above.

Each design project must include the following components:

1. **A Clear Technical Design Objective and the Project Contract** (Contract due on Monday of week 3 of the winter quarter): Each group must identify a design project and sign the Contract by the due date, and should have good estimated answers to the following questions and obtain the endorsement of the section professor:
   - Is the objective achievable within two quarters?

- Does the group have the expertise to complete the design, prototype, and testing?
- Does the group have access to the financing for the prototype?
- Does the group have access to the required test equipment?
- Is this a design problem (not research, nor fabrication)?
- Is the project significant enough to be worthy of eight credits (12 hours/week/person)?

2. **Experiment Design and Feasibility Study** (Required section in Final Report, 5% of final grade) Design and carry out experiments to evaluate the feasibility of project ideas, alternatives, trade-offs and realistic engineering constraints. Analyze the experimental results to prove the feasibility of your project idea and select the best solution to be further developed in the design project.
3. **A Detailed Design Specification** (Due in week 7 of the winter quarter): Describes the functions and quantitatively measurable design objectives, design methods, hardware and software architecture and interfaces, user interface, realistic constraints in terms of time, cost, safety, reliability, social impact, ethics, etc. It must also list and consider the industry standards related to your project, including hardware, protocols, software and tools (e.g., 802.11, RS232, USB, PCI, 3G, API, device drivers, VHDL).
4. **Global, Economic, Environmental and Societal Impact** (Due on Monday of week 7 of the winter quarter, 2% of final grade): Each student must write an essay (500 or more words) providing an analysis of the potential global, economic, societal, and environmental impact of the project. You do not need to address every aspect, just focus on a couple of aspects that are related to your project. For example, if your project is made into a product, how will it improve quality of life, affect the environment, enhance entertainment, education, globalization etc? Are there any ethical or political debates, laws and regulations that are related to your project?
5. **Contemporary Engineering Issues** (Due on Monday of week 8 of the winter quarter, 2% of final grade) Write an essay (500 or more words) on the contemporary engineering issues related to the project. Potential contemporary engineering issues related to your project are new technologies, new industry standards, new design methods, new materials, new trends in manufacturing, etc.
6. **Test Plan** (Required section in Final Report, 5% of final grade)**:** A detailed description of your design of experiments to test and measure whether the final product and each of its components meet the design specifications, and, if not, to test and measure the errors and deviations from specifications.
7. **Understanding of Professional and Ethical Responsibility** (Required section in Final Report, see grading below) Write an essay (500 or more words) on (a) what are the ethical implications of your project, (b) how you addressed them, and (c) what you learned through this design project about professional and ethical responsibility.
8. **Recognition of the need for and an ability to engage in lifelong learning** (Required section in Final Report, 2% of final grade) Write an essay (200 or more words) on how doing this design project helped you (a) recognize the need and (b) developed the ability in lifelong learning.

9. **Design Review Presentation** (Week 10 of the winter quarter, 5% of final grade): Each group must make a PowerPoint presentation of its design specification and progress to faculty and other students. Requirements of design review presentation will be provided.
10. **Detailed Quantitative Design and Prototype** (To be completed before week 8 of the spring Quarter): Each component of the selected solution and the overall system should be designed and implemented. In most cases, it is necessary to construct a system prototype (or component prototype).
11. **Test Report** (Due week 10 of the spring quarter, 5% of final grade): Carry out the Test Plan you developed to identify how well your final design meets the specifications under the defined constraints, and present the results in this report.
12. **Final Presentation** (Week 10 of the spring quarter, 5% of final grade): Each group must make a PowerPoint presentation of the final design and show a working demo to faculty and other students. Requirements of final presentation will be provided.
13. **Working Demo and Final Report** (Due on Monday of the finals week in spring quarter before 5pm,): The final report must include all the required sections and appendices in a template file, final presentation ppt file and video or data of a working demo must be uploaded on the iLearn website for the course. A working demo of the completed design is critical, it is convincing evidence that your design is completed and works. The demo should show whether and how design specifications are met.

Grading

In addition to the deliverables listed above, each project will also be graded on the following:

1. **Laboratory Notebook, Weekly Progress and Lecture Attendance:** Each student team needs to maintain a laboratory notebook for the duration of their projects and report progress to the section instructor at least weekly. Each week, you must show evidence of amount of work done and progress in the design, implementation and/or testing. Attendance of the lectures is mandatory. Everyone must sign in at each lecture. (This portion accounts for 7.5% of grade).
2. **Professional Ethics and Responsibility** (7.5% of the final grade): You will be evaluated by your team member(s) and by your section instructor. See the attached evaluation forms on how this is graded.

Grading is determined by all of the section professors conferring on each project and student. Please note that grades are assigned to an individual, not to a project.

Project Topics

Projects will be carried out in four different sections corresponding to the main electrical engineering areas taught at UCR. Each section will have a "section professor" (i.e., faculty supervisor). Possible project topics are obtained from or approved by the section professor. In addition, joint projects with other departments may be arranged. Topics that each section professor will supervise are presented to the students in an information meeting held in the fall quarter.

Steps in Selecting a Project

Upon reviewing the topic areas, students take the following steps to select a project, and sign the corresponding senior design contract (available on iLearn).

Step - 0: Prepare a brief academic resume, which describes the specific technical strengths and general background in less than two pages. It is very important that the students make a case for themselves as to why they should be doing a specific project. This step is more or less like applying for a job, and therefore this resume is the first draft of their future resume that opens a door for them. Then they follow one of the following Steps 1A to 1C, depending on their situation.

Step - 1A: Meet and talk to the section professor, and find out if the professor offers an project that interests the student and he/she considers the student qualified to do the project. Or,

Step - 1B: If they have an industrial project in mind that meets the requirements stated above, then they still need to talk to the EE175 section professor. This professor must approve and supervise the project. Or,

Step - 1C: If they have their own project, they must lobby for that idea with their section professor. This approach requires additional effort, but is doable if it is planned in advance.

Step - 2: Identify one or possibly two classmates who have similar interests and want to work with the student on the same project and have gone through the same steps. Discuss the project among team members and achieve a consistent project idea.

Step - 3: Make a brief written proposal to the section professor that includes resume, classmate(s) resume(s) if applicable, the title of the project, and a brief description. Also have one or more projects in this proposal as the second or third choices. Please note that every effort is made to match the student with his/her best choices, although in certain instances changes may be required.

Step – 4: Once the projects are verbally approved by the section professors, each student team is to fill out a project contract available on the class web site.

Course Organization

Table 34 shows the typical organization of the course (sample from 2011-12 academic year).

Table 34: Typical organization of the EE 175 course

Date	Week	Lecturer	Lecture Content
1/13	Week 01	PL, RC, EP	Introduction, course outline, preliminary issues, requirements and expectations
1/20	Week 02	RC	Design methodologies and approaches; block diagrams, analysis of solutions, evaluation of feasibility.
1/27	Week 03	EP	Introduction to the design process, specification process, laboratory notebooks, library techniques, literature and information search
2/3	Week 04	RC	Experiment design, developing a test plan, collecting data, and evaluation. Design constraints, industry standards
2/10	Week 05	EP	Project management: organization, teamwork, scheduling, budgeting, etc.
2/17	Week 06	RC	Systems engineering
2/24	Week 07	RC	Engineering ethics (exam given at the end of the lecture)
3/2	Week 08	RC	Contemporary engineering issues, societal, environmental and cultural impact, international engineering projects
3/9	Week 09	EP	Lab skills and exam for gaining lab access
3/16	Week 10	ALL	No lecture. Design Review presentations. Time TBA
			Lecture time for Spring quarter is tentative and subject to change
4/6	Week 01	PL	Career choices and strategies, how to write resumes
4/13	Week 02	EP	Printed circuit board design, layout, and fabrication
4/20	Week 03	RC	Data analysis techniques
4/27	Week 04	RC	Writing Technical reports

5/4	Week 05	PL	Engineering economics, marketing engineering products
5/11	Week 06	PL	Patents and intellectual properties
5/18	Week 07	RC	Final testing requirements, test report, preparation for the final presentation
5/25	Week 08	PL	Entrepreneurial, venture capital and start-ups
6/1	Week 09	PL	TBA
6/8	Week 10	ALL	Last week, no lecture. Final Presentations. Demo required. Time TBA

Design Experience

The design experience follows the same process as practice in industry. Under the supervision of the instructor, students start with the project definition and feasibility study, and go through one or more iterations of specification, design review, prototyping, testing and revision. Students are also responsible for project management including budgeting, researching and ordering parts, task definition, assignment and scheduling. The design process also requires them to consider applications, engineering and professional ethics and potential societal impact of their design projects if they were to be marketed as a product. This design process gives them a first understanding and experience of a design project and as a result it prepares them for engineering practice after they graduate.

1. From early on in the project students face the necessity of following the fundamental design cycle phases:

- **Exploration** (study of possibilities and constraints);
- **Redefinition** (specification of design solutions)
- **Management** (time management, budget management, supply chain management);
- **Prototyping** (subsystem scenarios, interfacing, data communication protocols, etc.);
- **Redesign** (system changes due to efficiency or newly discovered constraints).

2. The complexity of project systems requires their subdivision into multiple subsystems grouped either by their function, e.g., signal conditioning, digital/analog control, power amplifiers, etc. or, by work separation among project team-members, e.g., a lead member in sensor interfacing, data communication and protocol development or, in electric drives and control, or in telemetry and sensor design, etc.

3. Assembly of project subsystems requires a preparation of test plans and test reports; requires conducting relevant data analysis and a development of subsystems' specifications.

4. Final system testing, validation and verification, and final design report preparation are other strict project requirements.

Knowledge and Skills Acquired in Earlier Coursework

The course instructors ensure all projects contain sufficient technical complexities that require both knowledge and skills acquired in earlier coursework and new knowledge and skills the students must learn in the design process. This is best shown by actual design projects.

Multiple projects on wireless ECG and EEG Monitors that transmits ECG/EEG signal via Bluetooth to a smartphone or computer which records and plots the data in real time: These projects require knowledge and skills acquired in earlier coursework including circuits and electronics (EE1AB, EE100AB), logic circuits and microcontroller (EE120AB, EE128), sampling and signal processing, A/D conversion (EE110AB, EE141), programming and computer organization (CS10, CS13, CS61), technical writing (ENGR180), communications (EE115), and also requires students to learn about wireless personal area networking and the associated Bluetooth industry standard, electrodes and biomedical properties of ECG and EEG signals. In addition to the general design constraints listed in the next section, the specific

constraints of these projects may include processor speed, data rate, transmission range, memory size, parameters of available amplifiers and filters.

A wide range of projects on robotic vehicles (Sumo Robot, micromouse, cleaning robot, autonomous navigation robots): These projects require knowledge and skills acquired in earlier coursework including circuits and electronics (EE1AB, EE100AB), logic circuits and microcontroller (EE120AB, EE128), sampling and A/D conversion (EE110AB), control (EE105, EE132, EE151), robotics (EE144 which some students took, other students who did not will acquire the needed knowledge through the design project), programming and computer organization (CS10, CS13, CS61), technical writing (ENGR180), and also requires students to learn about motor control, various sensors (infrared, ultrasound, accelerometer, gyros), inertial based navigation and GPS (for projects that require it), wireless networking (Bluetooth, 802.11, for projects that require remote control and data transmission) and the associated multiple industry standards. In addition to the general design constraints listed in the next section, the specific constraints of these projects may include processor speed, sampling rate, data rate, traveling speed and/or time, transmission range, memory size, accuracies of the sensors, parameters of motors and drive circuits.

Design Experience: CS 179 Option:

The CS Senior Design Project (CS179 E-Z) is a one-quarter course that provides students the experience of designing a real-life project.

The catalog description of each CS179 offering begins with the following overarching vision for the offering:

> *Under the direction of a faculty member, student teams propose, design, build, test, and document software and/or hardware devices or systems. Emphasizes professional and ethical responsibilities; the need to stay current on technology; and its global impact on economics, society, and the environment.*

The project has the following options for concentrations:

- **CS 179E. Compilers**: Covers the planning, design, implementation, testing, and documentation of a compiler-related system.
- **CS 179F. Operating Systems**: Covers the planning, design, implementation, testing, and documentation of an operating-related system.
- **CS 179G. Database Systems**: Covers the planning, design, implementation, testing, and documentation of a database-related system.
- **CS 179I. Networks**: Covers the planning, design, implementation, testing, and documentation of a network-related system.
- **CS 179J. Computer Architecture and Embedded Systems**: Covers the planning, design, implementation, testing, and documentation of a computer architecture and embedded systems-related system
- **CS 179K. Software Engineering**: Covers the planning, design, implementation, testing, and documentation of a software engineering related system
- **CS 179M. Artificial Intelligence:** Covers the planning, design, implementation, testing, and documentation of an artificial intelligence related system.
- **CS 179N. Graphics and Electronic Games**: Covers the planning, design, implementation, testing, and documentation of a graphics- or electronic game-related system

Each concentration has different prerequisites, ensuring the students have the requisite background classes taken. In addition, senior standing in Computer Engineering is required.

Projects are either suggested by the instructors or proposed by students and approved by the instructors. The instructors ensure that all design projects have sufficient level of technical difficulty and make use of knowledge and skills from earlier computer engineering courses.

Objectives

The Senior Design Project is the culmination of coursework in the bachelor's degree program in computer science or computer engineering. Students are expected to apply the concepts and theories of computer science or computer engineering to a real-world design project. Detailed written reports, pseudocode, prototypes, test reports, working demonstration, and oral presentations are required.

The following are the specific course objectives.

1: Balancing design tradeoffs: cost performance schedule and risk
2: Writing project proposals
3: Team-project organization and management (including time lines)
4: Requirements capture and analysis
5: Design and architecture
6: Prototyping (possibly via simulation)
7: Verification/validation
8: Writing and presenting final reports
9: Engineering professionalism and responsibility
10: Engineering careers and the modern world

Table 35 below shows the mapping between the course objectives and the Student Outcomes. The value '3' indicates a strong mapping, '2' and '1' a weaker mapping (zero mappings left blank.

Table 35: The mapping between the CS 179 course objectives and the Student Outcomes

Outcome Related Learning Objectives	a	b	c	d	e	f	g	h	i	j	k
1: Balancing design tradeoffs: cost performance schedule and risk	2		3	3	3						3
2: Writing project proposals				3	3		3				3
3: Team-project organization and management (inc time lines)			2	3			3				3
4: Requirements capture and analysis	2		3	3	3						3
5: Design and architecture	2			3	3						3
6: Prototyping (possibly via simulation)	3	3		3	3						3
7: Verification/validation	3	3		3	3						3
8: Writing and presenting final reports				3			3				3
9: Engineering professionalism and responsibility						3				1	3
10: Engineering careers and the modern world						3		3	3	3	3

Credits and Hours

Four quarter units of credit are granted for the completed project and other required components listed here. It is expected that approximately twelve hours of laboratory work will be required weekly for satisfactory completion of the project.

Weekly Class Meetings

The entire class of CS179 meets once each week for one hour. These meetings are intended to provide instruction in topics common to all design projects (engineering economics, ethics, etc.). In addition, it is required that each project team meet with their faculty supervisor on a weekly basis to report and discuss the progress of the project. They may include brief presentations by each team, aimed at improving technical presentation skills. Attendance of the lectures and weekly meetings is mandatory.

Project Participants

Projects are completed in small teams with shared responsibility. If the team option is elected, each student will be held responsible for a distinct component of the total team effort. Team projects will be sufficiently more complex than individual projects so as to allow for an appropriate workload for all team members.

Project Elements

The senior design projects include proposal and report writing, experiment design, (hardware, were appropriate) and software design, test plan and test, broad impact and ethical issues, among other things. Recall that this is a design course and students must define a ***design*** project, not a research, nor an evaluation or fabrication project. It is designed to be a balanced approach to encompass all of the elements stated above.

Each design project must include the following components:

1. **A Clear Technical Design Objective and the Project Contract** (Contract due on Monday of week 2): Each group must identify a design project and sign the Contract by the due date, and should have good estimated answers to the following questions and obtain the endorsement of the section professor:
   - Is the objective achievable within the time frame?
   - Does the group have the expertise to complete the design, prototype, and testing?
   - Does the group have access to the financing for the prototype? (where appropriate)
   - Does the group have access to the required test equipment? (where appropriate)
   - Is this a design problem (not research, nor fabrication)?
   - Is the project significant enough to be worthy of four credits (12 hours/week/person)?
2. **Experiment Design and Feasibility Study** (Required section in Final Report, 5% of final grade) Design and carry out experiments to evaluate the feasibility of project ideas, alternatives, trade-offs and realistic engineering constraints. Analyze the experimental results to prove the feasibility of your project idea and select the best solution to be further developed in the design project.
3. **A Detailed Design Specification** (Due in week 3): Describes the functions and quantitatively measurable design objectives, design methods, hardware and software architecture and interfaces, user interface, realistic constraints in terms of time, cost, safety, reliability, social impact, ethics, etc. It must also list and consider the industry standards related to your project, including hardware, protocols, software and tools (e.g., 802.11, RS232, USB, PCI, 3G, API, device drivers, VHDL).
4. **Global, Economic, Environmental and Societal Impact** (Due on Monday of week 4, 2% of final grade): Each student must write an essay (500 or more words) providing an analysis of the potential global, economic, societal, and environmental impact of the project. You do not need to address every aspect, just focus on several aspects that are related to your project. For

example, if your project is made into a product, how will it improve quality of life, affect the environment, enhance entertainment, education, globalization etc? Are there any ethical or political debates, laws and regulations that are related to your project?

5. **Contemporary Engineering Issues** (Due on Monday of week 4 of the winter quarter, 2% of final grade) Write an essay (500 or more words) on the contemporary engineering issues related to the project. Potential contemporary engineering issues related to your project are new technologies, new industry standards, new design methods, new materials, new trends in manufacturing, etc.
6. **Test Plan** (Required section in Final Report, 5% of final grade)**:** A detailed description of your design of experiments to test and measure whether the final product and each of its components meet the design specifications, and, if not, to test and measure the errors and deviations from specifications.
7. **Understanding of Professional and Ethical Responsibility** (Required section in Final Report, see grading below) Write an essay (500 or more words) on (a) what are the ethical implications of your project, (b) how you addressed them, and (c) what you learned through this design project about professional and ethical responsibility.
8. **Recognition of the need for and an ability to engage in lifelong learning** (Required section in Final Report, 2% of final grade) Write an essay (200 or more words) on how doing this design project helped you (a) recognize the need and (b) developed the ability in lifelong learning.
9. **Design Review Presentation** (Week 9 or 10, 5% of final grade): Each group must make a presentation of its design specification and progress to faculty and other students. Requirements of design review presentation will be provided.
10. **Detailed Quantitative Design and Prototype** (To be completed before week 7 at the latest): Each component of the selected solution and the overall system should be designed and implemented. In most cases, it is necessary to construct a system prototype (or component prototype).
11. **Test Report** (Due week 9, 5% of final grade): Carry out the Test Plan you developed to identify how well your final design meets the specifications under the defined constraints, and present the results in this report.
12. **Final Presentation** (Week 10, 5% of final grade): Each group must make a presentation of the final design and show a working demo to faculty and other students. Requirements of final presentation will be provided.
13. **Working Demo and Final Report** (Due on Wednesday of the finals week before 5pm,): The final report must include all the required sections and appendices in a template file, final presentation ppt file and video or data of a working demo must be archived into the project binder. A working demo of the completed design is critical, it is convincing evidence that your design is completed and works. The demo should show whether and how design specifications are met.

Grading

In addition to the deliverables listed above, each project will also be graded on the following:

1. **Laboratory Notebook, Weekly Progress and Lecture Attendance:** Each student team needs to maintain a laboratory notebook for the duration of their projects and report progress to the section instructor at least weekly. Each week, you must show evidence of

amount of work done and progress in the design, implementation and/or testing. Attendance of the lectures is mandatory. Everyone must sign in at each lecture. (This portion accounts for 7.5% of grade).

2. **Professional Ethics and Responsibility** (7.5% of the final grade): Each student will be evaluated by their fellow team member(s) and by your section instructor. An evaluation form that explains how this is graded is handed out on the first week

Grading is determined by all of the section professors conferring on each project and student. Note that grades are assigned to an individual, not to a project.

Project Topics

Projects topics depend on the concentration. Typical examples include:

CS 179G. Database Systems: Design and build a spatial database that would allow the owner of a vending machine company to manage an inventory of 30,000 machines, serviced by 20 technicians.

CS 179M. Artificial Intelligence: Design and build an intelligent tutoring system to teach non-native speakers sentence tagging.

CS 179M. Artificial Intelligence: Design and build a path-finding algorithm that optimizes the loading and unloading of container ships.

CS 179J. Computer Architecture and Embedded Systems: Fluid routing algorithms for programmable microvalve arrays.

CS 179J. Computer Architecture and Embedded Systems: Create electronic blocks that assist in at-home care, including detectors of various sounds (alarms, knocks, screams, etc.), out-of-bed detector, fall detector, etc. Blocks interface with an existing web-based system.

CS 179J. Computer Architecture and Embedded Systems: Human detection using webcam and/or MS Kinect.

CS 179I. Networks: Design and build a distributed peer to peer system that can collaboratively store, search for, and download a file.

CS 179I. Networks: Design and implementation of an application layer multicast protocol for information sharing..

CS 179K. Software Engineering: Write the specification, design, test plan, user manual, and code for a stand-alone system to manage bibliographical references to be processed by bibtex/latex.

CS 179K. Software Engineering: Write the specification, design, test plan, user manual, and code for a decision diagram library.

CS 179N. Graphics and Electronic Games: Teams design and implement a complete video game following practices of good software engineering and iterative user testing. They also interface with sound and art talents to realize their vision.

Materials that will be available for review during the visit to demonstrate achievement related to this (Design Experience) criterion.

For each EE 175 A/B course, we have maintained an *electronic* folder that details the syllabus, homework and lab assignment and solutions, student outcomes, sample student work, assessment of student outcomes, and changes that have been made and are recommended for the future, among others. All the course folders will be available to the ABET reviewers.

For the CS179 option, we have annotated *physical* binders that will be placed in the ABET evaluators room. Theses binders contain the syllabus, graded homework and lab assignments with solutions, student outcomes, sample student work, assessment of student outcomes, and changes that have been made and are recommended for the future.

Table 5-1 Curriculum for Computer Engineering: Part I

COMPUTER ENGINEERING COURSES			Subject Area (Credit History)					
Department and Course Number	Title	**R**equired **E**lective or a **S**elected **E**lective	Math & Basic Sci	Eng. Topics	Gen. Ed.	Other	Last Two Terms the Course was Offered:	Maximum Section Enrollment for Last 2 Terms Offered:
FALL QUARTER, YEAR 1								
CS 010	C++ Programming	R		X			W2012, F2011	240, 242
ENGL 001A	Beginning Composition	R			X		W2012, F2011	917, 1136
ENGR 001G	Professional Development & Mentoring	R				X	F2011, F2010	87, 107
MATH009A	First-Year Calculus	R	X				W2012, F2011	275, 440
WINTER QUARTER, YEAR 1								
CS 012	C++ Programming II	R		X			W2012, F2011	114, 27
ENGL 001B	Intermediate Composition	R			X		W2012, S2011	1716, 2145
MATH 009B	First-Year Calculus	R	X				W2012, F2011	848, 756
PHYS 040A	General Physics	R	X				W2012, F2011	354, 283
SPRING QUARTER, YEAR 1								
CS 061	Machine Organization & Assembly Language Programming	R		X			W2012, F2011	88, 61
MATH 009C	First-Year Calculus	R	X				W2012, F2011	407, 423
MATH/CS 011	Introduction to Discrete Structures	R	X				W2012, F2011	60, 71
PHYS 040B	General Physics	R	X				W2012, S2011	260, 345
FALL QUARTER, YEAR 2								
CS 014	Introduction to Data Structures & Algorithms	R		X			W2012, F2011	29, 59
EE 001A & EE 01LA	Engineering Circuit Analysis I and Lab	R		X			F2011, S2011	175, 145
MATH 046	Differential Equations	R	X				W2012, F2011	272, 421
PHYS 040C	General Physics	R	X				F2011, S2011	289, 244
WINTER QUARTER, YEAR 2								
EE 001B	Engineering Circuit Analysis II and Lab	R		X			W2012, F2011	87, 27
EE/CS 120A	Logic Design	R		X			W2012, F2011	60, 60
MATH 010A	Multivariable Calculus	R	X				W2012, F2011	331, 257
CS 111	Discrete Structures	R		X			W2012, F2011	50, 42
SPRING QUARTER, YEAR 2								
CS 100	Software Construction	R		X			W2012, F2011	30, 57
CS/EE 120B	Embedded Systems	R		X			W2012, S2011	67, 30
MATH 113	Linear Algebra	R	X				F2011, S2011	62, 48
Breadth _____		R			X			
FALL QUARTER, YEAR 3								
CS 141	Intermediate Data Structures & Algorithms	R		X			F2011, S2011	30, 31
EE 100A	Electronic Circuits	R		X			W2012, F2011	32, 47
EE 110A	Signals and Systems	R		X			W2012, F2011	34, 52
ENGR 101G	Professional Development & Mentoring	R				X	F2011, F2010	27, 12

Table 5-1 Curriculum for Computer Engineering: Part II

COMPUTER ENGINEERING COURSES		Required Elective or a Selected Elective	Subject Area (Credit History)				Last Two Terms the Course was Offered:	Maximum Section Enrollment for Last 2 Terms Offered:
Department and Course Number	Title		Math & Basic Sci	Engin Topics	Gen. Ed.	Other		
WINTER QUARTER, YEAR 3								
CS 153 OR CS 160	Operating Systems or Concurrent Programming	R		X			W2012, S2011	29, 13
EE 100B	Electronic Circuits	R		X			W2012, S2011	46, 21
EE 110B	Signals and Systems	R		X			W2012, S2011	46, 26
Breadth _____		R			X			
SPRING QUARTER, YEAR 3								
CS 161 & CS 161L	Design & Architecture of Computer Systems & Lab	R			X		F2011, S2011	29, 17
EE 114	Probability, Random Variables & Processes	R					S2011, S2010	45, 27
ENGR 180W	Technical Communications	R				X	F2011, W2011	48, 47
Breadth _____		R			X			
FALL QUARTR, YEAR 4								
CS 122A OR EE 128	Intermediate Embedded/Real-time Systems or Data Acquisition, Instrumentation, & Process Control	R		X			F2011, F2010	30, 44
Technical Elective**		R						
Breadth _____		R			X			
Breadth _____		R			X			
WINTER QUARTER, YEAR 4								
CHEM 001A/LA OR CHEM 003	General Chemistry or Concepts of Chemistry	R	X				W2012, F2011	539, 1140
Technical Elective**		R						
Technical Elective**		R						
Breadth _____		R			X			
SPRING QUARTER, YEAR 4								
Technical Elective**		R						
Technical Elective**		R						
Breadth _____		R			X			
		R						

Table 5-1 Curriculum for Computer Engineering: Part III

COMPUTER ENGINEERING COURSES			Subject Area (Credit History)					
Department and Course Number	Title	**R**equired **E**lective or a **S**elected **E**lective	Math & Basic Sci	Eng Topics	Gen Ed.	Other	Last Two Terms the Course was Offered:	Maximum Section Enrollment for Last 2 Terms Offered:
TECHNICAL ELECTIVES								
CS 122A	Intermediate Embedded & Real-Time Systems	SE					F2011, F2010	30, 44
CS 122B	Advanced Embedded & Real-Time Systems	SE					W2007, W2006	10, 13
CS 130	Computer Graphics	SE					W2011, F2009	30, 51
CS 133	Computational Geometry	SE					W2009, W2008	6, 5
CS 150	Theory of Automata and Formal Languages	SE					W2012, S2011	48, 28
CS 152	Compiler Design	SE					W2012, W2011	40, 30
CS 153	Design of Operating Systems	SE					W2012, S2011	29, 13
CS 160	Concurrent Programming & Parallel Systems	SE					W2011, S2009	13, 19
CS 162	Computer Architecture	SE					S2006, S2004	10, 14
CS 164	Computer Networks	SE					W2012, W2011	30, 31
CS 165	Computer Security	SE					F2011, F2010	29, 21
CS 166	Database Management Systems	SE					F2011, S2011	32, 50
CS 168	Introduction to VLSI Design	SE					W2004, W2003	6, 19
CS 169	Mobile Wireless Networks	SE					S2011	10
CS 170	Introduction to Artificial Intelligence	SE					W2012, W2011	35, 10
CS 177	Modeling & Simulation	SE					W2012, S2011	30, 21
CS 179 E-Z	Project in Computer Science	SE			X			
CS 180	Introduction to Software Engineering	SE					W2012, W2011	31, 30
CS 181	Principles of Programming Languages	SE					S2010, W2009	23, 7
CS 183	UNIX System Administration	SE					F2011, F2010	34, 33
CS 193	Design Project	SE					W2012, F2011	4, 5
EE 105	Modeling and Simulation of Dynamic Systems	SE					W2012, W2011	58, 41
EE 115	Introduction to Communication Systems	SE					F2011, F2010	38, 32
EE 128	Data Acquisition, Instrum., & Process Control	SE					F2011, F2010	28, 29
EE 132	Automatic Control	SE					S2011, S2010	41, 36
EE 133	Solid-State Electronics	SE					F2011, F2010	23, 26
EE 134	Digital Integrated Circuit Layout and Design	SE					W2012, W2011	10, 5
EE 135	Analog integrated Circuit Layout and Design	SE					S2011, S2010	6, 17
EE 136	Semiconductor Device Processing	SE					S2011, S2008	7, 22
EE 140	Computer Visualization	SE					F2009, S2007	19, 3
EE 141	Digital Signal Processing	SE					F2011, F2010	40, 34
EE 144	Introduction to Robotics	SE					S2011, S2010	22, 21
EE 146	Computer Vision	SE					W2012, W2010	34, 20
EE 150	Digital Communication	SE					W2012, W2011	18, 14
EE 151	Introduction to Digital Control	SE					S2011, S2010	13, 12
EE 152	Image Processing	SE					W2009, W2008	18, 34
EE 175A	Senior Design Project	SE			X		W2012, W2011	44, 27
EE 175B	Senior Design Project	SE			X		S2011, S2010	27, 38

TOTALS-ABET BASIC-LEVEL REQUIREMENTS							
OVERALL CREDIT HOUS FOR COMPLETION OF THE PROGRAM		**48**	**80**	**36**	**3**	**167**	
PERCENT OF TOTAL		29%	48%				
Total must satisfy either credit hours or percentage	Minimum Quarter Credit Hours	42	63				
	Minimum Percentage	25%	37.5%				

CRITERION 6. FACULTY

A. **Faculty Qualifications**

The Computer Engineering Program possesses a wealth of talent, experience, and education in its faculty. The faculty has a wide diversity of emphasis areas within the electrical and computer engineering fields. This allows us to cover all major areas in our curriculum with ease. In fact, for *every* course offering in CE, there are *at least* three faculty that can teach it.

The Computer Engineering program is jointly administered by CS and EE:

- The Department of Computer Science currently has five lecturers and twenty-two tenure-track faculty that include three ACM Fellows, four IEEE Fellows, five AAAS Fellows, one NSF Presidential Young Investigator, one AFOSR Young Investigator, and seven NSF CAREER award holders.
- The Department of Electrical Engineering has twenty-two faculty members: seven IEEE Fellows, six AAAS Fellows, four NSF Career Awardees, three ARO/ONR Young Investigator Awardees, two SPIE Fellows, one OSA and one APS Fellow.

While many of our faculty are famous for contributions to research. Their achievements in teaching are no less impressive. For example, Dr. Vahid's book, *Embedded Systems Design* (Vahid/Givargis, Wiley) is used in more than 50 universities, and his textbook *Digital Design* (Vahid, Wiley) is has been adopted in more than 60 universities worldwide. Similarly Dr. Keogh's teaching materials on *Introductory Artificial Intelligence* have been used in at least 60 universities worldwide, and a quick web search reveals Spanish, Portuguese, Chinese and Polish translations have been created by others.

6.A.1 An Overview of the Personnel Changes made since the last ABET Visit

Since the last ABET visit, the Computer Science Department lost:

- Dimitrios Gunopulos: *Databases*.
- Vana Kalogeraki: *Operating Systems*/ *Distributed Systems*.
- Brett Fleisch: *Computer* and *Network Systems*.
- Teodor Przymusinski: *Artificial Intelligence*.

Dr. Gunopulos and Dr. Kalogeraki (a married couple) left in 2010 to return to Greece to start a family. Dr. Fleisch left in 2011 to pursue an opportunity in Thailand. Dr Przymusinski retired in 2010. While he remains an emeritus professor, he is not active and does not retain an office at UCR.

We also had:

- Thomas Payne: *Programming Languages*.

retire and become an Emeritus Professor in 2010. However, Dr. Payne retains an office and remains *very* active, teaching one class per quarter, attending all faculty meetings and doing other department service. His retirement is just a bookkeeping device based on UC retirement rules.

Since the last ABET cycle we hired:

- Iulian Neamtiu: *Software Engineering*.
- Philip Brisk: *Embedded Systems/Computer Architecture*.

- Vagelis Hristidis: *Databases*/*Information Retrieval*
- Harsha Madhyastha: *Distributed Systems/Networking/Security*.
- Tamar Shinar: *Scientific Computing*/*Computer Graphics*.

Below we briefly discuss why these faculty were hired, and the contributions to our strengths in undergrad teaching. Their significant contributions to undergraduate research are discussed elsewhere in this document.

Dr. Iulian Neamtiu was hired in 2008 to strengthen the existing Software Engineering group. Dr. Neamtiu has adjusted the lecture material for CS 180 to increase the use of formal methods in software construction. The use of formal methods in software specification and software validation leads to a better understanding of software requirements and software behavior, and prepares students to write higher quality software, i.e., more usable and less prone to errors. Moreover, the emphasis on rigor and formality gives students an opportunity to use their training and knowledge in mathematics and logic towards solid software construction methods. For the project part of the course, Dr. Neamtiu has chosen an approach that emphasizes flexibility in team formation and implementation strategy, while adhering to strict documentation and schedule guidelines; this approach includes the role of exposing students to realistic software development practices, as well as issues and solutions that appear in the development of large projects in a multi-person team. Projects change each quarter and topics are highly relevant to what students will work on after graduation. For example, recent team projects included implementing “lite" versions of LinkedIn, Facebook, YouTube, Twitter, Blockbuster online store, Netflix, IMDB. Other projects involved developing Android and iPhone applications for augmented reality, time management, and restaurant reservations. The approach has already started to bear fruit, with outgoing students indicating they were able to find jobs and internships based on the large, team-oriented, highly-relevant project topics in CS 180.

Dr. Philip Brisk was hired in 2009 to strengthen the existing embedded systems, architecture, and CAD group. Dr. Brisk's primary undergraduate teaching responsibility has been CS.120B; he has integrated learning materials developed by his colleague, Dr. Vahid, into the course. Through NSF funding Dr. Vahid and Dr. Tony Givargis (UC Irvine) developed an electronic textbook on undergraduate embedded systems which focuses on the usage of state machines as design patterns for microcontroller programming; the textbook also introduces fundamental concepts such as fixed-point arithmetic (in software), real-time systems, concurrent state machines, digital signal processing, and control theory. Dr. Vahid and Dr. Givargis also developed a software learning suite comprised of the Riverside-Irvine Builder of State Machines (RIBS) and the Riverside-Irvine Microcontroller Simulator (RIMS), which are used extensively in CS.120B. Although the development of these learning materials pre-dates Dr. Brisk's appointment at UCR, he has promoted their use and adoption in CS.120B. Students use RIBS and RIMS for homework assignment, and to assist them in the laboratory sections where they program state machine applications using AVR microcontrollers.

Dr. Brisk also teaches the CS 179J senior design project course on computer architecture and embedded systems. Dr. Brisk has introduced several new project options into CS 179J, included the smart phone application development for the Android platform, which was received quite favorably by the students. Dr. Brisk has also developed projects around his research on programmable microfluidics, which expose undergraduates to an exciting and emerging interdisciplinary technology. Finally, Dr. Brisk has introduced video processing projects as

options for CS 179J, which include the use of webcams and Microsoft Kinect 3D cameras. Dr. Brisk obtained an equipment donation from Intel for use in present and future CS 179J offerings. The equipment includes 10 Intel Atom processor development boards, and one Intel Atom E600 "Stellarton" development, which includes an lntel Atom processor and Altera Arria FPGA integrated into the same package. Dr. Brisk has used this equipment in video processing projects in the Winter 2012 offering of CS 179J, and they will be made available for future offerings of CS 179J as well.

Dr. Vagelis Hristidis was hired in 2011 partly to replace the loss of Dr. Gunopulos, but also to give us more of a presence in information retrieval. Since coming to UCR Dr. Hristidis created new course CS 172, "Introduction to Information Retrieval," which was offered for the first time in Spring 2012. This course teaches students the cutting edge technologies employed in Web search engines and other domain-specific search systems. In addition to examinations, this course involves group projects, where students study and develop various aspects of Information Retrieval. Further, Dr. Hristidis has experience in teaching Database Systems and Data Structures courses. He has also been involved in undergraduate research activities funded by the NSF, as supplements to his research grants. In the past, he has mentored about 10 undergraduate students through this program.

Dr. Harsha Madhyastha was hired in 2010 to augment our existing strength in networking and to add a more systems-building approach to research and teaching at UCR. Dr. Madhyastha has significantly revised the material for CS 153 to make the material more up-to-date. The class now covers all issues underlying operating systems, with a discussion on how various operating systems components (such as scheduling and virtual memory management) are implemented in modern operating systems such as Windows, Linux, and Mac OS. Dr. Madhyastha has also ensured now that the students in CS 153 get their "hands dirty" implementing the basics of operating systems, rather than simply learning the theory underlying them in class. For this, the class now includes projects based on the popular Nachos framework, which is also used in undergraduate operating systems classes at UC Berkeley and UC San Diego. Moreover, these projects are done in teams and requires students to build on top of a basic Nachos code base. This gives the students experience with working in groups and with adding to legacy code, issues that they will have to deal with when they graduate and take up positions in the industry. Since the Nachos framework requires students to write code in Java, an added benefit of the revised CS 153 is that UCR CSE students gain expertise in a new programming language.

Dr. Tamar Shinar was hired in 2010 because we only had one professor (Dr Zordan) who could teach our very popular classes in computer graphics, and in order to strengthen the department's presence in computer graphics and scientific computing. She has given informational lectures about her research in the undergraduate Computer Science seminar, advised undergrads with an interest in pursuing a career in graphics, and will be teaching undergraduate level computer graphics this academic year.

Finally, at the time of writing this document we have permission to hire **two new faculty**. We have completed our interview cycle and we have offers out. We are seeking candidates in Operating/Distributed Systems, Cyber-security and Cyber-physical systems.

Since the last ABET visit, the Electrical Engineering Department lost:

- **Ilya Lyubomirsky** left as of the end of 10/11.
- **Afshin Abdollahi left** as of the end of 10/11.
- **Gerardo Beni** retired as of the end of 10/11.

Over the same time, two faculty have taken extended leaves of absence:

- **Jie Chen** (LOA: 10/11—12/13) is at City University of Hong Kong.
- **Daniel Xu** (LOA: 11/12 – 13/14) is at Tsinghua University.

In the same time periods, the EE department has hired five faulty and expects to hire two more to start in Fall 2012:

Albert Wang (Ph.D. 1996, State University of New York at Buffalo) was hired as a Full Professor in 2007. He has expertise in RF/analog/mixed-signal integrated circuits; on-chip electrostatic discharge; system-on-a-ship; IC CAD and modeling; nano and emerging devices and circuits.

Elaine Haberer (Ph.D. 2005, University of California, Santa Barbara) was hired as an Assistant Professor in 2008. Her expertise is in bio-templated materials for electronic, optoelectronic, and energy applications; nano-structured hybrid materials; novel top-down and bottom-up assembly techniques.

Anastasios Mourikis (Ph.D. 2008, University of Minnesota) was hired as an Assistant Professor in 2008. His expertise is in autonomous vehicle localization; multi-robot systems; estimation in mobile sensor networks; vision-aided inertial navigation; simultaneous localization and mapping.

Wei Ren (Ph.D. 2004, Brigham Young University) was hired as an Associate Professor in 2011. His expertise is in in distributed control of multi-agent systems; networked control systems; autonomous control of unmanned vehicles.

Qi Zhu (Ph.D. 2008) was hired as an Assistant Professor in 2011. His expertise is in computer engineering.

B. Faculty Workload

The Faculty workload is shown in table 6-2 later in this section.

C. Faculty Size

The faculty cover all the broad areas of the program as mentioned above. All required courses are covered by the tenured/tenure-track faculty and lecturers. Faculty are actively involved with the students (examples of faculty leading undergraduate research are listed below). Each faculty holds weekly office hours for the students in the courses. Moreover, our BCOE has an informal "open door" policy, and students are invited to drop by professor's offices any time the door is open, which it is at least 30 hours for the majority of faculty.

All faculty serve on various committees that look into student evaluation and curriculum. University service consists primarily of involvement in department and college committees, as

well as Academic Senate committees (as per the shared governance structure of the University of California). All faculty in the CEN Program actively participate in research activities and most of them have large research groups funded by extramural grants and contracts. This requires them to be up-to-date on the latest developments in the field by reading journals, attending conferences, participating in government panels, and reviewing activities.

As noted above the Computer Engineering program is jointly administered by CSE and EE. The Department of Computer Science and Engineering currently has five lecturers and twenty-two tenure-track faculty, and the Department of Electrical Engineering also has twenty-two faculty members.

For ladder-track faculty, the teaching load is relatively light. For full-time lecturers, the teaching load is three courses per quarter, but these are not three unique courses. Typically, in the UCR system we expect a faculty member to devote 40% of his/her time to teaching, 40% to research, and 20% to service. The research and service components in particular afford opportunities to remain abreast of developments in the professor's research field and in pedagogy.

Many of the faculty have close associations with industry, and these are exploited to expose the students to industry. For example in ENGR 101 the instructors bring in industrial and professional practitioners to both give formal talks, and participate in informal question and answer sessions. In the most recent offering, guest speakers included, Dr. Casey Czechowski (Teradata), Diego Villasenor (Microsoft), Dr. Lisa McIlwain and Dr. Sivaram Gopalakrishnan (Synopsys), Jose Medina (Dreamworks) and Marc Soriano (RCC Norco and Art Institute Santa Monica).

Faculty are eligible for sabbaticals. Faculty members have resources from initial complements, "*various donors*" funds, and contract and grant awards to travel to meetings and conferences in their disciplinary areas or in engineering education. Some additional funds are available from the College, the campus, and the Faculty Senate. These resources are sufficient to assure that professors are able to maintain currency in their fields. New faculty receive startup packages that allow them to purchase excellent facilities. Every four years, each UCR faculty member gets a $2000 stipend to upgrade office computing facilities.

To address faculty's currency in pedagogy, the UCR Office of Instructional Development has established a Scholarship of Teaching lecture series for faculty and instructors to enhance the quality of teaching throughout the campus. Presentations highlight

- The effective use of current and emerging instructional methodologies and technologies.
- Strategies for the introduction of active learning, peer to peer learning, and collaborative approaches in teaching.
- Pedagogical approaches to enhance student engagement and optimize student learning outcomes.
- Effective approaches to teaching and learning in and outside of the classroom.
- The engagement of teaching community in the collaborative, scholarly examination of their practice as teachers.
- The development of assessment tools to measure student learning outcomes.
- The development of a campus culture of evidence regarding our academic programs.

Not only do many faculty *attend* these lectures, but members of the Computer Science department have *taught* them. For example Dr. Victor Zordan taught a lecture on teaching to Multidisciplinary teams. Most lectures are presented by faculty or administrators from UCR,

and some by outside presenters. Many deal with new teaching resources and technologies available for use at UCR.

6.C.1 An Overview of our Efforts and Achievements in Undergraduate Research

The department has a long tradition of encouraging undergraduate research. For example, research efforts with undergraduates are highlighted in the department's cover letter for promotion and tenure. In every case the faculty members labs are large enough to allow undergrads desk space next to graduate students and post-docs, and most of our faculty take advantage of this.

Some Representative Examples of how our Faculty Engages Undergraduate Research:

In his three years at UC Riverside, Dr. **Iulian Neamtiu** has established a strong track record of supervising and publishing with undergraduate students. He has supervised one undergraduate student (Michael Lambert) under a Title V/STEM project (undergraduate research for Hispanic and low-income students). He has supervised another undergraduate student, Garrett Wong, for more than one year (2010--2011). Garrett is now an MS student at UC Irvine. In Summer 2011 he has supervised two undergraduate students, (one female, Nada Hashem), and one Hispanic (Lorenzo Gomez) on research projects. Nada Hashem is currently applying to MS programs in bioinformatics. Lorenzo Gomez will pursue a PhD in Computer Science; he has been offered admission into the PhD programs at USC, UCI and UCLA.

Dr. **Philip Brisk** is a strong advocate of undergraduate research at UCR. He presently supervises approximately 10 undergraduate student researchers, the most advanced of which (approximately 5) are funded part-time through his NSF grant. The majority of these undergraduate student researchers are working on topics relating to programmable microfluidics, and one is using the Stellarton development board to accelerate image processing algorithms using the FPGA. Several of these students have co-authored papers submitted for publication to top-tier conferences in embedded systems, and several other papers co-authored by undergraduates are in preparation at the time of writing.

Dr. **Eamonn Keogh** demonstrates the decade-long culture of the CS department in encouraging and valuing undergraduate research. In his first year with the department he wrote two papers with an undergrad, Ms. Shruti Kasetty. One of those papers, now has 539 citations (Google Scholar) and is widely regarded as a classic work in time series data mining. Dr Keogh has also published at least one top-tier paper with the following UCR undergrads Shashwati Kasetty, Scott Sirowy, Sam Meshkin, Jin Shieh and Isaac Espinoza. Dr Keogh is currently supervising two undergraduate students, Vinci Sevilla and Dante Jamal O'Hara who are both working on an insect classification project funded by the Bill and Melinda Gates foundation and a gift from IBM. With Dr. Keogh's help and advice, both students are using this research experience as the cornerstone of their applications to graduate schools, and to apply for funding to cover their last year as undergrads. For example, Vinci has just applied for a UCR Chancellor's Research Fellowship, and Dante has *won* a HSI (Hispanic Serving Institution) Undergraduate Research Award based on the insect classification device he built in Keoghs Lab. Dr. Keogh has won more than $17,000 of grants just for undergrad research.

Dr. **Christian Shelton** has mentored four undergraduate students in his lab over the past five years. One is a current UCR undergraduate who has applied to PhD programs. The other three graduated in 2010. Two are current PhD students (at UCSD and UCI) in computer science, one

just finished his MS degree (from UCSD). They are authors on two papers from Dr. Shelton's group, including a collaboration after leaving UCR. Dr. Shelton makes a point to include all undergraduates in group research meetings, to give them equal space in his research lab, and to encourage them to fully participate in the research activities so that they can better understand the research process and whether graduate work is of interest to them. He meets with undergraduate students in his group weekly (just as with graduate students) to discuss progress and possible solutions.

Dr. **Vagelis Hristidis** has worked with several undergraduate students on research projects in the last five years. These students were mostly supported by NSF Research Experiences for Undergraduates supplements. Dr. Hristidis has rigorously followed the process of regular research meetings, where students are exposed to the research process, as well as concrete research/implementation assignments. He has worked with students Alejandro Hernandez and Dionny Santiago, currently working for Ultimate Software in Miami, Michael Tracey, currently at Lockheed Martin, Salma Rodriguez, currently a senior student, and others.

Drs. **Marek Chrobak** and **Neal Young** have been working with undergraduate students on two research projects related to the design of algorithms and data structures. One project was focused on algorithms for drawing diagrams. Of the three students involved in this project, two (M. Yang and M. Ngan), are now in graduate programs, one at UCR and one at USC. The other research projects involved four students: S.Denny, F.Thomas, J.Fang and C.Manghane, who are working on designing efficient algorithms for computing dominators in graphs, a problem that has a variety of applications ranging from compiler design to the design of multi-plot games. S.Denny has graduated last year and entered our graduate program, while the other three students continue working on this project. All of these students were supported by an REU grant from NSF. One of the students (M. Ngan) is female and one (C. Manghane) is African-American.

Dr. **Walid Najjar** has always been a very strong advocate of extensive faculty support for undergraduate research, having been himself the beneficiary of such efforts. Over the past four years Dr. Najjar has supervised the research experience of six undergraduate students. All of these are either already enrolled in a graduate program in CSE or have applied to one. These include Adrian Park (co-author on two research papers), Robert Halstead (co-author on two research papers), Joseph Tarango, Xi Luo, Scott Denny and Skyler Windh.

Dr. **Stefano Lonardi** has advised several undergraduate students either in a quarter of "directed studies" and/or by involving them directly in the research of his lab. He has advised eight undergraduate students since 2002. At least four of these students were admitted to graduate school. The last undergraduate student under his supervision, Matt Alpert, worked in his lab for the last two years. Dr. Lonardi was able to obtain NSF REU for him twice during the summer. His contributions to Lonardi's project on the genome sequencing of barley have been very significant. He is a co-author of a manuscript currently submitted a high impact factor journal and as a result of his work, Matt was awarded the 2011 CEPCEB Undergraduate Research Award, which is a campus-wide recognition at UC Riverside.

Prof. **Frank Vahid** actively seeks undergraduate researchers to work in his embedded systems research lab, to give them experiences that may improve their chances of completing their degree, to better understand and master their course material, and to encourage top students to consider graduate study. Prof. Vahid has consistently employed between 3-6 undergraduates at any given time during the past 15 years. Prof. Vahid presently employs six undergraduate

students, with the two seniors planning on graduate studies with Vahid at UCR next year. Last year's two seniors went on to graduate studies in top research groups at UCLA and at EPFL (Switzerland). Eight of his past undergrad researchers obtained PhDs with Vahid, five of those became professors (two female), three of those thus far have received NSF CAREER awards, and one other recently won the prestigious international Terman award for young professors. Of the 20 or so undergraduates employed by Vahid in the past 10 years (about half of them female), nearly all have gone on to graduate studies, with most of those indicating they'd originally had no intention of considering grad school, and with the other students obtaining excellent jobs in part due to their unique lab experiences. In the past 10 years, Prof. Vahid has obtained more than 5 grants specifically to support undergrad research, totaling $150,000.

Dr. **Gianfranco Ciardo** has worked with several undergraduate students at UCR in the past years. Jevons Chen and Miguel Rodriguez spent the 2000 Summer quarter in an internship in Dr. Ciardo's lab, working in conjunction with graduate students on implementation of a software verification tool. Diego Villasenor was affiliated for two years with Dr. Ciardo's lab, supported by a UC LEADS fellowship; he implemented a run-time dynamic visualization tool in java to display large decision diagrams as they are being built. He is now a PhD student at UCLA. Currently, Dr. Ciardo is supervising Mantej Singh Rajpal on a research, and eventually implementation, project aimed at storing very large sets of arbitrary (but finite) length strings, and efficiently manipulating them symbolically (instead of one-by-one).

Dr. **Victor Zordan** has a continuing history of working with undergraduates in his research lab. He averages projects with 2-3 undergraduates per year and many of these have gone on to graduate school. One example is David Brown who has seen good success thus far. As an undergraduate David began volunteering in Dr. Zordan's lab and published a paper as a co-author in a top conference in 2010. He also was admitted into our first cohort for the 5-year BS/MS program. Beyond being a top student academically, he has recently submitted a strong submission to Siggraph and has been admitted to several good schools to pursue his Ph.D. He plans to attend University of British Columbia in the fall. A second example, Raul Arista, (an ME undergraduate) has been working with Dr. Zordan for the past year, he will also be a co-author on a solid submission (in preparation) and is likely to attend graduate school. Other students (CS/CE) have worked with Dr. Zordan and most choose to attend graduate school after the experience.

Dr. Sheldon Tan has been very actively involving with undergraduate researchers at his MSLAB in the past. After he joined UCR in 2002, he has invited about 40 undergraduate researchers to work in his lab for one or more quarters. Some of them are female students, including Amalia Aviles and Mary Ma, Nemata Blyden, Muhua Ngan Jaqueline Garay, Among them, Kenneth Anguka and Nemata Bkyden are African American. Daniel Sandez, Melvin Dialo are Hispanic students. Jaqueline Garay is Hispanic female student. Many of the undergraduate students were funded by the previous REU fund (2005, 2007, 2008, 2009, 2010, 20111). From 2007 and 2008, Dr. Tan also recruited 9 UCR undergraduate students to participated NSF IRES program (OISE-0623038).The nine students are : David Kwak, Curtis Yu and Thom J. Eguia in 2007, Jacob Relles, Krystof Litomisky and Nemata Blyden in 2008 and Kevin Lemen, Muhua Ngan and Daniel Sandez in 2009. The nine students visited Tsinghua University in the summers 2007 to 2009 and participated in the jointed research works, which resulted in five research papers in ISRS-UCR 09-10 and SCCUR 07-09. In 2012, Dr. Tan recruited another four U.S. students for his new NSF IRES program (OISE-1130402): Jaqueline

Garay, Omar Olmos, Alexander Chaney, Eric Mlinar. Many of the undergraduate students are now pursuing the graduate study in UCR and other schools. Two of the students, Thom Eguia and Jacob Relles became the PI's Ph.D. graduate students in the fall 2008.

D. Professional Development

All faculty members are expected to be active in research and professional activity throughout their careers. It is common for new faculty hires to have money in their initial complements for travel to meetings of professional societies or other scholarly events. Later in their careers, grant funding typically supports the cost of travel to meetings and conferences, where they share research results.

The departments and degree programs cooperate to present lecture series every academic year. These series bring faculty candidates and distinguished guests from academia or industry to campus. Faculty and students attend these sessions.

Intramurally, professional development opportunities include workshops on teaching skills, interpersonal skills, and other matters. State law and University policy also require training in sexual harassment prevention, laboratory safety, and other matters.

For the past few years, the National Science Foundation has required grantees to provide training in responsible conduct of research (RCR) to all trainees who are paid on NSF grants. In response, UCR and the College have established training resources including an on-line tutorial, and departments are encouraged to include topics in research ethics and engineering ethics in their lecture series and courses. By being required to train their students in RCR, faculty members continually refresh themselves in this subject area. Similarly, NSF requires postdoctoral trainees who are supported by its grants to be mentored by their faculty advisors so they can become independent investigators. This mentoring takes many forms but requires faculty members to maintain their skills as mentors.

Faculty members have significant resources from initial complements, "various donors" funds, and contract and grant awards to travel to meetings and conferences in their disciplinary areas or in engineering education. Many of the faculty aggressively seek, and have been successful in obtaining REU supplements to NSF awards. Additional funds are available from the College, the campus, and the Faculty Senate. One concrete example includes the yearly Academic Senate Award, which faculty may applied for to allow funding for conference travel, undergrad research etc. These awards range in value, but are typically $1,500. While these awards are not guaranteed, the acceptance rate is over 80%. These resources are more than sufficient to assure that professors are able to maintain currency in their fields.

Regular sabbatical leave provides salary at varying percentages of regular salary, depending on the amount of accrued sabbatical leave credit and the option elected by the eligible appointee. However, as a concrete example, a faculty member that has worked 18 quarters is entitled to two quarters sabbatical at full salary. An individual on such regular sabbatical leave is excused from all regular duties to enable full-time effort to research and/or study. The Leaves of Absence/Sabbatical Leave policies are detailed in document APM-740, which is publicly available at this URL:

www.ucop.edu/acadpersonnel/apm/apm-740.pdf

The faculty frequently attend and present at conferences and workshops worldwide.

E. Authority and Responsibility of Faculty

All program issues are initiated by the Departmental faculty. Many of the faculties devise new courses as technical electives based on their research expertise. Changes in program

must be approved by a vote of the Departmental faculty and also the Executive Committee of the College of Engineering as depicted in Figure 21.

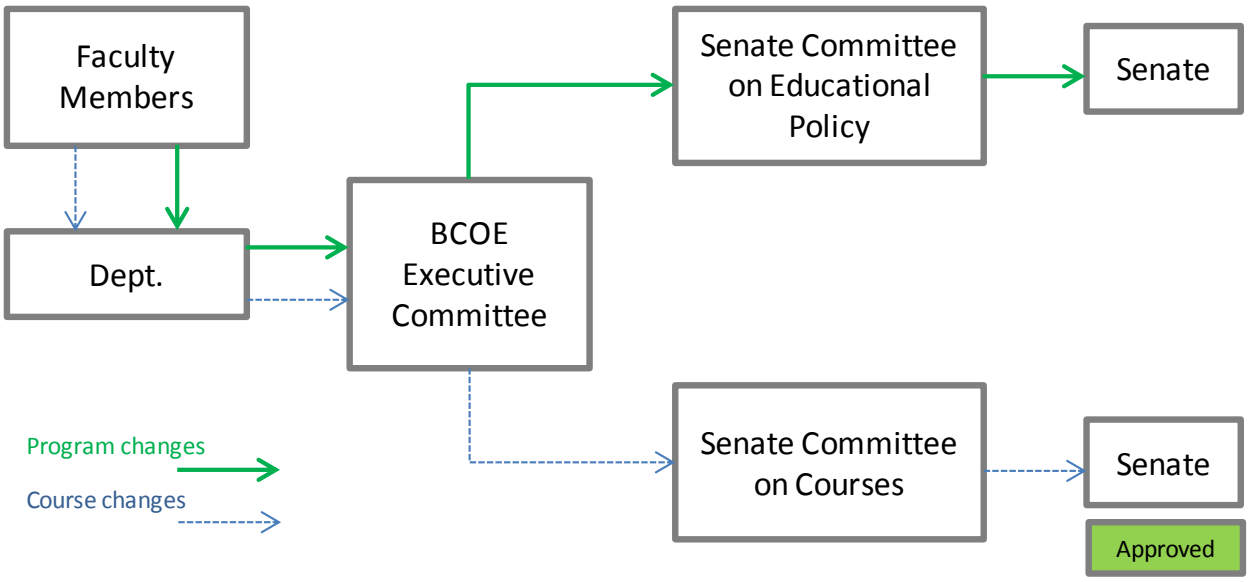

Figure 21: Process for Obtaining Academic Approval for Program/Course Changes

Note: Below we describe the role played by the faculty in *course revision*. The role they play *in the development and implementation of the processes for the evaluation, assessment, and continuing improvement of the program, including its program educational objectives and student outcomes* is subsumed by Section 4.

Course creation, modification and evaluation are entirely the responsibility of CEN faculty. The Dean of the College (or anyone else) may make suggestions about curricular matters, but it is the faculty's responsibility to take action.

Courses may be created or modified through an established process through the faculty governance system. Ultimately, the Committee on Courses (a campus wide-committee), has authority for final approval of all courses of the Riverside Division. This committee consists of a minimum of eight members, normally with at least one member representing each of the areas: humanities, social sciences, biological sciences, and physical sciences, and each of the colleges/schools. One member of the Committee on Courses is also a member of the Committee on Educational Policy. In the recent past, Dr. Zhengyuan Xu, Electrical Engineering and Dr. Neal E. Young, Computer Science & Engineering have been committee members, and in the next Academic year, Dr. Philip Brisk, Computer Science & Engineering will serve.

The procedure for course creation or modification is as follows:

1. A department faculty member identifies a need for course creation or modification. If the faculty member is not familiar with the process, he/she will read the following documents, which are maintained at *http://senate.ucr.edu/committee/?do=info&id=8* :
    - Preparer's Course Request Checklist and Quick Tips
    - Faculty Checklist

- General Rules and Policies Governing Courses of Instruction (Course Guidelines)
- Submission Deadlines for Course Proposals for 2012-13

These documents are *very* detailed and complete, and perhaps a little intimating to a first time proposer. However, Academic Senate support staff member, Ms. Marla Jo Booth is very responsive to requests for help.

2. After discussion with other department faculty, a "*Request to Approve a New Course or Revise a Course*" form is completed.
3. Department faculty members, at every rank, vote on the proposal. At this stage the ABET Binders (c.f. Section 4.B) are consulted.
4. The request is sent to the Committee on Courses, which presents the request at a meeting of the Committee for a vote.

Responsibility for consistency and quality of courses resides within the department.

Table 6-1. Faculty Qualifications

Computer Engineering (from the CS Dept)

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment [2] T, TT, NTT	FT or PT [3]	Years of Experience			Professional Registration/ Certification	Level of Activity [4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Laxmi N. Bhuyan	Phd: 1981	P	T	FT	3	23	12		M	M	M
Philip Brisk	Phd: 2006	AST	TT	FT	6	3	3		M	M	L
Marek Chrobak	Phd: 1985	P	T	FT	0	17	15		M	M	M
Gianfranco Ciardo	Phd: 1989	P	T	FT	6	20	9		M	M	L
Michalis Faloutsos	Phd: 1999	P	T	FT	0	13	13	ACM/IEEE	L	M	M
Rajiv Gupta	Phd: 1987	P	T	FT	3	22	5	ACM/IEEE	H	M	L
Vagelis Hristidis	Phd: 2004	ASC	T	FT	0	8	1		M	M	L
Tao Jiang	Phd: 1988	P	T	FT	0	23	13	ACM	H	M	L
Eamonn Keogh	Phd: 2001	P	T	FT	0	11	11	ACM	M	H	L
Srikanth Krishnamurthy	Phd: 1997	P	T	FT	3	11	11	ACM/IEEE	H	M	L
Stefano Lonardi	Phd: 2001	P	T	FT	0	11	11	ACM/IEEE	M	M	M
Harsha Madhyastha	Phd: 2008	AST	TT	FT	0	2	2	ACM/IEEE /USENIX	M	M	L

Mart Molle	Phd: 1980	P	T	FT	0	21	14		M	M	M
Walid Najjar	Phd: 1988	P	T	FT	0	24	12	ACM/IEEE /AAAS	H	M	H
Iulian Neamtiu	Phd: 2008	AST	TT	FT	3	3	3	ACM	H	M	M
Chinya Ravishankar	Phd: 1993	P	T	FT	5	24	13	ACM/IEEE	M	L	L
Christian Shelton	Phd: 2001	ASC	T	FT	1	8	8		M	M	M
Tamar Shinar	Phd: 2008	AST	TT	FT	5	1	1	ACM	M	M	L
Frank Vahid	Phd: 1994	P	T	FT	1	19	18		M	M	M
Neal Young	Phd: 1991	P	T	FT	4	12	8		L	M	M
Victor Zordan	Phd: 2002	ASC	T	FT	1	10	9		M	M	M
Vassilis Tsotras	Phd: 1991	P	T	FT	0	21	15		L	M	L
Thomas Payne	Phd: 1967	ASC	T	FT	0	44	44		M	M	M
Ray Klefstad	Phd: 1998		NTT	FT					L	H	L
Brian Linard	Phd: 1998		NTT	FT					L	M	L
Kris Miller	Msc:		NTT	FT					L	M	L
Ryan Rusich	Phd: 2010		NTT	FT					L	M	L
Scott Sirowy	Phd: 2010		NTT	FT					M	L	L
Victor Hill	Msc:		NTT	FT					H	H	L

Table 6-1. Faculty Qualifications (Continued)

Computer Engineering (from the EE Dept)

Name	Rank	FT or PT	Highest Degree	Institution from which Highest Degree Earned & Year	Years of Experience			State in which registered	Level of Activity (high, med, low, none) in:		
					Gov't./Industry Practice	Total Faculty	This Institution		Professional Society (Indicate Society)	Research	Consult/ Smr. Work in Industry
Balandin, Alexander	Professor	FT	Ph.D.	University of Notre Dame, 1997	0	13	13		High (IEEE, APS, OSA, SPIE, IOP, MRS, ECS)	High	High
Barth, Matthew	Professor	FT	Ph.D.	UC Santa Barbara, 1990	1	17	17		IEEE: High Trans. Rsch. Board: High ITS America: Med.	High	Low
Bhanu, Bir	Distinguished Professor	FT	Ph.D.	University of Southern California, 1981		22	21			High	High
Chen, Jie	Professor	FT	Ph.D.	University of Michigan, 1990	0	18	18				
Dumer, Ilya	Professor	FT	Ph.D.	Institute for Problems of Information Transmission Russian Academy, 1981	0	17	17		High	High	Low
Farrell, Jay	Professor	FT	Ph.D.	University of Notre Dame 1989	4.5	18.5	18.5		High	High	Medium
Hua, Yingbo	Professor	FT	Ph.D.	Syracuse Univ., 1988	2	21	11		High	High	Medium
Korotkov, Alexander	Professor	FT	Ph.D.	Moscow State Univ., 1991	0	13	12		Medium	High	Non
Lake, Roger	Professor	FT	Ph.D.	Purdue University 1992	7	12	12		IEEE(High), APS(Low), MRS(Low), AAAS(Low)	High	Low
Liang, Ping	Associate Professor	FT	Ph.D.	University of Pittsburgh, 1987	5	20	20		IEEE: Med	Med	Med
Liu, Jianlin	Professor	FT	Ph.D.	UC Los Angeles, 2003	0	9	9				
Ozkan, Mihrimah	Professor	FT	Ph.D.	UC San Diego, 2001	0	11	11				

Ren, Wei	Associate Professor	FT	Ph.D.	Brigham Young University 2004	0	8	1		High	High	None
Roy-Chowdhury, Amit	Associate Professor	FT	Ph.D.	University of Maryland, College Park 2002	0	8	8				
Tan, Sheldon	Professor	FT	Ph.D.	Univ. of Iowa, 1999	3	10	10		Medium	High	Medium
Tuncel, Ertem	Associate Professor	FT	Ph.D.	UC Santa Barbara, 2002	0	9	9				
Wang, Albert	Professor	FT	Ph.D.	State University of New York, Buffalo, 1996			5				
Xu, Zhengyuan (Daniel)	Associate Professor	FT	Ph.D.	Stevens Institute of Technology, 1999	0		13				

Instructions: Complete table for each member of the faculty in the program. Add additional rows or use additional sheets if necessary. Updated information is to be provided at the time of the visit.

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other
2. Code: T = Tenured TT = Tenure Track NTT = Non Tenure Track
3. Code: FT = Full-time PT = Part-time Appointment at the institution.
4. The level of activity (high, medium or low) should reflect an average over the year prior to the visit plus the two previous years.

Table 6-2. Faculty Workload Summary

Computer Engineering: (Electrical Engineering Department)

Faculty Member (Name)	FT or PT	Classes Taught (Course No. /Credit Hrs.)	Total Activity Distribution			Other service (if applicable)
			Teaching Year	Research Year	Other Year	
Balandin, Alexander	FT	EE 190 (11F),EE202 (12W), EE 216 (12S)	20%	50%	30%	MSE Program Chair
Barth, Matt	FT	EE 128 (11F) , EE 197 (12W)	20%	50%	30%	CE-CERT Director
Bhanu, Bir	FT	N/A	20%	50%	30%	CRIS Director
Dumer, Ilya	FT	EE 115 (11F), EE 150 (12W), EE 224 (12W), EE 225 (12S)	30%	50%	20%	
Farrell, Jay	FT	EE 105 (12W), EE 236 (12W),	30%	50%	20%	
Haberer, Elaine	FT	EE 138 (11F), EE 203 (12S)	30%	50%	20%	
Hua, Yingbo	FT	EE 110A (11F), EE 210 (12W), EE 211 (12S), EE 226 (12S)	30%	50%	20%	
Korotkov, Alexander	FT	EE 133 (11F), EE 201 (11F), EE 100A (12W)	40%	40%	20%	
Lake, Roger	FT	N/A	0	100	0	Sabbatical
Liang, Ping	FT	EE 141 (11F), EE 175A (12W), EE 175B (12S)	30%	40%	30%	EE Undergraduate Advisor
Liu, Jianlin	FT	EE 190 (12W), EE 136 (12S), EE 206 (12S)	20%	50%	30%	
Mourikis, Anastasios	FT	EE 230 (11F), EE 146 (12W), EE 144 (12S)	40%	40%	20%	
Ozkan, Mihri	FT	EE 137 (12W)	20%	60%	20%	
Ren, Wei	FT	EE 235 (11F), EE 237 (12W), EE 151 (12S)	40%	40%	20%	
Roy Chowdhury, Amit	FT	EE 247 (12W), EE 114 (12S)	20%	50%	30%	ABET Coordinator (for EE)
Tan, Sheldon	FT	EE 120A (12W)	20%	50%	30%	CEN Associate Director & Undergraduate Advisor CmpE
Tuncel, Ertem	FT	EE 215 (11F), EE 110B (12W), EE 259 (11F, 12W, 12S)	20%	50%	30%	Graduate Advisor
Wang, Albert	FT	EE 135 (12S), EE 221 (12S),	20%	50%	30%	UC Light Director
Xu, Zhengyuan	FT	N/A				

Zhu, Qi	FT	EE 120A (11F), EE 134(12W)	30%	50%	20%	
Abou-Galala, Feras	PT	EE 001A (11F), EE 001B (11F), EE 110A (12W), EE 020 (12S), EE 110B (12S), EE 132 (12S)	100%			
Amos, Nissim	PT	EE 100B (12S)	100%			
Chen, Gang	PT	N/A		100%		
Chomko, Roman	PT	EE 100A (11F), EE 100B (12W), EE 139 (12W), EE 175A (12W), EE 001A (12S), EE 116 (12S), EE 175B (12S)	100%			
El-Sherief, Hossny[6]	PT	EE 001B (12W)	100%			
Khitun, Alexander	PT	N/A			100%	
Khizroev, Sakhrat	PT	N/A	20%	60%	20%	

Computer Engineering: (Computer Science Department)

Faculty Member (Name)	FT or PT	Classes Taught (Course No. /Credit Hrs.)	Total Activity Distribution			Other service (if applicable)
			Teaching	Research	Other	
			Year	Year	Year	
Laxmi N. Bhuyan	FT		20%	50%	30%	CS Chair
Philip Brisk	FT	(W11) CS120B, (W12) CS120B, (F11) CS161, CS161L, (W12)179J, (S12) CS120B	20%	50%	30%	
Marek Chrobak	FT	W(11) CS111, (S11) CS111, (F11) CS111, (W12) CS111, (S12) CS111	20%	50%	30%	
Gianfranco Ciardo	FT	(S11) CS177, (F11) CS179K, (W12) CS150	20%	50%	30%	CS Grad Advisor
Michalis Faloutsos	FT	(F10) ENGR001G, (F11) ENGR 001G,I,M	20%	50%	30%	Publicity chair
Rajiv Gupta	FT	(W11) CS152, (W12) CS152	20%	50%	30%	
Vagelis Hristidis	FT	(S12) CS172	20%	50%	30%	
Tao Jiang	FT	(W11) CS150, (S11) CS150, (S12) CS150	20%	50%	30%	Graduate Admissions
Eamonn Keogh	FT	(F10) CS179M, (W11) CS005	20%	50%	30%	ABET Chair
Srikanth Krishnamurthy	FT	(S11) CS169, (W12) CS164	20%	50%	30%	Search Chair
Stefano Lonardi	FT	(F10) CS141, (F11) CS141	20%	50%	30%	Associate Chair
Harsha Madhyastha	FT	(S11) CS153, (W12) CS153	20%	50%	30%	Search Committee

[6] For all part-time Adjunct faculty and Lecturers, the percentages in the "Other" category represent time spent through their regular employment outside of the university

Mart Molle	FT	(W11) CS164, (S11) CS30, CS179I, (W12) CS177, (S12) CS30, CS179I	20%	50%	30%	
Walid Najjar	FT	(F10) CS161, CS161L, (S11) CS161, CS161L, (S12) CS161, CS161L	20%	50%	30%	CEN Program Director
Iulian Neamtiu	FT	(W11) CS180, (W12) CS180	20%	50%	30%	Search Committee
Chinya Ravishankar	FT	(F10) CS165, (F11) CS165	20%	30%	50%	Associate Dean
Christian Shelton	FT	(W11) CS170, (W12) CS170, (S12) CS181	20%	50%	30%	Grad Admissions
Tamar Shinar	FT	(S12) CS130	20%	50%	30%	Grad Admissions
Frank Vahid	FT	(F10) CS122A, (W11) CS61, CS179J, (W12) CS120B	30%	50%	20%	Undergrad Committee
Neal Young	FT	(F10) ENGR101, (S11)CS141, (F11) ENGR101, (S12) CS141	20%	50%	30%	Undergrad Adviser
Victor Zordan	FT	(W11) CS130, (S11) CS134	0%	0%	0%	Sabbatical
Vassilis Tsotras	FT	(F10) CS166, (S11) CS166, (F11) CS166, (S12) CS166	20%	50%	30%	Search Committee
Thomas Payne	FT	(F10) CS100, (W11) CS153, (S11) CS100, (F11) CS100, (W12) CS100, (S12) CS153	60%	10%	30%	Emeritus
Sharon Burton	PT		100%	0%	0%	Burton & Graham always *co-teach* ENGR 180
Bonni Graham	PT	(F10,F11,S11,S12) ENGR 180	100%	0%	0%	
Toby Gustafson	FT	Does not teach major classes		0%	0%	
Ray Klefstad	FT	(F10) CS5, CS14, (W11) CS6, CS14, (S11) CS6, CS14, (F11) CS5, (W12) CS6, CS14, (S12) CS6, CS100	100%	0%	0%	
Brian Linard	FT	(F10) CS10, CS61, (W11) CS5, CS12, (S11) CS12, CS61, (F11) CS6, CS61, (W12) CS12, CS61, (S12) CS12, CS61	100%	0%	0%	
Richard McHard	PT	(F10) CS6, CS111, (F11) CS12, CS14	100%	0%	0%	
Kris Miller	FT	(F10) CS10, (W11) CS10, (S11) CS10, CS13, (F11) CS10, (W12) CS10, (S12) CS10, CS13	100%	0%	0%	
Ryan Rusich	PT	(summer2010) CS10	100%	0%	0%	
Scott Sirowy	PT	(F11) CS122A	100%	0%	0%	
Victor Hill	PT	(F10) CS183, (F11) CS183	100%	0%	0%	

CRITERION 7. FACILITIES

A. Offices, Classrooms and Laboratories

The Bourns College of Engineering occupies Bourns Hall (approximately 105,000 assignable square feet with wet labs, classrooms, and offices), Winston Chung Hall (approximately 104,000 square feet with dry labs, classrooms, and offices), and part of the Materials Science and Engineering Building (approximately 77,000 assignable square feet with wet labs, classrooms, and offices). Bourns Hall opened in 1995. Winston Chung Hall opened in 2001, and the MSE Building opened in 2011.

The Department of Electrical Engineering has dedicated office space and laboratory space in all three buildings. The Department of Computer Science and Engineering has dedicated space in Winston Chung Hall.

All departments share classrooms and conference rooms. The assignment of classrooms for each course is made by a joint effort between the Student Affair Office of the Bourns College of Engineering and the Scheduling Office of the Registrar Office. The Student Affair Office requests a room from the Scheduling Office providing the enrollment for the individual class. The centralized Scheduling Office then assigns a room in different buildings on campus with the best availability to accommodate the size of the class. Special request for additional lectures, tutorials, discussions, and examinations can be made by the instructor directly within the College of Engineering. The TA office in Winston Chung Hall sometimes can be used to hold additional tutorials with prior acknowledgment.

The Campus has 60 general-assignment classrooms of varying sizes, each of which is equipped with wireless Internet access, a 3000-lumen video projector connected to a networked PC, and the targets/receivers for wireless audience-response clickers.

Instructional Laboratories

Computer Science and Engineering (which partly hosts CEN)

The Computer Engineering program is designed to provide students with extensive experience beginning in their first year of classes. Nearly all courses have an associated mandatory lab component.

There are five general purpose instructional labs located on the first floor of Winston Chung Hall in rooms 127, 129, 132, 133, and 136 in which courses are scheduled that support the CEN curriculum. These laboratories run CentOS Linux as their base operating system, and provide access to Windows desktop environment and applications via connection over the LAN to a Windows 2008R2 Terminal Server cluster, Each lab is equipped with 32 desktop PCs with a network printer, and laboratory section sizes are typically 30. Lab sections are scheduled in the range from 8 AM to 9 PM in these labs.

There is an additional computer laboratory located in Winston Chung 226 which provided access to the same software as other labs, but is an open lab where students can go to work at any time of the day, even if other laboratories are all scheduled for courses.

There is also a CE laboratory located in Winston Chung 136 that has specialized equipment including Intel IXP 1200 and 2400 network processor cards, and for specific CEN courses is

supplied with a range of equipment including oscilloscopes, power supplies, function generators, digital multimeters, and FPGAs. The computers in the laboratory run Linux, and so the fraction of embedded systems software that only runs under Windows and additionally requires direct hardware access is run in a virtual machine environment, currently VMWare. Lab sections are scheduled from 8 AM to 11 PM in this lab.

All of these facilities are accessible 24/7 via card access. Additionally, they are accessible on the Internet – Linux via Secure Shell or NX, and Windows via Terminal Services. Computers, printers, and supplies for the laboratories are paid for via a course materials fee that provides approximately $25K per quarter. This fee was established in 2004 and ensures that technology refresh in the laboratories will be sustained for the foreseeable future.

Electrical Engineering (which partly hosts CEN)

The Electrical Engineering program and the Bourns College of Engineering is built to provide students extensive hands-on experience from their sophomore year through a mandatory sophomore-level laboratory class (EE 1LA) to a number of different laboratories required by the upper-division courses, including the senior design class (EE 175A,B). Depending on the area of study chosen by the students, they are required to enroll in different laboratory classes. All laboratories require and enhance students' teamwork, communication and technical skills. The courses also introduce the students to the operational equipments used in the laboratories and give them a precious opportunity to be familiarized with the equipments.

Since EE 01LA – Engineering Circuit Analysis I Laboratory – is a requirement for the Electrical Engineering program, all students are to complete the safety orientation session as part of the course.

In particular, there are four major laboratories:

1. Circuits and Control Systems Lab located in Winston Chung Room 121
2. Embedded Systems and Logic Design Lab in Winston Chung Room 125
3. Advanced Systems and Senior Design Lab in Winston Chung Room 126
4. Communication and Intelligence Systems Lab in Winston Chug Room 128

Recently, we added two new labs on Photonic Devices and Nano-Device Characterization, corresponding to the new courses EE160 and EE136, respectively.

These labs provide excellent educational and instructional opportunities to students during their academic years at the College. There are also two non-instructional laboratories in Winston Chung Hall: the Electronics & Prototyping Shop at Winston Chung 137 and the Computer Lab at Winston Chung 234.

The Electronics & Prototyping Shop provides and maintains all the equipments and accessories used in the laboratories. The Computer Lab provides a computing environment that allows the students to access the Internet in doing research projects or to use a number of very powerful fully-licensed software when working on assignments.

All laboratories are located at the ground floor of Winston Chung Hall. They are opened during the assigned schedule with the supervision of the TAs or are accessible with permission from the technical staff. Each laboratory occupies an area of 900 sq. ft. equally and has 16 workstations. The maximum capacity for each lab is 32 students with 2 students per workstation. Two different

sections of labs are offered when the number of enrollment of the class exceeds the maximum allowable capacity in the lab.

The labs are equipped with oscilloscopes, digital multimeters, function generators, power supplies, and desktop computers, with a quantity of 16 each per lab. Each workstation has one set of the equipment listed above except for Lab 125 which only has power supplies and computers. Some fully-licensed and well-known software/tools are provided on the computers for students' use, such as Cadence, Orcad, PSpice, Matlab, and Codewarrier C Development. Students have an opportunity to gain the knowledge to utilize and manipulate the software in achieving the objectives for the certain courses.

B. Computing Resources

Information technology support, services and facilities are available from several sources for use by the programs of The Marlan and Rosemary Bourns College of Engineering and its students, faculty, and staff:

1. Campus-wide support, services, and facilities are provided by Computing and Communications (C&C) and managed by full-time professional staff.

2. The College, through its programs of Chemical/Environmental Engineering, Computer Science and Engineering, Electrical Engineering, and Mechanical Engineering, and its Research units also provide a variety of technical services and support.

Details of these support, services, and facilities are as follows:

C&C Overview

- **Support Services**
- **Facilities and Infrastructure**
- **Other Services and Support**

C&C (which includes the Instructional Technology Group, Computing Infrastructure and Security, the Computer Support Group, and Communications) is under the direction of the Associate Vice Chancellor and CIO who reports to the Provost. The Instructional Technology Group, Computer Support Group, and Communications sub-units have primary responsibility for providing network access and general computing services to the UC Riverside campus.

Support Services

- **Instructional Technology Support**

  C&C's Instructional Technology Group offers faculty and students technical and pedagogical support that is academic discipline specific. The Instructional Technology Group emphasize a "hands-on" approach to its services including Blackboard (learning management system) training and support and the management and support of campus site-licensed software.

- **Classroom Technology Support**

  C&C provides classroom technology support, services, and infrastructure services (e.g. connection to the wireless network, projection systems, etc.). UCR's best-of-breed technology-enabled classrooms include the following:

- The capability to present materials from a wide variety of sources, including (at a minimum) DVD, document camera, a personal computer, laptop computer, and Internet.
- Chalkboard or whiteboard that is available and viewable at the same time digital or analog presentations are underway.
- Combination of high-powered data projectors and/or lighting zone controls that allow students to take notes and view presentation material at the same time.
- "Self-service" design which allows instruction to occur without the aid of technical operators and without the delivery of equipment.
- Based on the academic discipline, sound systems and data projection resolution requirements may drive certain classroom minimum standards.

UCR has implemented "clicker" technology in all its classrooms. In actual use on this campus clicker technology has been shown to:

- Increase attendance (sometimes dramatically)
- Coax participation from normally non-participative students
- Create a more engaging lecture environment

Additionally, all UCR classrooms are equipped with podcasting capabilities. This can be in the form of audio podcasting or lecture capture as supported by Echo360 course capture technology. Students in these classrooms will have on-demand access to archived educational content as presented during lecture, including a video camera feed and classroom audio.

- **General Technology Support**

  C&C provides UCR faculty and students with technology to assist them in their instructional and academic pursuits. Services like e-mail, iLearn (Blackboard Learning Management System) and the wireless network ensure that all of UCR faculty and students stay connected with their colleagues, peers and the rest of the world. The Computer Support Group provides desktop computing support for faculty and staff. Services include consulting on hardware, software and networking, plus assistance with acquiring, learning and using stand-alone or networked microcomputers (Windows, Macintosh, Linux, and UNIX platforms). Services offered include telephone support, on-site and carry-in services, on-line remote support, a knowledge base and software downloads. C&C also implemented and spearhead the Microcomputer Support Specialist (MSS) program, which provides decentralized departmental support.

- **Multimedia Development and Research Visualization Support**

  This group provides innovative and creative full service web and graphic design for the UCR campus and community. With fully integrated, back-end programming solutions tailored to each client's specific needs, the group supports the university's efforts to secure extramural funds and the campus' various outreach efforts.

Facilities and Infrastructure

- **Computer Labs**

  Student Computing Services maintains four public computer labs featuring approximately 149 computers available for academic use by all UCR students, with open hours of approximately 160 hours per week. Faculty instructing a course may reserve the

public computing facilities for instructional use or request to have software installed on the machines. Lab assistance and software checkout is available in the labs. C&C provides research software (SAS, SPSS, Mathematica) in most public computer labs.

- **Classrooms and Learning Spaces**

  The Multimedia Technologies Group maintains all of UCR's general assignment classrooms that have been equipped with data/video projectors, document cameras, DVD players, PC computer on the network, computer interface for laptop users and network connections. Lecture halls are also equipped with wireless microphones and multiple (two to three) projection systems. Their commitment to instructional technology has led the design and implementation of "smarter" classrooms, such as the Flex Rooms and the Hyperstruction Studio. These rooms feature mobile furniture, whiteboards on every wall, and multiple projection systems.

  All general assignment classrooms are equipped with a multimedia controller maintained by C&Cs Multimedia Technologies Group for operation of the various presentation technologies and audio equipment. Internet connectivity is via a robust wired and wireless network. Each controller has a "Help" button for the instructor to alert technicians if there is a problem with the equipment.

  A help desk is staffed full time, and at least one field technician is available on campus during instructional hours. Either the help desk (working remotely) or the field technician (in the classroom) can quickly resolve any problem that occurs. In a survey (most recently conducted in 2011), 90% of instructors responded that UCR's available classroom technology either "Completely" or "Mostly" met their pedagogical needs.

- **Research Technology**

As part of UCR's Cyberinfrastructure (CI) strategy, C&C supports three computational cluster support models. These include departmentally maintained clusters, dedicated clusters, and a shared collaborative cluster. Three programs are described as follows:

1. A centrally managed, standardized/dedicated cluster of processors, in which researchers pay an annual fee for essentially unlimited use.

2. A collaborative computational cluster, in which each PI can buy a certain amount of hardware, which Computing and Communications will manage. The PI has priority access to the equipment that he or she acquired, plus access to the entire cluster as available. UCR's collaborative cluster provides a shared system as a computing resource for campus researchers with limited financial resources.

3. Departmentally maintained clusters, centrally managed. This type of cluster is meant for researchers who have computing needs that fall outside of the campus cluster standards. These systems are built to particular PI/lab/center specifications and managed by PI funded staff, but housed within C&C's data center with C&C staff management / mentoring / backup provided to the departmental administrator

C&C also provides other research technology support, ranging from network creation / configuration, colocation support, budget preparation / equipment configuration, and cloud services provisioning.

- **Wired and Wireless Networks**

  UCR supports 1,200+ wireless access points that provide wireless connectivity to approximately 8,000 concurrent users daily. Additionally, the campus network backbone consists of 10 GB fiber-optic connections, with a minimum of 1 GB capacity to each building on campus. The campus has more than 500,000 feet of air blown fiber conduit, which enables the addition of fiber connectivity essentially "on demand".

Other Services and Support

- **Libraries**
  - The UCR Libraries have over 400 public computers among the four campus libraries with selected information resources and software to support and enhance student learning and the research and scholarship activities of the University. Specialized software has been installed on the Learning Commons Computers located in Rivera Library 1st Floor, Rivera Basement, Rivera 2nd Floor, Rivera 3rd Floor, and Science Library 1st Floor. 20 wireless laptops/netbooks are available in Rivera and Science Libraries to faculty, students and staff.

- **CENIC Regional Higher Education Network**
  - C&C provides support and maintenance of off-campus network access via connections to the CENIC regional higher education network. All Bourns College of Engineering computing facilities and faculty have high-speed access to CENIC members (e.g. other UC campuses, private research universities in California, the California State University System, etc.) and to Internet2 via C&C support of the CENIC network.

C. Guidance

The computer science labs are offered in labs that have just computer workstations, and thus offer few safely challenges of any kind. For the EE classes, the students receive guidance on basic equipment use with equipment orientation documents and help from the TA in the first circuits course EE001A. EE Shop provides hands on support of tool use and equipment. In addition the IEEE student branch, under the guidance of the EE Senior Electronic Technician, offers workshops on beginner and advanced circuit prototyping.

D. Maintenance and Upgrading of Facilities

BCOE budgets approximately $300,000/year for instructional equipment acquisition and upgrades. These funds are allocated to BCOE academic programs on an annual request basis. Table 36 shows a listing of the instructional equipment obtained by this process over the last three fiscal years can be found on the following list.

Table 36: A listing of the instructional equipment obtained in the last three years.

Computer Engineering	
Computer Science	**Electrical Engineering**
Lab Chairs	Instructional Clean Room (for EE 136)
Lab Tables	Lab Equipment for WCH 126:
Windows Terminal Server license	Digital multimeters and power supplies
Remark Office OMR upgrade	Replacement PCs and monitors
Supermicro Server Chasis	Oscilloscopes
AMD Server Processors	Function Generators
Intel SATA drives	Metal Lab Stools
Hitachi 3TB hard drives	New Server
8 GB RAM	HP Laserjet P4015n networkable printer
Kodak i1220 scanner	FPGA Evaluation boards
MSDN AA License	Computers and monitors for WCH 121
File Server support contract renewal	
File Server	
RBC27 Batteries	
Barebones server	
Mac Workstations	
RAM, harddrives, displays, licenses, etc	
Projector mounts	
Supplmental NICS	

Upgraded hardware must meet the minimum specifications for the courses/labs taught, software requirements, and hardware interaction. Software upgrades must work with the current labs being taught. Additionally, computers must meet the minimum hardware requirements as required by the software. Both hardware & software upgrades are done in a non-disruptive process. This usually occurs during summer before the beginning of the fall quarter.

E. Library Services

Library collections that support the Bourns College of Engineering are housed in the Orbach Science Library. The Orbach Science Library has a seating capacity of 1,500 including individual carrels, study tables and **25** group study rooms. The library makes available 79 computer workstations for students to use in their research and study, and another 32 computers to support information literacy instruction. The entire UCR library system provides both wired and wireless access to the internet for student laptop use, and laptops are available for check-out at the Circulation Desk.

Normal library hours during the regular school year are as follows:

Monday-Thursday 7:30am – 11pm
Friday 7:30am to 5:00pm
Saturday Noon to 5:00pm and Sunday 1:00pm to11:00pm.

The Orbach Science Library maintains a professional staff of eight librarians, all of whom provide reference and research assistance to engineering students, faculty, and staff. Of these librarians, one is assigned subject responsibility for engineering and is available to assist students, faculty and staff with in depth research questions. The Engineering Librarian and Subject Specialist also offers tutorials and classes on engineering information topics, and maintains Web pages and path-finders to assist engineering students, faculty, and staff in locating the information they need.

The UCR Libraries offers a full range of reference services, including walk-up, telephone, and 24/7 e-mail reference services (*Ask A Librarian*) through a UC-wide and national network as well as reference by appointment. The Orbach Science Library reference desk is staffed 52 hours per week during the academic year (9am-8pm. Monday-Thursday, 9am-5pm on Friday) and 40 hours per week during inter-session periods. In addition to these standard services, engineering students can receive additional reference help from other reference librarians who are assigned to the Science Information Services desk. The Engineering Librarian is available for extended consultation on Senior Design or other research projects.

Incoming freshmen typically receive library orientation sessions in their introductory classes. They might also have additional information literacy instruction in classes that require independent research, such as senior design classes. One-on-one or group tutorials are available for any research topic that might be desired and helpful to engineering students.

Library Collections

- **Books**

  Engineering books are acquired as part of the Orbach Science Library's purchasing profile, ordered from catalogs or suggested by students, faculty, and staff. Within the past three years, the library has initiated the purchase of engineering e-books and currently supports and maintains a collection of thousands of electronic books in the discipline. The Libraries provides licensed access to all of the current Springer books online, many of the e-books from the CRC EngNetBase, the Knovel Collection, the Wiley Online collection and many more.

  Recently, through a special competitive initiative, the UCR Libraries has brought to our campus, from its former Berkeley location, the extensive and world class Water Resources and Archives Collection (WRCA) containing many materials relevant to dam and bridge construction which is also available to engineering students and researchers from across UCR and the UC system.

- **Journals**

  The Libraries currently subscribe to 121 engineering print journals, and Engineering students have access to a vast collection of online journals (94,770 unique titles). UCR maintains access, for example, to all of the journals and proceedings of IEEE, OSA, MRS, and ACM, as well as either proceedings or journals from many other societies. Faculty, staff, and students may suggest new books, journals or other media to be purchased by the library. Library users may request materials that are not available on campus through Interlibrary Loans, and the materials will be made available to them at no cost in a very reasonable amount of time.

- **Research (Journal Article) Databases**

  UC Riverside engineering students have access to a number of journal databases to assist them in their research in engineering and in other areas of study. Through co-investments with the other eight UC campuses and the California Digital Library (CDL) Inspec, Compendex, and the Web of Science as well as SciFinder Scholar for chemistry and chemical engineering and Biosis or MEDLINE for biotechnological literature are all available to engineering faculty and students. UCR also licenses Water Resources Abstracts locally with the arrival on our campus in 2010 of the Water Resources Archives and Collections.

- **LIBRARY COLLECTIONS**

	Books	Periodicals
Entire Institutional Library	2,810,229: (PrintVols.) 404,191: (e-Books) Total Vols.: 3,214,420	6,329 (Active Local Titles)
Engineering and Computer Science	71,757 Print / 29305 online	168 print / 3976 online

LIBRARY EXPENDITURES (See key below)

	2008-2009	2009-2010	2010-2011
Expenditures for Engineering (Total)	$75,749	$75,107	$45,975
Print Books	$13,264	$11,824	$9,629
[7]Local Costs Only for Engineering Periodicals Subscriptions	$47,589	$47,706	[8]$21,163
E-Book Packages (EngNetbase, O'Reilly)	$7,043	$7,332	$6,483
[9]Research Databases	$15,185	$14,741	$15,957

F. Overall Comments on Facilities

BCOE follows the University of California Policy on Management of Health, Safety and the Environment and partners closely with UCR's Office of Environmental Health & Safety, UC Police Department, and UCR Office of Risk Management, and system-wide laboratory best practices to ensure student, faculty, and staff safety while also protecting the environment and BCOE resources.

Each BCOE department has assigned a Laboratory Safety Officer (LSO). The LSOs assist with class lab operations and equipment management, with their departments with development and implementation of the department Chemical Hygiene Plan, and perform periodic laboratory safety audits (at least annually). BCOE LSOs meet monthly to discuss strategy, share lessons learned, and ensure safety in learning and research.

[7] This figure does not include the total amount ($2.4 million) expended annually by the UCR Libraries as co-investments with other UC campuses and the California Digital Library (CDL) to support access to e-journals, e-books, and electronic databases. The value of the e-journals for supporting engineering alone is over a million dollars annually

[8] This figure reflects a major journal cancellation which included duplicate and low use titles especially targeting print titles that duplicated e-journal titles. This was a UCR project in response to budget reductions

[9] Cost for Compendex and Inspec databases. Other databases such as SciFinder, Water Resources Abstracts, Web of Science support multiple disciplines, in addition to Engineering.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

The Computer Engineering Program (CEN) is led by a Program Director (Prof. Najjar Walid) and an Associate Program Director (Prof. Sheldon Tan). The current Faculty of the CEN Program is drawn from the EE and CSE Departments. The CEN Program does not have any full time staff, it relies on the EE and CSE staff for its administrative support.

The Program Director acts as the Graduate Advisor for the Program, the Associate Director as the Undergraduate Advisor.

All the courses of the CEN Program are drawn from the EE or CSE course offerings. The teaching assignments and TA allocations are similarly done by the EE and CSE Chairs. The CEN curriculum is periodically revised by the Program Director and Associate Director in close coordination with the EE and CSE Chairs and UG Advisors when relevant. The recommendations are subsequently presented to and voted on by the CEN Faculty and may also be brought before the BCOE Executive Committee and/or the EE and CSE Board of Advisors.

The Associate Director interacts with the staff in the BCOE Student Affairs Office in determining the recommended CEN Course Plan.

B. Program Budget and Financial Support

B.1 Resources Provided to the Program

The program is supported by staff, part-time student assistants, teaching assistants, readers, and graders as needed to support individual courses and program administration. The College provides Student Advisors who interact with program students, monitor academic progress, enable registration, and direct them to appropriate services on campus for tutoring, career counseling, etc. Tutoring service is provided at the Learning Center and in the student dormitories (free for students living on campus). The College has developed a Professional Milestones Program to enable each program student to prepare for internships, job interviews, and research opportunities.

The College provides funds to support teaching assistants, graders, and readers, assigned based on course enrollment and need for laboratory supervision. Teaching Assistants conduct discussion sessions in which students are exposed to additional problems and concepts to reinforce material covered in lectures, and to enable students to complete course assignments. All instructors and teaching assistants maintain posted office hours for assisting students outside scheduled classes. The program has a designated Undergraduate Advisor (currently Dr. Sheldon Tan) to oversee curricular matters and to offer advice on curricular issues.

B.2 Budgeting

The University of California, Riverside has a multi-step budget development process. The major steps in the annual process are:

February: Campus Budget Call Letter is distributed and meetings held with academic units to discuss faculty renewal models

March: Comprehensive Planning Documents are submitted to the Executive Vice Chancellor

April: Individual unit hearings with senior UCR management

May: Input and feedback from Faculty Senate Committee on Planning and Budget to EVC

June: Final unit budgets announced

All BCOE academic programs receive Permanent University funding for tenure track faculty, program staff, materials and supplies and travel. Table 37 summarizes Permanent University funding allocations to BCOE departments over the last five fiscal years.

Table 37: College of Engineering 5-year PERM Budget History

College of Engineering 5-year PERM Budget History					
PERMANENT BUDGET	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Bioengineering	1,058,145	1,227,145	1,234,245	1,396,905	1,518,223
Chemical Engineering	1,123,049	1,162,226	1,180,026	914,226	944,701
Environmental Engineering	1,123,049	1,162,226	1,180,026	914,226	944,701
Computer Science	2,665,015	2,759,768	2,739,142	2,747,073	2,649,119
Electrical Engineering	2,122,786	2,249,370	2,285,339	2,144,774	2,297,533
Computer Engineering	1,196,950	1,252,284	1,256,120	1,222,848	1,236,663
Mechanical Engineering	1,787,872	1,874,172	1,861,691	1,831,767	1,859,708
Materials Science & Engr.	31,018	40,058	40,058	85,452	85,452
Grand Totals >	**11,107,884**	**11,727,248**	**11,776,646**	**11,257,270**	**11,536,099**

In addition, BCOE academic departments receive Temporary University funding each fiscal year for lecturers, teaching assistants, instructional equipment, etc. The amounts of these annual allocations over the last five fiscal years can be found in Table 8-2. (Note: FY 11/12 allocations for Instructional Equipment will be made at the end of the fiscal year).

C. Staffing

The total headcount of administrative, instructional and technical staff in BCOE for FY 11/12 can be found in Appendix D2.

Several years ago, BCOE centralized the following functions in the Dean's Office: undergraduate student affairs and advising; contract/grant pre-award processing and academic personnel. All other administrative functions (purchasing, payroll, grad student support, etc.) are provided at the departmental level. Over the past five fiscal years, the number of BCOE administrative and technical staff has decreased by 8.75 FTE due to UCR budget reductions. However, all but 0.25 FTE of these positions have occurred in central Dean's Office operations and were accomplished with little direct impact on BCOE's academic programs.

During each fiscal year, BCOE administrative and technical staff salaries are compared with salaries of similar positions within BCOE and within other UCR academic and administrative units. Any significant salary lags are addressed through UCR's staff equity and reclassification process. During the past two fiscal years, 10-11 staff reclass/equities were processed per year. This process has helped to reward and retain experienced BCOE staff.

In addition to offering on-line and in-class training required to perform a staff position's basic responsibilities (i.e., payroll, purchasing, etc.), UCR offers extensive career development training programs including:

- Certificate programs in Building Core Competencies, Diversity Training, Performance Management, Professional Academic Advising, Professional Graduate Student Advising and Work Leadership
- Emerging Leader (mentorship) Program
- Management Skills Assessment Program

Most of the above training is at no cost to the employee. All required and optional training is offered through UCR's Human Resource's Learning Center. The completion of employee's required and optional training is recorded in UCR's automated Learning Management System (LMS).

D. Faculty Hiring and Retention

BCOE is still growing toward its target size of approximately 120 faculty members, so, even despite budget pressures, faculty recruitment is an annual event. The basic faculty hiring process is as follows:

1. Each year, departments are asked to submit a faculty recruitment plan that is consistent with their strategic plan.
2. The recruitment plan is sent to the Dean for his review.
3. The Dean then outlines a collective recruitment plan for the College and requests ladder-rank faculty lines from the Provost.
4. The Provost makes an allocation of ladder-rank faculty lines to the College and the Dean determines the overall priorities for the College.
5. The Dean lets the departments know if they can begin a search for faculty members and, if so, how many.
6. The department then forms a faculty committee to prepare a detailed recruitment plan for the position(s). The detailed recruitment plan includes a listing of the search committee, written ads and where they will be placed, flyers for distribution at professional conferences, letter templates for bulk mailings to other relevant departments, an affirmative action plan, and a deadline for priority recruitment.
7. Those detailed plans are sent to the Dean, Provost, and Affirmative Action offices for approval.
8. Once approved, ads are placed, mailings are sent, and the College on-line recruitment website is opened. All applications are received through the College recruitment website.
9. All applications received by the priority deadline are reviewed by the faculty search committee. The committee assesses how well the applicants meet the goals of the department and their potential as a faculty colleague.
10. An initial short-list is developed, then further refined until a list of interviewees is developed.
11. Once the list of interviewees is developed, the list is shared with the department at large, the Dean, and the Affirmative Action office. The Affirmative Action office requires reasons for why candidates were not considered for further consideration.

12. Once the department, Dean, and Affirmative Action Office approve the list, the candidates are invited to campus for an interview where they give one or two seminars, meet with department and other potentially relevant faculty, and the dean.
13. Following the interviews, the department recommends one or more candidates to the Dean for approval to make an offer of appointment. Upon his approval, the candidates are informed of the offer.
14. The offer is contingent upon approval through the campus policies (Academic Personnel Manual and the Call) for faculty appointments. Procedures differ depending on level of appointment.
15. Once a formal offer is signed and approved by the Chancellor, the candidate becomes a faculty member in the department.

D. 2 Faculty Retention

The primary strategy is to maintain an atmosphere conducive to achieving excellence in all that we do. We strive to recognize excellent performance in teaching, research and service. We provide sufficient resources for the faculty to advance their research: initial complement funds, laboratory space, and assigned students. Annual training is provided for improving teaching methods. The faculty is encouraged to take online training on a regular basis in topic areas such as Health and Safety, Information Security, Leadership, Effective Use of Advanced Technology in the Classroom, etc. They are given assignments to college and campus committees to provide service and growth of responsibilities. We work to accelerate promotion opportunities for outstanding performance. Junior faculty are provided with mentoring by senior faculty members and provided opportunities for them to mentor students.

We want our faculty to be of the highest quality and thereby attractive to other engineering schools. If as a result a faculty member receives an offer from another institution we provide matching offers to retain the individual. These strategies and actions are predominately successful.

E. Support of Faculty Professional Development

Faculty professional development funds are provided to assistant professors as part of their faculty start-up packages. In addition, the Academic Senate provides travel assistance grants, and the campus provides grants to support innovative teaching. Also, funds are available to all faculty from their faculty support accounts, which are funded by a number of activities including a (small) portion of indirect costs generated by grants and contracts.

The University offers leaves of absence with pay to attend professional meetings or other University business in addition to its normal sabbatical leave program in order to maintain faculty currency. The University also offers other types of leave with or without pay that may extend over a longer period of time, for good cause. The University Leave policies are covered in section V. (Benefits and Privileges) of the Academic Personnel Manual (APM) http://www.ucop.edu/acadpersonnel/apm/sec5-pdf.html.

The College provides funds to cover the cost of the faculty member's replacement while on leave. Faculty are also given latitude to modify class schedules/exams to some extent when necessary to accommodate specific professional development needs that require short or intermittent absences during the academic year. In some cases, other department faculty assist with covering a particular class or exam.

PROGRAM CRITERIA

The CEN Program covers all the requirements of the Program Criteria. The CEN Course Plan, which is attached in Table Course Plan, provides ample evidence for each of these components. The technical electives provide a broad range of options from which the students can choose based on their interests. The details may be found in Table 29 and Table 31.

For ease of reference, the program criteria for CEN are:

The structure of the curriculum must provide both breadth and depth across the range of engineering topics implied by the title of the program.

The curriculum must include probability and statistics (STAT 155), including applications appropriate to the program name; mathematics through differential and integral calculus (MATH 009A, MATH 009B, MATH 009C); sciences (Four or more units of Chemistry, PHYS 040A, PHYS 040B, PHYS 040C); and engineering topics (including computing science) (CS010, CS012, CS061, CS014, CS111, CS100, EE/CS120B, CS141, EE100A, CS153, CS 161 & 161L, CS 122A) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components (EE 001A, EE 001B, EE/CS120A, EE100B, EE110B, EE114).

The curriculum for programs containing the modifier "electrical" in the title must include advanced mathematics, such as differential equations (MATH 046), linear algebra (MATH 113), complex variables (PHYS 040C), and discrete mathematics (MATH/CS 011 , MATH/CS 111).

The curriculum for programs containing the modifier "computer" in the title must include discrete mathematics (MATH/CS 011, MATH/CS 111).

APPENDICES

Appendix A – Course Syllabi

CS10: Introduction to Computer Science for Science, Mathematics and Engineering I

Lecture: 3 hours; laboratory 3 hours

Prerequisite(s): MATH 009A (may be taken concurrently), First Year Calculus. Introduction to the differential calculus of functions of one variable.

Instructor: In the last five years, the following instructors have taught this class: Kris Miller

Text book(s):

- Big C++, Cay Horstmann and Timothy Budd

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Use variables to store computer program data	2	0	0	0	0	0	0	0	0	0	3
Form and use mathematical and Boolean expressions of variables	3	0	0	0	0	0	0	0	0	0	3
Process program input and generate program output	1	0	2	0	0	0	0	0	0	0	3
Use branches to create programs incorporating decision making	1	0	2	0	0	0	0	0	0	0	3
Use loops to create programs that repeat certain behaviors	1	0	2	0	0	0	0	0	0	0	3
Use functions to modularize programs	1	0	2	0	0	1	0	0	0	0	3
Use arrays to store collections of data	1	0	2	0	0	0	0	0	0	0	3
Use strings to handle textual data	1	0	2	0	0	0	0	0	0	0	3
Use classes as a record that keeps related data together	1	0	2	0	0	0	0	0	0	0	3
Convert a problem description into a set of about 50-100 computer instructions	3	0	3	0	0	0	0	0	0	0	3
Debug programs written by oneself or by others	3	3	0	0	0	0	0	0	0	0	3
Understand very basic methods of testing a program	3	2	0	0	0	0	0	0	0	0	3
Incorporate useful comments into programs	0	0	0	0	0	1	0	0	0	0	3

Catalog Description:

Structured and object-oriented programming in C++, emphasizing good programming principles and development of substantial programs. Topics include recursion, pointers, linked lists, abstract data types, and libraries. Also covers software engineering principles.

Requirement Status: Required

CS12: Introduction to Computer Science for Science, Mathematics and Engineering II

Lecture: 3 hours; laboratory 3 hours

Prerequisite(s): MATH 009A: Introduction to the differential calculus of functions of one variable. May be taken concurrently.

Instructor: In the last five years, the following instructors have taught this class: Brian Linard, Rick McHard, Kris Miller

Text book(s):

- Big C++, Cay Horstmann and Timothy Budd

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Use recursion to solve certain programming problems elegantly	3	0	0	0	0	0	0	0	0	0	3
Use pointers to access data	1	0	0	0	0	0	0	0	0	0	3
Develop pointer-based linked lists	1	0	0	0	0	0	0	0	0	0	3
Understand the advantages of abstract data types	2	0	0	0	0	0	0	0	0	0	3
Use and understand the advantages of libraries	1	0	1	0	0	0	0	0	0	0	3
Convert a problem description into a set of about 100-to-200 computer instructions	3	0	3	0	0	1	0	0	0	0	3
Debug programs written by oneself or by others, using a debugger tool	3	2	2	0	0	0	0	0	0	0	3
Test programs using basic methods	3	3	2	0	0	0	0	0	0	0	3
Develop basic proficiency of working in a Unix environment	0	0	0	0	0	0	0	0	0	0	3

Catalog Description:

Structured and object-oriented programming in C++, emphasizing good programming principles and development of substantial programs. Topics include recursion, pointers, linked lists, abstract data types, and libraries. Also covers software engineering principles.

Requirement Status: Required

CS14: Introduction to Data Structures and Algorithms

Lecture: 3 hours; laboratory 3 hours

Prerequisite(s): CS 011/MATH 011: Introduction to Discrete Structures. Prepositional and predicate calculi, elementary set theory, functions, relations, proof techniques, elements of number theory, enumeration and discrete probability. CS 012: Structured and object-oriented programming in C++, emphasizing good programming principles and development of substantial programs. Topics include recursion, pointers, linked lists, abstract data types, and libraries. Also covers software engineering principles.

Instructor: In the last five years, the following instructors have taught this class: Rick MacHard, Ray Klefstad, Thomas Payne, Ryan Rosich, Morek Chrobak, and Teodor Przymusinski.

Text book(s):

- Data Structures and Algorithm Analysis in C++ (3rd Edition), Mark A. Weiss

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Design and use arrays, lists, stacks and queues, and know when each is most appropriate	2	0	1	0	0	0	0	0	0	0	3
Design and use binary search trees	2	0	1	0	0	0	0	0	0	0	3
Design and use hash tables	2	0	1	0	0	0	0	0	0	0	3
Design and use heaps	2	0	1	0	0	0	0	0	0	0	3
Understand basic algorithm analysis	3	1	1	0	0	0	0	0	0	0	3
Be able to design and use several different sorting algorithms, understanding the differences and trade-offs among them	2	0	3	0	0	0	0	0	0	0	3
Basic understanding of object-oriented programming, including abstract data types, inheritance and polymorphism	0	0	0	0	0	1	0	0	0	0	3
Convert a problem description into an algorithm that efficiently solves the problem	3	3	2	0	0	0	0	0	0	0	3
Convert a problem description into a program 200-400 lines long	2	0	3	0	0	0	0	0	0	0	3
Debug programs written by oneself or by others, using a debugger tool	1	3	0	0	0	0	0	0	0	0	3
Make extensive use of software tools, including debuggers, in writing programs	3	0	0	0	0	0	0	0	0	0	3
Know how to thoroughly test programs	2	3	0	0	0	1	0	0	0	0	0

Catalog Description:

Topics include basic data structures such as arrays, lists, stacks, and queues; dictionaries including binary search trees and hashing; priority queues(heaps); introductory analysis of algorithms; sorting algorithms; and object-oriented programming including abstract data types, inheritance, and polymorphism. Also covers solving complex problems through structured software development.

Requirement Status: Required

CS61: Machine Organization and Assembly Language Programming

Lecture: 3 hours; laboratory 3 hours

Prerequisite(s): MATH CS 005 or CS 010: Introduction to Computer Science for Science, Mathematics and Engineering I. Solving problems through structured programming of algorithms on computers, using the C++ object-oriented language. Topics include variables, expressions, input/output (I/O), branches, loops, functions, parameters, arrays, strings, file I/O, and classes. Also covers software design, testing, and debugging; or knowledge of programming or consent of instructor.

Instructor: In the last five years, the following instructors have taught this class: Brian Linard, Frank Vahid, and Harry Hsieh.

Text book(s):

- Introduction to Computer Systems, 2nd Edition, Patt & Patel (McGraw Hill), ISBN 0-07-24267509

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Represent numbers in different bases, including decimal, hexadecimal, and binary, and perform arithmetic on such numbers	2	0	1	0	0	0	0	0	0	0	3
Understand the basic combinational and sequential digital logic components as they relate to understanding the basic parts of a computer, including registers and arithmetic-logic units	2	0	1	0	0	0	0	0	0	0	3
Understand how computer instructions work for a simple computer addressing modes	2	0	1	0	0	0	0	0	0	0	3
Understand the von Neumann model of computing	2	0	1	0	0	0	0	0	0	0	3
Understand how computer instructions use memory, including different	3	1	1	0	0	0	0	0	0	0	3
Know how interrupts interact with regular computer execution	2	0	3	0	0	0	0	0	0	0	3
Understand modes of input/output	0	0	0	0	0	1	0	0	0	0	3
Understand the roles of assemblers and linkers	3	3	2	0	0	0	0	0	0	0	3
Understand how some Higher Level Language constructs are built in assembly language	2	0	3	0	0	0	0	0	0	0	3
Write assembly language programs of 100-200 instructions	1	3	0	0	0	0	0	0	0	0	3

Catalog Description:

An introduction to computer organization. Topics include number representation, combinational and sequential logic, computer instructions, memory organization, addressing modes, interrupt, input/output (I/O), assembly language programming, assemblers, and linkers.

Requirement Status: Elective

CS111: Discrete Structures

Lecture: 3 hours; discussion 1 hour

Prerequisite(s): CS 010: Introduction to Computer Science for Science, Mathematics and Engineering I; CS 011/MATH 011: Introduction to Discrete Structures; MATH 009C or MATH 09HC: First Year Calculus; Introduction to the integral calculus of functions of one variable.

Instructor: In the last five years, the following instructors have taught this class: Morek Chrobak and Teodor Przymusinski.

Text book(s):

- Discrete Mathematics and its Applications, K.R. Rosen, MacGraw Hill

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
To learn how to use correct mathematical terminology and notation.	3	0	0	0	0	0	0	0	0	0	3
To learn the methods of formal mathematical reasoning and proof techniques, including proofs by contradiction and by induction.	3	0	0	0	0	0	0	0	0	0	3
To learn how to model real-life problems using discrete mathematical structures: sets, sequences, combinations, permutations, graphs, trees, relations, and algebraic structures.	2	0	0	0	0	0	0	0	0	0	3
To master the concept of asymptotic notation and its application to estimating running time of various algorithms.	3	0	0	0	0	0	0	0	0	0	3
To learn fundamentals of number theory and its applications to cryptographic protocols.	2	0	0	0	0	0	0	0	0	0	3
To learn techniques for solving recurrence equations, and their applications to counting and to analyzing the complexity of divide-and-counter algorithms.	2	0	0	0	0	0	0	0	0	0	3
To learn the basic concepts in graph theory, including connectivity, cycles, planarity, coloring.	1	0	0	0	0	0	0	0	0	0	3

Catalog Description:

Study of discrete mathematical structures with an emphasis on applications to computer science. Topics include asymptotic notation, generating functions, recurrence equations, elements of graph theory, trees, algebraic structures, and number theory. Cross-listed with MATH 111.

Requirement Status: Required

CS120A: Introduction to Embedded Systems

Lecture: 3 hours; **Laboratory**: 6 hours

Prerequisite(s): CS 61 machine organization

***Instructor:** In the last five years, the following instructors have taught this class: Harsha V. Madhyastha, Vana Kalogeraki, Thomas Payne.

***Text book(s):**

- Operating Systems: Principles and Practice, Anderson and Dahlin (Local copy)
- Operating Systems Concepts, Silberschatz, Galvin, and Gagne
- For Virtual Memory related chapters: Operating Systems: Four Easy Pieces, Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau.

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Able to perform the conversion among different number systems; familiar with basic logic gates – AND, OR & NOT, XOR, XNOR; independently or work in team to build simple logic circuits using basic.	2	3	3	2	2	1	1	1	0	0	3
Understand Boolean algebra and basic properties of Boolean algebra; able to simplify simple Boolean functions by using the basic Boolean properties.	2	3	3	2	2	1	1	1	0	0	3
Able to design simple combinational logics using basics gates. Able to optimize simple logic using Karnaugh maps, understand "don't care".	2	3	3	2	2	1	1	1	0	0	3
Familiar with basic sequential logic components: SR Latch, D Flip-Flop and their usage and able to analyze sequential logic circuits.	2	3	3	2	2	1	1	1	0	0	3
Understand finite state machines (FSM) concept and work in team to do sequence circuit design based FSM and state table using D-FFs.	2	3	3	2	2	1	1	1	0	0	3
Familiar with basic combinational and sequential components used in the typical datapath designs: Register, Adders, Shifters, Comparators; Counters, Multiplier, Arithmetic-Logic Units (ALUs), RAM. Able to do simple register-transfer level (RTL) design.	2	3	3	2	2	1	1	1	0	0	3
Able to understand and use one high-level hardware description languages (VHDL or Veriliog) to design combinational or sequential circuits.	0	0	3	0	0	0	0	0	0	0	3
Understand that the design process for today's billion-transistor digital systems becomes a more programming based process than before and programming skills are important.	0	0	3	0	0	0	0	0	0	0	3

Catalog Description:

Design of digital systems. Topics include Boolean algebra; combinational and sequential logic design; design and use of arithmetic-logic units, carry-lookahead adders, multiplexors, decoders, comparators, multipliers, flip-flops, registers, and simple memories; state-machine design; and basic register-transfer level design. Laboratories involve use of hardware description languages, synthesis tools, programmable logic, and significant hardware prototyping. Cross-listed with CS/EE 120A.

Requirement Status: Required

CS120B: Introduction to Embedded Systems

Lecture: 3 hours; **Laboratory**: 6 hours

Prerequisite(s): Prerequisite(s): CS 120A/EE 120A.

Instructor: In the last five years, the following instructors have taught this class: Frank Vahid, Philip Brisk, Scott Sirowy, and Harry Hsieh.

Textbook(s):

- The C Programming Language, 2nd Edition, Kernighan and Ritchie, Prentice Hall, ISBN: 0-13-1103628

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Understand chip technology trends Moore's law the nature of embedded computing the need to balance competing design factors and the growing productivity gap.	3	0	0	0	0	0	0	0	0	2	3
Calculate estimated time and cost impacts of various design decisions	3	0	0	0	0	1	0	0	0	1	3
Describe system behavior as a state machine and design a controller digital circuit implementation.	3	0	0	0	0	0	0	0	0	0	3
Describe system behavior as extended state machines and design a custom processor (controller and data path) implementation.	3	0	0	0	0	0	0	0	0	0	3
Describe system behavior as a sequential algorithm and design a custom processor implementation	3	0	0	0	0	0	0	0	0	0	3
Understand basic pipelining and hazards	1	0	0	0	0	0	0	0	0	0	3
Design a basic but working instruction-set processor	3	0	0	0	0	0	0	0	0	0	3
Understand assembly language and write simple assemblylevel programs.	1	0	0	0	0	0	0	0	0	0	3
Understand the function design and use of common peripherals: timers UART PWM A2D D2A converters.	2	0	0	0	0	0	0	0	0	0	3
Convert a problem description into a set of about 50-100 computer instructions	1	0	0	0	0	0	0	0	0	0	3
Understand communication methods including I/O schemes interrupts direct-memory access and arbitration	1	0	0	0	0	0	0	0	0	0	3
Draw timing diagrams to represent communication	1	0	1	0	1	0	0	0	0	0	3
Understand hardware/software trade-off through examples.	1	0	1	0	1	0	0	0	0	0	3
Write VHDL and program FPGAs write assembly and C code for microcontroller and build embedded systems in a laboratory environment.	3	0	0	0	0	0	0	0	0	0	3
Make short presentations in class about contemporary topics concerning embedded systems such as security energy novel circuit structures graphic interfaces ubiquitous computing and ethics.	1	0	0	0	0	2	3	0	0	2	3

Catalog Description:

Introduction to hardware and software design of digital computing systems embedded in electronic devices (such as digital cameras or portable video games). Topics include custom and programmable processor design, standard peripherals, memories, interfacing, and hardware/software tradeoffs. Laboratory involves use of synthesis tools, programmable logic, and microcontrollers and development of working embedded systems. Cross-listed with EE 120B.

Requirement Status: Required

CS122A: Intermediate Embedded and Real-Time Systems

Lecture: 3 hours; **Laboratory**: 6 hours

Prerequisite(s): Prerequisite(s): CS 012, CS 120B/EE 120B.

Instructor: In the last five years, the following instructors have taught this class: Scott Sirowy and Frank Vahid.

Textbook(s):

- The C Programming Language, 2nd Edition, Kernighan and Ritchie, Prentice Hall, ISBN: 0-13-1103628

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Understand competing design metrics and cost and time implications of various design decisions	3	0	0	0	0	0	0	0	0	2	3
Understand hardware/software trade-offs	3	0	0	0	0	1	0	0	0	1	3
Be able to use and choose among different behavior models like FSMD sequential programs HCFSM and dataflow languages for describing system behavior.	3	0	0	0	0	0	0	0	0	0	3
Understand basic concurrent process execution synchronization and communication methods	3	0	0	0	0	0	0	0	0	0	3
Compute valid and analyze invalid real-time schedules with techniques such as Rate-Monotonic Scheduling and Earliest-Deadline-First Scheduling.	3	0	0	0	0	0	0	0	0	0	3
Be able to recognize systems that represent Open-Loop and Closed-Loop control systems.	1	0	0	0	0	0	0	0	0	0	3
Design and use PID controllers.	3	0	0	0	0	0	0	0	0	0	3
Understand basic two-level and multi-level logic minimization techniques and apply to simple logic equations.	1	0	0	0	0	0	0	0	0	0	3
Understand reliability issues and how to use redundancies.	2	0	0	0	0	0	0	0	0	0	3
Write VHDL and program FPGA and FPGA platforms. Write assembly and C code for microcontroller and multimedia processor utilize the peripherals and build embedded systems in a laboratory environment.	1	0	0	0	0	0	0	0	0	0	3
Make short presentations in class about contemporary topics concerning embedded systems such as ubiquitous computing energy wireless security nano-tech novel circuit structures government and ethics.	1	0	0	0	0	0	0	0	0	0	3

Catalog Description:
Covers software and hardware design of embedded computing systems. Topics include hardware and software code sign, advanced programming paradigms including state machines and concurrent processes, real-time programming and operating systems, basic control systems, and modern chip and design technologies. Laboratories involve use of microcontrollers, embedded microprocessors, programmable logic and advanced simulation, and debug environments.

Requirement Status: Required

CS141: Intermediate Data Structures and Algorithms

Lecture: 3 hours; **Laboratory**: 3 hours

Prerequisite(s): CS 014 with a grade of "C-" or better; CS 111/MATH 111; MATH 009C or MATH 09HC; proficiency in C++.

Instructor: In the last five years, the following instructors have taught this class: Stefano Lonardi, Neal Young, Morek Chrobak, and Tao Jiang.

Textbook(s):

- Algorithms, Sanjoy Dasgupta, Christos Papadimitiou, Umesh Vazirani, McGraw Hill

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Perform asymptotic analysis of the efficiency of algorithms	3	0	0	0	0	0	0	0	0	2	3
Understand fundamental algorithms and data structures for discrete objects	3	0	0	0	0	1	0	0	0	1	3
Devise correct and efficient algorithms based on standard algorithmic design methods	3	0	0	0	0	0	0	0	0	0	3
Develop skills in systematic and rigorous computer programming by integrating the theory of algorithms with practical problem solving	3	0	0	0	0	0	0	0	0	0	3

Catalog Description:

Explores basic algorithm analysis using asymptotic notations, summation and recurrence relations, and algorithms and data structures for discrete structures including trees, strings, and graphs. Also covers general algorithm design techniques including “divide-and-conquer,” the greedy method, and dynamic programming. Homework and programming assignments integrate knowledge of data structures, algorithms, and programming.

Requirement Status: Required

CS153: Design of Operating Systems

Lecture: 3 hours; laboratory 3 hours

Prerequisite(s): CS 061, CS 141 with a grade of "C-" or better, C++ programming proficiency.

Instructor: In the last five years, the following instructors have taught this class: Harsha V. Madhyastha, Vana Kalogeraki, Thomas Payne.

Textbook(s):

- Operating Systems: Principles and Practice, Anderson and Dahlin (Local copy)
- Operating Systems Concepts, Silberschatz, Galvin, and Gagne
- For Virtual Memory related chapters: Operating Systems: Four Easy Pieces, Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau.

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Study basic principles underlying the design of operating systems with a focus on principles and mechanisms used throughout the design	1	0	1	0	1	0	0	0	0	0	3
An understanding of CPU scheduling storage management: memory management virtual memory and file systems	1	0	0	0	0	0	0	0	0	0	3
Study of concurrency control and synchronization classical algorithms for synchronization and concurrency management	1	0	1	0	0	0	0	0	0	0	3
Study Deadlocks Devices device management and I/O systems	1	0	0	0	0	0	0	0	0	0	3
Study dynamic binding	0	0	0	0	0	0	0	0	0	0	3
An understanding of protection access control and security	1	0	0	0	0	1	0	1	0	0	3
Improve skills in concurrent programming and introduce kernel programming	3	2	0	0	0	0	0	0	0	0	3

Catalog Description:

Covers the principles and practice of operating system design, including concurrency, memory management, file systems, protection, security, command languages, scheduling, and system performance. Laboratory work involves exercises about various aspects of operating systems.

Requirement Status: Required

CS160: Concurrent Programming and Parallel Systems

Lecture: 3 hours; **Laboratory**: 3 hours

Prerequisite(s): CS 061: Machine Organization and Assembly Language Programming; CS 141: Intermediate Data Structures and Algorithms.

Instructor: In the last five years, the following instructors have taught this class: Brett Fleisch and Ray Klefstad.

Textbook(s):

- Concurrent Systems, 2nd Edition, Jean Bacon

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Understand the requirements to support concurrent systems.	1	0	1	0	0	0	0	0	0	0	3
Introduce modular system structure for concurrent systems and the relationship to processes and threads.	1	0	0	0	0	1	0	0	0	0	3
Understand the process abstraction, support for concurrency, and dynamic execution models.	2	0	0	0	0	0	0	0	0	0	3
Understand the difference between process abstraction versus dynamic execution models that share and address space.	1	0	0	0	0	0	0	0	0	0	3
Understand process interaction, hardware support for process interaction, concurrency control without hardware support, and semaphores.	1	0	0	0	0	0	0	0	0	0	3
Introduce classic systems problems and the POSIX threads package.	0	0	0	0	0	0	0	0	0	0	3
Introduce IPC mechanisms for shared memory and nonshared memory systems.	1	0	0	0	0	0	0	0	0	0	3
Understand mechanisms used to support crash resilience and introduce persistent data.	1	0	0	0	0	0	0	0	0	0	3
Understand composite operations that span distributed systems in the presence of concurrency and crashes and the fundamentals of transactions.	1	0	0	0	0	0	1	0	0	0	3
Introduce concurrency control for transactions.	1	0	0	0	0	0	0	0	0	0	3
Provide laboratories that improve student programming competence and train students to better design, implement and analyze concurrent systems.	3	2	3	0	2	0	0	0	0	0	3
Provide assignments that give substantial hands on experience writing systems that use concurrency and require concurrency control and fine grain concurrency support.	3	0	2	0	2	0	0	0	0	0	3

Catalog Description:

Study of concurrent and parallel systems. Topics include modular structure and design, inter-process communication, synchronization, failures and persistence, concurrency control, atomic transactions, recovery, language support, distributed inter-process communication, and implementation mechanisms. Provides preparation for the study of operating systems, databases, and computer networking.

Requirement Status: Required

CS161: Design and Architecture of Computer Systems

Lecture: 3 hours; **Discussion**: 1 hour

Prerequisite(s): CS 120B/EE 120B: Introduction to Embedded Systems. Introduction to hardware and software design of digital computing systems embedded in electronic devices (such as digital cameras or portable video games). Topics include custom and programmable processor design, standard peripherals, memories, interfacing, and hardware/software tradeoffs. Laboratory involves use of synthesis tools, programmable logic, and microcontrollers and development of working embedded systems; concurrent enrollment in CS 161L.

Instructor: In the last five years, the following instructors have taught this class: Philip Brisk and Walid Najjar.

Textbook(s):

- Computer Organization and Design, The Hardware/Software Interface, 4th Edition, John L. Hennessy and David A. Patterson, Morgan Kaufmann Publishers, 2009

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Understand instructions as the language of the machine and the tradeoffs in instruction set design	1	1	1	0	1	0	0	0	0	0	3
Introduction to the issues and factors that impact performance, both hardware and software	2	2	2	0	1	0	0	0	0	0	3
Learn how to design the data-path and control unit as the heart of the CPU	3	2	3	0	0	0	0	0	0	0	3
Introduction to computer arithmetic: fast addition and Multiplication	3	0	3	0	2	0	0	0	0	0	3
Introduction to memory hierarchy: simple caches and virtual memory	2	2	3	0	2	0	0	0	0	0	3

Catalog Description:

A study of the fundamentals of computer design. Topics include the performance evaluation of microprocessors, instruction set design and measurements of use, microprocessor implementation techniques including multi-cycle and pipelined implementations, computer arithmetic, memory hierarchy, and input/output (I/O) systems.

Requirement Status: Required

CS161L: Laboratory in Design and Architecture of Computer Systems

Lecture: 1 hours; **Laboratory**: 3 hours

Prerequisite(s): CS 120B/EE 120B; concurrent enrollment in CS 161

Instructor: In the last five years, the following instructors have taught this class: Phillip Brisk and Walid Najar.

Textbook(s):

- Computer Organization and Design, The Hardware/Software Interface, 4th Edition, John L. Hennessy and David A. Patterson, Morgan Kaufmann Publishers, 2009

Course Objectives with Mapping to Student Outcomes:

Objective Outcome Matrix											
Objective Addresses Outcome: 1-slightly 2-moderately 3-substantially											
Outcome Related Learning Objectives	A	B	C	D	E	F	G	H	I	J	K
Understanding of computer arithmetic by (1) Design and implementation of an ALU and (2) Implementation of complex arithmetic algorithms in software.	3	0	3	0	1	0	0	0	0	0	3
Understanding of operation of a CPU by (1) Design and implementation of a data-path and (2) Design and implementation of a the control unit both for the MIPS architecture	3	0	3	0	1	0	0	0	0	0	3
Understanding of operation of a cache memory by designing and writing a cache-simulator program in C/C++	3	0	2	0	1	0	0	0	0	0	3
Familiarity with the cycle-level simulation of a complex computer architectures	1	0	0	0	0	0	0	0	0	0	3
Understanding of data-paths via a hands on introduction to data-paths	3	0	0	0	0	0	0	0	0	0	3

Catalog Description:

Students design and simulate a complete computer system, using hardware description language and simulator. Topics include instruction set architecture design, assemblers, data-path and control unit design, arithmetic and logic unit, memory and input/output (I/O) systems, and integration of all parts into a working computer system.

Requirement Status: Required

ENGL 01SC: Applied Intermediate Composition for Science and Engineering Majors

Lecture: 3 hours; extra writing and rewriting: 3 hours

Prerequisite(s): ENGL 001B

Instructor: In the last five years, the following instructors have taught this class: Gretchen Bartels, Deborah Willis, Jennifer Kavetsky, and Daniel Hepler

Text book(s):

- English 1SC Xerox packet (available at the campus copy center)
- Einstein's Dreams, Alan Lightman

Catalog Description:

A course for science and engineering majors corresponding to ENGL 001C and ENGL 01HC. Helps students build the writing skills most relevant to their future work in science or engineering fields.

Requirement Status: Required

MATH 9A: First-Year Calculus

Lecture: 3 hours; **Discussion**: 1 hour

Prerequisite(s): MATH 005

Instructor: In the last five years, the following instructors have taught this class: E. Haley, K. Wolf, D. Gumaer, S. Vidussi, A. Todd, F. Wilhelm, I. Bagci, A. Katz, M. Solorzano, M. Ignatova, G. Gie, L. Lee, D. Grandini, M. Sill, G. Gierz, J. Bergner, B. Herzog, J. Greenstein, P. Hackner

Text book(s):

- David Guichard: Calculus, Late Transcendentals. This is a free electronic book, available at http://www.whitman.edu/mathematics/calculus_late/

Catalog Description:

Introduction to the differential calculus of functions of one variable.

Requirement Status: Required or Math 008A

MATH 9B: First-Year Calculus

Lecture: 3 hours; **Discussion**: 1 hour

Prerequisite(s): MATH 008B with a grade of "C-" or better or MATH 009A with a grade of "C-" or better or MATH 09HA with a grade of "C-" or better.

Instructor: In the last five years, the following instructors have taught this class: J. Greenstein, S. Choi, K. Chandler, J. Baez, A. Censor, J. Buetti, M. Muraleetharan, Y. Kakihara, O. Dearicott, A. Khare, C. Yao, T. Ridenour, V. Dolgushev, E. Lopez, M. Wu, J. McCullough, N. Manning, M. Williams

Text book(s):

- David Guichard: Calculus, Late Transcendentals. This is a free electronic book, available at http://www.whitman.edu/mathematics/calculus_late/

Catalog Description:

Introduction to the integral calculus of functions of one variable.

Requirement Status: Required

MATH 9C: First-Year Calculus

Lecture: 3 hours; **Discussion**: 1 hour

Prerequisite(s): MATH 009B with a grade of "C-" or better or MATH 09HB with a grade of "C-" or better.

Instructor: In the last five years, the following instructors have taught this class: J. Greenstein, S. Choi, K. Chandler, J. Baez, A. Censor, J. Buetti, M. Muraleetharan, Y. Kakihara, O. Dearicott, A. Khare, C. Yao, T. Ridenour, V. Dolgushev, E. Lopez, M. Wu, J. McCullough, N. Manning, M. Williams

Text book(s):

- David Guichard: Calculus, Late Transcendentals. This is a free electronic book, available at http://www.whitman.edu/mathematics/calculus_late/

Catalog Description:

Further topics from integral calculus, improper integrals, infinite series, Taylor's series, and Taylor's theorem.

Requirement Status: Required

MATH 10A: Calculus of Several Variables

Lecture: 3 hours; **Discussion**: 1 hour

Prerequisite(s): MATH 009B with a grade of "C-" or better or MATH 09HB with a "C-" or better or equivalent.

Instructor: In the last five years, the following instructors have taught this class: R Schultz, F Yang, Q Zhang, G Heier, Z Ran, M Ait Nouh, O Dearricott, Z Guan, J Baez, M Muraleetharan, B Wong, S Vidussi, E Zoque Lopez, I Bagci, R Walia, Y Poon, T Ridenour, B Herzog, M Chang, I Bagci, G Gie, D Lam, G Gierz, J Zaragoza, Y Poon, M Wu, S Choi, K Wolf, J Fei, F Wilhelm, M Wu, M Asaeda, P Hackney, S Muir, K Fredrickson, L Lee, and S Muir

Text book(s):

- Vector Calculus, by Susan Colley

Catalog Description:

Topics include Euclidean geometry, matrices and linear functions, determinants, partial derivatives, directional derivatives, Jacobians, gradients, chain rule, and Taylor's theorem for several variables.

Requirement Status: Required

MATH 10B: Calculus of Several Variables

Lecture: 3 hours; **Discussion**: 1 hour

Prerequisite(s): MATH 010A with a grade of "C-" or better or equivalent.

Instructor: In the last five years, the following instructors have taught this class: Q Zhang, A Khare, K Chandler, F Wilhelm, F Yang, Z Ran, S Cho, Christodoulopou, J Greenstein, R Schultz, G Gierz, O Dearricott, M Muraleetharan, B Dodson, B Rolie, M Sill, A Ran, P Hackney, F Xu, N Manning, M Sill, G Gie, M Williams, I Henriques, K Wolf, J Keliher, Y Poon, K Fredrickson, J Bergner, and W Gan

Text book(s):

- Vector Calculus, by Susan Colley

Catalog Description:

Covers vectors; differential calculus, including implicit and extreme values; multiple integration; line integrals; vector field theory; and theorems of Gauss, Green, and Stokes.

Requirement Status: Required

MATH 11: Introduction to Discrete Structures

Lecture: 3 hours; **Discussion**: 1 hour

Prerequisite(s): MATH 009A or MATH 09HA; CS 010 or MATH 009B or MATH 09HB.

Instructor: In the last five years, the following instructors have taught this class: D Grandini, S Choi, M Ait Nouh, I Bagci, M Muraleetharan, O Dearricott, J McCullough, M Williams, K Wolf, M Ignatova

Text book(s):

- Schaum's Outline of Discrete Mathematics, Revised 3ed, by Lipschutz and Lipson.

Catalog Description:

Introduction to basic concepts of discrete mathematics with emphasis on applications to computer science. Topics include prepositional and predicate calculi, elementary set theory, functions, relations, proof techniques, elements of number theory, enumeration, and discrete probability. Cross-listed with CS 011.

Requirement Status: Required

MATH 46: Introduction to Ordinary Differential Equations

Lecture: 3 hours; **Discussion**: 1 hour

Prerequisite(s): MATH 009B with a grade of "C-" or better or MATH 09HB with a grade of "C-" or better or equivalent.

Instructor: In the last five years, the following instructors have taught this class: J. Greenstein, K. Wolf, I. Henriques, T. Laurent, K. Frederickson, I. Bagci, Z. Guan, K. Costello, S. Vidussi, M. Ignatova, P. Hackney, M. Williams, M. Chang, O. Dearricott, K. Lin

Text book(s):

- Schaum's Outline of Discrete Mathematics, Revised 3ed, by Lipschutz and Lipson.

Catalog Description:

Introduction to first-order equations, linear second-order equations, and Laplace transforms, with applications to the physical and biological sciences.

Requirement Status: Required

MATH 113: Applied Linear Algebra

Lecture: 3 hours; **Discussion**: 2 hours

Prerequisite(s): Concurrent enrollment in or completion of MATH 010A with a grade of "C-" or better.

A study of matrices and systems of linear equations, determinants, Gaussian elimination and pivoting, vector spaces, linear independence and linear transformation, orthogonality eigenvalues, and eigenvectors. Also examines selected topics and applications. Integrates numerical linear algebra and extensive computer use with these topics. Credit is awarded for only one of MATH 113 or MATH 131.

Instructor: In the last five years, the following instructors have taught this class: P. Hackney, K. Wolf, L. Lee, I Henriques, Christodoulopou, L. Ratliff, D. Grandini, M. Muraleetharan, D. Clahane

Text book(s):

- Schaum's Outline of Linear Algebra, 4th edition, by Seymour Lipschutz and Marc Lipson
  .

Catalog Description:

A study of matrices and systems of linear equations, determinants, Gaussian elimination and pivoting, vector spaces, linear independence and linear transformation, orthogonality eigenvalues, and eigenvectors. Also examines selected topics and applications. Integrates numerical linear algebra and extensive computer use with these topics. Credit is awarded for only one of MATH 113 or MATH 131.

Requirement Status: Required

PHYS 040A: General Physics

Lecture: 3 hours; **Discussion**: 1 hour; **Laboratory**: 3 hours

Prerequisite(s): MATH 008B with a grade of "C-" or better or MATH 009A with a grade of "C-" or better or MATH 09HA with a grade of "C-" or better; MATH 009B or MATH 09HB (MATH 009B or MATH 09HB may be taken concurrently).

Instructor: In the last five years, the following instructors have taught this class: Maurizio Biasini, John Ellison, Chun Lau, Allen Zych, Roya Zandi, Bipin Desai, James Buchholz, Robert Clare, and L. Zhu,

Text book(s):

- Physics for Scientists and Engineers, A Strategic Approach, 2nd Edition by Randall Knight, published by Pearson/Addison Wesley.

Catalog Description:

Designed for engineering and physical sciences students. Covers topics in classical mechanics including Newton's laws of motion; friction; circular motion; work, energy, and conservation of energy; dynamics of particle systems; collisions; rigid-body motion; torque; and angular momentum. Laboratories provide exercises illustrating experimental foundations of physical principles and selected applications.

Requirement Status: Required

PHYS 040B: General Physics

Lecture: 3 hours; **Discussion**: 1 hour; **Laboratory**: 3 hours

Prerequisite(s): MATH 009C or MATH 09HC (may be taken concurrently); PHYS 040A with a grade of "C-" or better.

Instructor: In the last five years, the following instructors have taught this class: Allen Zych, Roya Zandi, Richard Seto, Chun Lau, Shan-Wen Tsai, Stephan Wimpenny, and James Buchholz

Text book(s):

- Physics for Scientists and Engineers, A Strategic Approach, 2nd Edition by Randall Knight, published by Pearson/Addison Wesley.

Catalog Description:

Designed for engineering and physical sciences students. Covers topics in mechanics and thermodynamics including elasticity; oscillations; gravitation; fluids; mechanical waves and sound; temperature, heat, and the laws of thermodynamics; and the kinetic theory of gases. Laboratories provide exercises illustrating the experimental foundations of physical principles and selected applications.

Requirement Status: Required

PHYS 040C: General Physics

Lecture: 3 hours; **Discussion**: 1 hour; **Laboratory**: 3 hours

Prerequisite(s): MATH 009C or MATH 09HC; PHYS 040B with a grade of "C-" or better.

Instructor: In the last five years, the following instructors have taught this class: Owen Long, Gail Hanson, Kirill Shtengel, Leonid Pryadico, Mayra Tovar

Text book(s):

- Fundamentals of Physics, fifth edition by Halliday, Resnick, and Walker; John Wiley & Sons Publishing

Catalog Description:

Designed for engineering and physical sciences students. Covers topics in electricity and magnetism including electric fields and potential; Gauss' law; capacitance; magnetic fields; Ampere's law; Faraday's law and induction; electromagnetic oscillations; dc and ac current; and circuits. Laboratories provide exercises illustrating the experimental foundations of physical principles and selected applications.

Requirement Status: Required

STAT 155: Probability and Statistics for Science and Engineering

Lecture: 3 hours; **Discussion**: 1 hour; **Laboratory**: 3 hours

Prerequisite(s): MATH 009C or MATH 09HC (MATH 009C or MATH 09HC may be taken concurrently).

Instructor: In the last five years, the following instructors have taught this class: Yingtao Bi, W Wen, Jill Smith, Daniel Bolton, Analisa Vega, Linda Penas, C Wang, Jill Smith, Analisa Flores, James Flegal, S Benecke, and Shujie Ma

Text book(s):

- Textbook: Probability and Statistics for Engineering and the Sciences, seventh edition, by Jay L. Devore, Brooks/Cole Cengage Learning
- WebAssign software

Catalog Description:

Covers sample spaces and probability; random variables and probability distributions; elements of statistical inference; and testing and estimation. Also addresses selected topics in multivariate distributions and introduces stochastic processes.

Requirement Status: Required

Engr 180 Course Syllabus

Class Name: Technical Communication

Instructors: Sharon Burton and Bonni Graham
Contact info:
Sharon email: sharon@anthrobytes.com or
Bonni email: bgraham@manuallabour.com

Class Policies

Each student is responsible for the following policies.

1. Cheating is **not** allowed in this class. **Any** cheating at **any** time will result in an **F** for the entire class and further action as defined by the University.
2. All assignments must be turned into the Moodle site (located at http://moodle.cs.ucr.edu) by the assignment specific deadline. All assignments **must** be named as follows:
   [labperson][studentfirstlastname][assignmentname].[extension]
   For example: Bonni**SBurtonVarkEssay.doc**
   After the first week, incorrectly named assignments will **not** be graded and the student will receive a **zero** for that assignment.
   Assignments in non-acceptable electronic file formats will **not** be graded. Acceptable file formats are:
   - doc
   - pdf
   - rtf
   - zip
   - ppt
   - txt
3. Failure to adequately complete each assignment can result in failure for this class. It is the student's responsibility to understand the requirements of the assignment, complete the assignment, and upload the assignment to Moodle by the specified deadline.
4. Assignments, including reading assignments, will be explained in lecture and lab. It is the students' responsibility to attend lecture and lab for this information.
5. Based on the instructor's evaluation, a student may be required to work with the UCR writing lab on each assignment. If the student is required to do so, the student must provide a signed note from the writing lab that each assignment was reviewed with a tutor in the writing lab before the assignment can be graded. There are no exceptions to this decision.

Textbooks

A Guide to Writing as an Engineer. Beer and McMurrey 2009
Reading assignments to be determined and assigned in class

Websites

Course website: http://moodle.cs.ucr.edu - all course material will be on this site

Course Goals and Objectives

1. Ability to participate and contribute to discussions and meetings, both in leading and nonleading roles.
2. Ability to make cogent, well-organized verbal presentations, with and without visual aids prepared via presentation software.
3. Ability to produce cogent, well-written documents (including email).

4. Understanding of professional and ethical responsibility, particularly regarding well-designed human interfaces including documentation.
5. Understanding of what is expected in the professional workplace, including the need for long-term professional development.

Major Topics Covered in the Course

Importance of communication in science and engineering, defining an audience, organizing and drafting documents, technical writing standards, revising for organization and style, developing graphics, conducting meetings, memos/letters/email, proposals, progress reports, articles, instructions and procedures, electronic text, oral presentations, job search documents.

Also: inductive and deductive reasoning, truth tables, presentation style and skills, VARK, use cases, mind maps, grammar and style, writing functional specifications, usability testing, explanations and simplification, visual gestalt in design, designing for online use, and ethics in communication.

Oral and Written Communications

Every student is required to submit at least 15 written reports (not including exams, tests, quizzes, or commented programs) of typically 2 to 5 pages and to make 1 oral presentation of typically 5 minutes duration.

Social and Ethical Issues

Ethical implications of poor communication are discussed. Students are required to produce high-quality documentation and to rewrite poor documentation using the standards taught in lecture and reading. Ethical implication of design and audience awareness are discussed, and students are required to demonstrate this awareness in each unit project which is designed for different audiences: management, peers, end users. Social awareness of audience and the implications of technology are discussed. Projects are required to demonstrate said awareness.

Theoretical Content

Students are expected to understand critical thinking & logic as is applies to writing, and to synthesize that with other topics. Students are exposed to a variety of design & layout theories, including visual gestalt, and expected to discuss these topics not only theoretically, but articulate practical applications as well (~4-6 hours lecture, scattered throughout course). Students are exposed to cognitive processing and learning theory, and how it applies to interfaces and documentation (4-6 hours lecture, scattered throughout course)

Grading

50% written exams covering theory and writing, 30% homework, 10% presentations, 10% participation. Students are checked off on work completed in labs, are graded on drafts, revisions, and completed documents, and take quizzes and exams that have multiple choice and essay questions. Students are graded by at least the following standards: following the assignments, writing ability, logical argument, and the principles covered in class and in the reading assignments.

EE 100A: ELECTRONIC CIRCUITS I

Credits and Contact Hours
4.0 Units
Lecture: TR, 3:40 pm – 5:00 pm, MSE 113
Lab: Friday, 5:10 pm – 8 pm, WCH 128

Instructor and TA
Alexander Korotkov, Professor, Dept. of Electrical Engineering, WCH 434
Li Wang, Teaching Assistant, WCH 109

Textbooks and Related Materials
1. (Text) Microelectronic Circuits, 6th edition, A.S. Sedra and K.C. Smith, Oxford Univ. Press
2. (Online references for OrCAD PSpice) http://www.orcad.com, http://www.orcad.com/forums/

Course Description (Catalog Description)
Covers electronic systems, linear circuits, operational amplifiers, diodes, nonlinear circuit applications, junction and metaloxide-semiconductor field-effect transistors, bipolar junction transistors, MOS and bipolar digital circuits. Laboratory experiments are performed in the subject areas and SPICE simulation is used.

Prerequisite(s)
EE001B

Course Type
Electrical Engineering, required.

Course Objectives
1. Explain the basic operation and characteristics of semiconductor diodes, bipolar junction transistors (BJTs), and metal-oxide-semiconductor field-effect transistors (MOSFETs).
2. Design and analyze a rectifier circuit consisting of diodes, transformer, filter, and voltage regulator.
3. Design and analyze an amplifying stage based on the BJT or MOSFET.
4. Use small-signal models of the BJT and MOSFET for circuit analysis.
5. Analyze operation of a switching circuit based on BJT or MOSFET.
6. Perform laboratory experiments with electronic circuits containing semiconductor diodes, BJTs, and MOSFETs.
7. Write reports on performed laboratory experiments.
8. Use simulation software SPICE for analysis of electronic circuits.

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Basic operation and characteristics of semiconductor diodes, bipolar junction transistors (BJTs), and metal-oxide-semiconductor field-effect transistors (MOSFETs).	1										
2	Design and analyze a rectifier circuit consisting of diodes, transformer, filter, and voltage regulator.	1										
3	Design and analyze an amplifying stage based on the BJT or MOSFET.	1					1					
4	Use small-signal models of the BJT and MOSFET for circuit analysis.	1										
5	Analyze operation of a switching circuit based on BJT or MOSFET.	1										
6	Perform laboratory experiments with electronic circuits containing semiconductor diodes, BJTs, and MOSFETs.	1	1									
7	Write reports on performed laboratory experiments	1	1									
8	Use simulation software SPICE for analysis of electronic circuits.		1									

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

Brief List of Topics

1) Signals and amplifiers
2) Diodes
3) Bipolar Junction Transistors
4) MOS Field-Effect Transistors

EE 105: MODELING AND SIMULATION OF DYNAMIC SYSTEMS

Credits and Contact Hours
4.0 Units

Lecture:	MWF	8:10 –	9:00	WCH 138
Lab:	Mon.	11:10 –	2:00	ENGR II Rm 125
Lab:	Weds.	11:10 –	2:00	ENGR II Rm 125

Office Hours
Instructor: Weds. 1-2 PM, Fri. 12-1 PM, or by appointment
TA: F 9-10 AM or by request

Instructor and TA
Jay A. Farrell, Professor, Dept. of Electrical Engineering WCH 341
TA: Yiming Chen, WCH 369

Textbooks and Related Materials
The following books are on reserve at the Science Library.

1. Systems Dynamics Modeling And Simulation of Mechatronic Systems, by D. Karnopp, D. Margolis, R. C. Rosenberg, 2005, ISBN: 0471709654, 4th Ed., John Wiley & Sons Inc.
2. Mechatronic Modeling and Simulation Using Bond Graphs, Shuvra Das, CRC Press, 2009, ISBN 1420073141.

Neither will be used for homework assignment. The course is taught from my notes, which use the notation and approach of the Karnopp text. My notes, all homework, and all labs will be distributed via ILearn. The lecture will cover and explain much more than the notes, include many more examples, and give hints for exams. Skip lecture at your own peril.

Course Description (Catalog Description)
Introduction to the mathematical modeling of dynamical systems and their methods of solution. Advanced techniques and concepts for analytical modeling and study of various electrical, electronic, and electromechanical systems based upon physical laws. Emphasis on the formulation of problems via differential equations. Numerical methods for integration and matrix analysis problems. Case studies. Digital computer simulation.

Prerequisite(s)
CS 010, EE 001A, MATH 046 or consent of instructor

Course Type
Electrical Engineering, required.

Course Objectives
Development of the

1. Ability to construct ODE and TF models of physical systems
2. Ability to translate between alternative forms of system models: transfer function, ODE, state space
3. Ability to analyze and manipulate state space models using linear algebra

4. Ability to construct state space models for dynamic systems from physical principles
5. Ability to apply and interpret frequency response analysis
6. Ability to implement a numeric simulation for a physical system
7. Ability to analyze physical system dynamics using block diagram simulation
8. Ability to work in MATLAB
9. Ability to analyze, construct, and understand bond graphs and their relation to dynamic system modeling

Student Outcomes

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Ability to construct ODE and TF models of physical systems	X				X						
2	Ability to translate between alternative forms of system models: transfer function, ODE, state space	X				X						
3	Ability to analyze and manipulate state space models using linear algebra	X				X						
4	Ability to construct state space models for dynamic systems from physical principles	X				X						
5	Ability to apply and interpret frequency response analysis	X				X						
6	Ability to implement a numeric simulation for a physical system	X				X						
7	Ability to analyze physical system dynamics using block diagram simulation	X				X						
8	Ability to work in MATLAB	X				X						
9	Ability to analyze, construct and understand bond graphs and their relation to dynamic system modeling.	X				X						

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

EE110A: CONTINUOUS-TIME SIGNALS AND SYSTEMS

Credits and Contact Hours
4.0 Units
Lecture: TR 2:10pm – 3:30pm, SPTH 1222
Lab: F 11:10am – 2:00pm, WCH 125
Office Hours:
Instructor: R 11:00am – 12:00pm
TA: F 10am – 12 pm

Instructor and TA
Feras Abou-Galala, Lecturer, Dept. of Electrical Engineering, WCH411
TA: Yang Gao, WCH 109

Textbooks and Related Materials
1. (Text) Alan V. Oppenheim and A. S. Willsky, *Signals and Systems,* 2nd ed., Prentice-Hall 1997

Course Description (Catalog Description)
To provide an introduction to fundamental concepts and tools for analysis of signals and systems

Prerequisite(s)
EE001B, MATH09C, MATH046 or consent of instructor

Course Type
Electrical Engineering, required.

Course Objectives
1. Basic skills of sketching continuous-time signals and simple operations
2. Understand the meaning, purpose, and utility of continuous-time Fourier Series and Transform
3. Basic skills of performing continuous-time Fourier Transform
4. Calculate system's response via convolution
5. Understanding the basic properties of continuous-time linear time-invariant systems
6. Understanding the basic properties of continuous-time Fourier transform and how to use them to simplify analysis
7. Calculate Fourier Series and generate harmonics using MATLAB
8. Calculate Fourier Transform and perform computation using MATLAB
9. Understand and can explain the basic concepts an utilities of filters
10. Relating Communication Systems to Fourier Transform and understanding AM modulation/demodulation basics

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Basic skills of sketching continuous-time signals	1										
2	Understand ontinuous-time Fourier Series and Transform	1										
3	Performing continuous-time Fourier Transform	1										
4	Calculate system's response via convolution	1										
5	Understanding the basics of continuous-time linear time-invariant systems	1										
6	Understand the basics of continuous-time Fourier transform to simplify analysis	1										
7	Calculate Fourier Series and generate harmonics using MATLAB	1										
8	Calculate Fourier Transform and perform computation using MATLAB	1										
9	Understand and explain the basic concepts an utilities of filters	1										
10	Relating Communication Systems to Fourier Transform and understanding AM modulation/demodulation basics	1										

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

EE110B: DISCRETE-TIME SIGNALS AND SYSTEMS

Credits and Contact Hours
4.0 Units
Lecture: TR 12:40pm – 2:00pm, MSE 103
Lab: Check classes.ucr.edu for times, CHUNG 125
Office Hours:
Instructor: TR 11:00am – 12:00pm
TA: TBA

Instructor and TA
Feras Abou-Galala, Lecturer, Dept. of Electrical Engineering, WCH411
TA: Ali Cirik, WCH 109

Textbooks and Related Materials
1. (Text) Alan V. Oppenheim and A. S. Willsky, *Signals and Systems,* 2nd ed., Prentice-Hall 1997

Course Description (Catalog Description)
As a continuation to EE110A, this course is intended to provide an introduction to fundamental concepts and tools for analysis of discrete-time signals and systems

Prerequisite(s)
EE110A or consent of instructor

Course Type
Electrical Engineering, required.

Course Objectives
1. Basic skills of sketching discrete-time signals and simple operations
2. Understand the meaning, purpose, and utility of discrete-time Fourier Series and Transform
3. Basic skills of performing discrete-time Fourier Transform
4. Understanding the connections and distinctions between continuous-time and discrete-time Fourier transform
5. Understanding the basic properties of discrete-time linear time-invariant systems
6. Understanding the basic properties of discrete-time Fourier transform
7. Understanding the meaning, purpose, and utility of Z-transform
8. Basic skills of performing Z-transforms and inverse Z-transforms
9. Understanding the basic properties of discrete-time Z-transforms
10. Understanding the concept of the Sampling theorem and aliasing

Student Outcomes Addressed
A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.

D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulat e and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Basic skills of sketching discrete-time signals and simple operations	1										
2	Understand the meaning, purpose, and utility of discrete-time Fourier Series and Transform	1										
3	Basic skills of performing discrete-time Fourier Transform	1										
4	Understanding the connections and distinctions between continuous-time and discrete-time Fourier transform	1										
5	Understanding the basic properties of discrete-time linear time-invariant systems	1										
6	Understanding the basic properties of discrete-time Fourier transform	1										
7	Understanding the meaning, purpose, and utility of Z-transform	1										
8	Basic skills of performing Z-transforms and inverse Z-transforms	1										
9	Understanding the basic properties of discrete-time Z-transforms	1										
10	Understanding the concept of the Sampling theorem and aliasing	1										

EE 114: PROBABILITY, RANDOM VARIABLES, AND RANDOM PROCESSES IN ELECTRICAL ENGINEERING

Credits and Contact Hours
4.0 Units
Lecture: MWF 2.10 pm – 3pm; OLMH 1208
Discussion: W 5.10 pm – 6.00 pm; OLMH 1212

Office Hours
Instructor: M 1-2pm, W 10-11am
TA: T 4-5pm, W 3-4pm

Instructor and TA
Amit K. Roy-Chowdhury, Associate Professor, Dept. of Electrical Engineering,
WCH 431
TA: Shu Zhang, WCH 371

Textbooks and Related Materials

(Text) Roy D. Yates and David J. Goodman, "Probability and Stochastic Processes – A Friendly Introduction for Electrical and Computer Engineers", 2nd Edition, John Wiley and Sons Inc.

(Reference) A. Leon-Garcia, "Probability and Random Processes for Electrical Engineering", 2nd Edition, Addison Wesley Longman.

Course Description (Catalog Description)
Covers fundamentals of probability theory, random variables, and random processes with applications to Electrical and Computer Engineering. Topics include probability theory, random variables, densities, functions of random variables, expectations and moments, multivariate distributions, random processes, autocorrelation function, spectral analysis of random signals, linear systems with random inputs.

Prerequisite(s)
EE110A or consent of instructor

Course Type
Electrical Engineering, required.

Course Objectives:

1. Introduction to basic concepts of probability.
2. Introduction to basic concepts of random variables.
3. Understanding the role of probability and statistics in real life applications.
4. Applications of probability and random variables in electrical and computer engineering.
5. Introduction to multiple random variables, joint distributions, independence and correlation.
6. Introduction to random processes and their applications.

7. Ability to independently solve problems in probability, random variables and random processes.

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Introduction to basic concepts of probability	1										
2	Introduction to basic concepts of random variables	1										
3	Understanding the role of probability and statistics in real life applications	1										
4	Applications of probability and random variables in electrical and computer engineering.					1						
5	Introduction to multiple random variables, joint distributions, independence and correlation	1										
6	Introduction to random processes and their applications	1										
7	Ability to independently solve problems in probability, random variables and random processes	1				1						

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

EE 115: INTRODUCTION TO COMMUNICATION SYSTEMS

Credits and Contact Hours
4.0 Units
Lectures: TR 11:10 am -12:30 pm, MSE 113
Lab:R 8:10 am - 11 am ENGR2 128

Office Hours
Instructor: R 1 – 2:00pm
TA: T 4 – 6:00pm

Instructor and TA
Ilya Dumer, Professor, Dept. Of Electrical Engineering, WCH 427
TA: Yiming Ma, WCH 109

Textbooks and Related Materials
Syllabus, course materials, lab manuals, homework assignments are posted on http://www.ilearn.ucr.edu/

Textbook:

1. B.P. Lathi, Modern Digital and Analog Comm. Systems, 3rd Ed.; Oxford, 1998 (ISBN 019511009-9) or :
2. B.P. Lathi and Zhi Ding. Modern Digital and Analog Comm. Systems, 4th ed. Oxford, 2009 (ISBN 0195331451)

References:

1. Simon Haykin, Communication Systems, Wiley, 4th Edition, 2001 (ISBN 0-471-17869-1).
2. Leon W. Couch, Digital and Analog Communication Systems. Macmillan Publishing Co., 4th Edition, 1993.

Course Description (Catalog Description)
Covers spectral density and correlation, modulation theory, amplitude, frequency, phase and analog pulse modulation and demodulation techniques, signal-to-noise ratios, and system performance calculations. Laboratory experiments involve techniques of modulation and demodulation.

Prerequisites
EE 110 B

Course Type
Electrical Engineering, required.

Course Objectives
Introduction to basic techniques in continuous communication systems**.**

1. Briefly explain what are Energy and Power spectral density, Bandwidth, Amplitude modulation, Frequency modulation.

2. Plot Fourier response of a power signal. Calculate the first-null bandwidth of base band signals.
3. Design of modulators/demodulators for AM and DSB-SC signals in software and hardware.
4. Design modulators and demodulators for phase-modulated and frequency-modulated signals.
5. Learn and use MATLAB for communication systems.

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Briefly explain what are: Energy and Power spectral density, Bandwidth, Amplitude modulation; Frequency modulation	2				2						
2	Plot Fourier response of a power signal. Calculate the first-null bandwidth of base band signals.	2				2						
3	Design of modulators/demodulators for AM and DSB-SC signals in software and hardware.	2	2			1						
4	Design modulators and demodulators for phase-modulated and frequency-modulated signals.	2	2			1	2					
5	Learn and use MATLAB for communication systems	1	2			1						

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

EE/CS 120A: LOGIC DESIGN

Credits and Contact Hours
4.0 Units
Lecture: MW 9:40am-11:00am; Sproul Hall 2339
Lab Section 021: MW 8:10am to 11:00am; ENGR2 125
Lab Section 022: MW 6:10pm to 09:00pm; ENGR2 125

Instructor and TA
Dr. Sheldon Tan, Professor, Dept. of Electrical Engineering;
WCH 424
TA: Eric Mlinar, Armen Gholian

Textbooks and Related Materials
(Text) Digital Design with RTL Design, VHDL, and Verilog, 2nd Edition by Prof. Frank Vahid
(Prof. Vahid will not receive any royalty from the sale of this text book)

Course Description (Catalog Description)
EE/CS120A introduces you to the exciting world of digital design. Digital circuits not only form the foundation of computers, but make possible many of the advances around us, like cell phones, video games, medical instruments, automotive systems, satellites, PDAs, music equipment, military equipment, store automation. You name it -- if it runs on electricity, it's probably got digital circuits (known as embedded systems) inside! 120A gets you up to speed on the basics; the follow-up course, 120B, teaches you to build a computer, and to build complete working embedded computing systems. EE/CS 120A and 120B are taught jointly by the EE and CS&E departments.

Prerequisite(s)
CS 061 or consent of instructor

Course Type
Electrical Engineering, required.

Course Objectives
1. Able to perform the conversion among different number systems; Familiar with baisc logic gates -- AND, OR & NOT, XOR, XNOR; Independently or work in team to build simple logic circuits using basic gates.
2. Understand Boolean algebra and basic properties of Boolean algebra; able to simplify simple Boolean functions by using the basic Boolean properties.
3. Able to design simple combinational logics using baisc gates. Able to optimize simple logic using Karnaugh maps, understand "don't care".
4. Familiar with basic sequential logic components: SR Latch, D Flip-Flop and their usage and able to analyze sequential logic circuits.
5. Understand finite state machines (FSM) concepte and work in team to do sequence circuit design based FSM and state table using D-FFs.
6. Familiar with basic combinational and sequential components used in the typical datapath

designs: Register, Adders, Shifters, Comparators; Counters, Multiplier, Arithmetic-Logic Units (ALUs), RAM. Able to do simple register-transfer level (RTL) design.

7. Understand that the design process for today's billion-transistor digital systems becomes a more programming based process than before and programming skills are important.

Student Outcomes Addressed

Item	OUTCOME-RELATED LEARNING OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Able to perform the conversion among different number systems	3	2	1	2		1	2			1	
2	Understand Boolean algebra and basic properties of Boolean algebra; able to simplify simple Boolean functions by using the basic Boolean properties.	1		1		2						
3	Able to design simple combinational logics using baisc gates. Able to optimize simple logic using Karnaugh maps, understand "don't care".	2	1	1		1						
4	Familiar with basic sequential logic components: SR Latch, D Flip-Flop and their usage and able to analyze sequential logic circuits.	1	3			2						
5	Understand finite state machines (FSM) concepte and work in team to do sequence circuit design based FSM and state table using D-FFs.	2	1	2	3		1	2				
6	Familiar with basic combinational and sequential components used in the typical datapath designs: Register, Adders, Shifters, Comparators; Counters, Multiplier, Arithmetic-Logic Units (ALUs), RAM. Able to do simple register-transfer level (RTL) design.		3	1	2		2			1	1	
7	Able to perform register-transfer level (RTL) design. Understand behavioral-level design.		2	3		1			1	1	1	
8	Understand that the design process for today's billion-transistor digital systems becomes a more programming based process than before and programming skills are important.								2	3	3	2
	SUBTOTALS	**9**	**12**	**9**	**7**	**6**	**4**	**4**	**3**	**5**	**6**	**2**

Objectives Addresses Outcome: SLIGHTLY – 1, MODERATELY – 2 SUBSTANTIALY – 3

EE 128: DATA ACQUISITION, INSTRUMENTATION, AND PROCESS CONTROL

Credits and Contact Hours
4.0 Units
Lecture: MWF 12.10 pm – 1pm; MSE 113
Lab: W 8.10 am – 11.00 am; EBU-II 128
Lab: F 8.10 am – 11.00 am; EBU-II 128

Instructor and TA
Matthew Barth, Professor, Dept. of Electrical Engineering;
WCH 342
TA: Hongliang Pan, WCH 371

Textbooks and Related Materials
1. (Reference) Han-Way Huang, "The HCS12/9S12: An Introduction to Software and Hardware Interfacing", Publisher: Thomson Delmar Learning (www.delmarlearning.com), ISBN: 1-4018-9812-2, First Printing, 2006.
2. (Reference) R. Haskell, and D. Hanna, "Learning by Example Using C: Programming the miniDRAGON-Plus2 Using CodeWarrior", Publisher: LBE Books, LLC (www.lbebooks.com), ISBN: 978-0-9801337-2-1, First Printing, 2008.

Course Description (Catalog Description)
Analog signal transducers, conditioning and processing; step motors, DC servo motors, and other actuation devices; analog to digital and digital to analog converters; data acquisition systems; microcomputer interfaces to commonly used sensors and actuators; design principles for electronic instruments, real time process control and instrumentation.

Prerequisite(s)
EE100B, EE/CS-120A, or consent of instructor. You must be able to program in C (or C++).

Course Type
Electrical Engineering, technical elective.

Course Objectives
1. Ability to implement Boolean logic in software; includes techniques on how to read and write bit-level memory;
2. Ability to understand and design general architectures of a microcontroller-based digital system and their application to real-time process control;
3. Form fundamental understanding of a bus-architecture system and be able to interface memory and peripheral hardware within;
4. Ability to understand how interrupts work within microprocessor/microcontroller systems; design a process control system using interrupts;
5. Understand fundamentals of sequence- and state-machines and learn how to implement a process as a sequence- or state-machine;
6. Learn principles of digital-to-analog and analog-to-digital conversion and techniques of implementation;

7. Learn principles of serial & parallel communications, timers & counters (e.g., output compares, input captures, pulse accumulation) and techniques of implementation;
8. Ability to understand how a variety of sensors and actuators can be interfaced to a microcontroller system; key emphasis is on the design of interface circuitry.

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Ability to implement Boolean logic in software			1								
2	Ability to understand and design general architectures of a microcontroller-based digital system			1								
3	Fundamental understanding of a bus-architecture system			1								
4	Ability to understand how interrupts work within microprocessor / microcontroller systems; design a process control system using interrupts		1	1								
5	Understand fundamentals of sequence- and state-machines and learn how to implement a process as a sequence- or state-machine		1	1								
6	Learn principles of digital-to-analog and analog-to-digital conversion and techniques of implementation		1	1								
7	Learn principles of serial & parallel communications, timers & counters (e.g., output compares, input captures, pulse accumulation) and techniques of implementation		1	1								
8	Ability to understand how a variety of sensors and actuators can be interfaced to a microcontroller system; key emphasis is on the design of interface circuitry		1	1								

EE132: AUTOMATIC CONTROL SYSTEMS

Credits and Contact Hours
4.0 Units
Lecture: TR 9:40am – 11:00am, MSE 103
Lab: MW Check classes.ucr.edu for times, CHUNG 125
Office Hours:
Instructor: R 11:00am – 12:00pm

Instructor and TA
Feras Abou-Galala, Lecturer, Dept. of Electrical Engineering, feras@ieee.org, WCH411
TA: Rathavut Vanitsthian rvanitsthian@ee.ucr.edu, WCH 109

Textbooks and Related Materials
1. (**Text**) Control Systems Engineering, N. S. Wise, 6th Ed., John Wiley and Sons.

Course Description (Catalog Description)
This is a one quarter course for four credits. The subject matter includes the design and analysis of control systems. It is assumed that the student is familiar with ODE's, Laplace transforms, complex variables, transfer functions, and modeling. Specific topics to be covered include:
Time domain performance, Laplace domain analysis, Control system design, Performance Metrics
Stability analysis by Routh's Criterion, Root locus, and Nyquist Criterion

Prerequisite(s)
EE105, EE110A or consent of instructor

Course Type
Electrical Engineering, required.

Course Objectives
1. Basic skills of analyzing time-domain performance
2. Perform the Laplace transform to obtain the transfer function of the system
3. Understand the basic components and requirements of Control System Design
4. Analyze and design control systems based on give performance metrices
5. Analyze and design systems for given stability requirements based on Routh's Criterion
6. Use the Root Locus and the Nyquist Criterion to analyze systems transient response
7. Design and analyze PI, PD, and PID controllers
8. Calculate Transfer Functions and perform computation using MATLAB

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Basic skills of analyzing time-domain performance	1										
2	Perform the Laplace transform to obtain the transfer function of the system	1										
3	Understand the basic components and requirements of Control System Design	1										
4	Analyze and design control systems based on give performance metrices	1										
5	Analyze and design systems for given stability requirements based on Routh's Criterion	1		1								
6	Use the Root Locus and the Nyquist Criterion to analyze systems transient response	1		1								
7	Design and analyze PI, PD, and PID controllers	1		1								
8	Calculate Transfer Functions and perform computation using MATLAB	1				1						

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

EE 133: SOLID-STATE ELECTRONICS

Credits and Contact Hours
4.0 Units
Lecture: TR, 5:10 pm – 6:30 pm , MSE 113
Discussion: W, 2:10 pm – 3 pm, WAT 2240

Instructor and TA
Alexander Korotkov, Professor, Dept. of Electrical Engineering; WCH 434
TA: Zonglin Li, zli006@ucr.edu

Textbooks and Related Materials
1. (Text) "Solid State Electronic Devices," (6th ed.) by Ben G. Streetman and Sanjay K. Banerjee, Pearson Prentice Hall, 2006, ISBN: 0-13-149726-X.

Course Description (Catalog Description)
Presents the fundamentals of solid-state electronics. Topics include electronic band structure, Fermi and quasi-Fermi levels; doping; contacts; junctions; field-effect, bipolar, and metal-oxide-semiconductor (MOS) transistors; and charge-coupled devices. Also reviews device fabrication concepts.

Prerequisite(s)
EE100A

Course Type
Electrical Engineering, elective.

Course Objectives
1. Ability to determine crystallographic directions, planes, equivalent directions, and equivalent planes.
2. Understand an energy band diagram including Ec, Ev, Ei, Ef, Fn, and Fp.
3. Understand the relationship between the applied voltage and the movement of the quasi-Fermi levels.
4. Ability to determine the depletion width of a pn junction diode.
5. Ability to determine the depletion capacitance of a pn junction diode.
6. Ability to determine the current of a pn junction diode.
7. Ability to draw and recognize the band diagram of a pn junction diode in forward and reverse bias.
8. Understand fundamentals of BJTs.
9. Ability to determine the flat-band voltage and the threshold voltage of a MOS capacitor.
10. Ability to determine the threshold voltage from a MOS C-V curve.

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Ability to determine crystallographic directions, planes, equivalent directions, and equivalent planes.	1										
2	Understand an energy band diagram including Ec, Ev, Ei, Ef, Fn, and Fp.					1						
3	Understand the relationship between the applied voltage and the movement of the quasi-Fermi levels.					1						
4	Ability to determine the depletion width of a pn junction diode.	1										
5	Ability to determine the depletion capacitance of a pn junction diode.	1										
6	Ability to determine the current of a pn junction diode.	1										
7	Ability to draw and recognize the band diagram of a pn junction diode in forward and reverse bias.					1						
8	Understand fundamentals of BJTs.	1										
9	Ability to determine the flat-band voltage and the threshold voltage of a MOS capacitor.	1										
10	Ability to determine the threshold voltage from a MOS C-V curve.	1										

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

EE 134: DIGITAL INTEGRATED CIRCUIT LAYOUT AND DESIGN

Credits and Contact Hours
4.0 Units
Lecture: TR 8:10 am – 9:30 am Olmsted Hall 1136
Lab: M 8:10 am – 11:00 am WCH 125

Office Hours:
Instructor: T 2:00 pm – 3:00 pm, WCH 322

Instructor and TA
Instructor: Qi Zhu, Assistant Professor, Dept. of Electrical Engineering, WCH 322
TA: Yuan Tian, WCH 461

Textbooks and Related Materials
1. (Text) Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic, "Digital Integrated Circuits", 2nd Edition, Prentice Hall.

Course Description (Catalog Description)
The objective of this course is to introduce the student to CMOS (complementary metal-oxide-semiconductor) digital integrated circuit layout and design. The course covers CMOS integrated circuit design, layout and verification using CAD (computer-aided design) tools. Topics include digital models, inverters, static logic gates, transmission gates, flip-flops, and dynamic logic gates.

Prerequisite(s)
CS 120A / EE 120A, EE 001A, EE 001B, EE 100A, EE 100B, EE 133

Course Type
Electrical Engineering

Course Objectives

1. Basic knowledge of the integrated circuit manufacturing process.
2. Understanding of the device model for modern CMOS transistors.
3. Understanding of the operation modes of CMOS inverters.
4. Ability to calculate delays of inverters and logic gates.
5. Ability to size a chain of inverters to drive a large capacitive load.
6. Understanding of static CMOS logic gates.
7. Understanding of latches and registers.
8. Ability to layout, DRC and LVS CMOS digital integrated circuits.

Student Outcomes Addressed

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.

D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Basic knowledge of the integrated circuit manufacturing process	1									1	
2	Understanding of the device model for modern CMOS transistors	1										
3	Understanding of the operation modes of CMOS inverters	1										
4	Ability to calculate delays of inverters and logic gates	1				1						
5	Ability to size a chain of inverters to drive a large capacitive load	1		1		1						
6	Understanding of static CMOS logic gates	1										
7	Understanding of latches and registers	1										
8	Ability to layout, DRC and LVS CMOS digital integrated circuits		1	1	1	1		1				

List of Topics

CMOS manufacturing, design rules, packaging
Basic MOSFET operation, deep sub-micron MOS, dynamic behavior
Inverter, voltage transfer curve, capacitance, switching delay time
Sizing a chain of inverters
Power and Energy
Complementary static CMOS gates
Static latches and registers
Dynamic logic gates

EE 141 DIGITAL SIGNAL PROCESSING

Credits and Contact Hours
4.0 Units
Lecture: TR 02:10 p.m. - 03:30 p.m. BOYHL 1471
Laboratory: Section 021 M 08:10 a.m. - 11:00 a.m. ENGR2 125
Section 022 T 08:10 a.m. - 11:00 a.m. ENGR2 125

Instructor and TA
Ping Liang, Associate Professor, Dept. of Electrical Engineering; WCH 323
Office Hours: TR: 3:30-5:00pm

TA: Yingying Zhu, WCH 109
Office Hours: MW 1:00-2:00pm

Grading: Lab 20%, Homework 5%, Mid-Terms 35%, and Final Exam 40%

Textbook and Related Materials
(Text) A. V. Oppenheim, R. W. Schafer, and J. R. Buck, Discrete-Time Signal Processing, 3rd edition, Prentice Hall.

Course Description (Catalog Description)
Transform analysis of Linear Time-Invariant (LTI) systems, discrete Fourier Transform (DFT) and its computation, Fourier analysis of signals using the DFT, filter design techniques, structures for discrete-time systems. Laboratory experiments on DFT, fast Fourier transforms (FFT), infinite impulse response (IIR), and finite impulse response (FIR) filter design, and quantization effects.

Prerequisite(s)
EE110B

Course Type
Electrical Engineering, required.

Course Objectives
1. Students know the differences between continuous-time Fourier transform (CTFT) and discrete-time Fourier transform (DTFT).
2. Students know the difference between discrete-time Fourier transform (DTFT) and discrete Fourier transform (DFT).
3. Students know fast Fourier transform (FFT) and how to implement.
4. Students know how to design FIR and IIR filters (low pass, high pass, band pass).
5. Students know how to design FIR filters (low pass, high pass, band pass, generalized linear phase, Kaiser window, multiband filter).
6. Students know sampling, up and down sampling, A/D conversion, oversampling, noise-shaping in sigma-delta modulation A/D

7. Students know how to use FFT/IFFT and circular convolution to implement fast linear filtering of practical digital signals
8. Students understand the importance of DSP in electrical engineering systems and applications and know examples of DSP applications

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Students know the difference between continuous time Fourier transform (CTFT) and discrete-time Fourier transform (DTFT)	1										
2	Students know the difference between DTFT and discrete Fourier transform (DFT)	1										
3	Students know fast Fourier transform (FFT) and how to implement	1										
4	Students know how to design FIR and IIR filters (low pass, high pass, band pass)					1						
5	Students know how to design FIT filters (low pass, high pass, band pass, generalized linear phase, Kaiser window, multiband filter)					1						
6	Students know sampling, up and down sampling, A/D conversion, and oversampling	1				1						
7	Students know how to use FFT/IFFT and circular convolution to implement fast linear filtering of practical digital signals	1				1						
8	Students understand the importance of DSP in electrical engineering systems and applications and know examples of DSP applications					1						

EE 144: INTRODUCTION TO ROBOTICS

Credits and Contact Hours
4.0 Units
Lecture: TR 9.40 am – 11am; HMNSS 1404
Labs W 11:10-2am WCH 128

Instructor and TA
A. Mourikis, Assistant Professor, Dept. of Electrical Engineering; WCH 306
TA: M. Li WCH 109

Textbooks and Related Materials
1. (Text) J.J Craig, "Introduction to Robotics: Mechanics and Control," 3rd Ed, Pearson Prentice Hall, 2005.

Course Description (Catalog Description)
Basic robot components from encoders to microprocessors. Kinematic and dynamic analysis of manipulators. Open-and closed-loop control strategies, task planning, contact and noncontact sensors, robotic image understanding, and robotic programming languages. Experiments and projects include robot arm programming, robot vision, and mobile robots.

Prerequisite(s)
EE132

Course Type
Electrical Engineering, technical elective

Course Objectives
1. Understand and describe the structure of a robot manipulator.
2. Describe and analyze the position and orientation of frames in 3D.
3. Derive models for the forward and inverse kinematics of a manipulator
4. Utilize robot sensor data, such as images from a camera, to perceive objects in a robot's surroundings.
5. Program a mobile robot for performing simple tasks.

B. Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Understand and describe the structure of a robot manipulator.	1										
2	Describe and analyze the position and orientation of frames in 3D	1										
3	Derive models for the forward and inverse kinematics of a manipulator	1										
4	Utilize robot sensor data, such as images from a camera, to perceive objects in a robot's surroundings.	1		1								
5	Program a mobile robot for performing simple tasks.	1		1								

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

List of Topics

1) Spatial descriptions and transformations
2) Manipulator kinematics
3) Inverse manipulator kinematics
4) Jacobians for velocities and static forces
5) Manipulator dynamics
6) Robot control
7) Robot sensing
8) Robot programming

EE 146: COMPUTER VISION

Credits and Contact Hours
4.0 Units
Lecture: TR 12.40 pm – 2pm; WCH 141
Labs W 8:10-11am WCH 125

Instructor and TA
A. Mourikis, Assistant Professor, Dept. of Electrical Engineering; WCH 306
TA: Ramya Malur Srinivasan WCH 371

Textbooks and Related Materials
1. (Text) L. Shapiro and G. Stockman "Computer Vision," Prentice Hall, 2001.

Course Description (Catalog Description)
Imaging formation, early vision processing, boundary detection, region growing, two-dimensional and three-dimensional object representation and recognition techniques. Experiments for each topic are carried out.

Prerequisite(s)
Senior standing in Computer Science or Electrical Engineering, or consent of instructor.

Course Objectives
1. Understand the fundamentals of digital image capturing and manipulation on a computer
2. Apply basic image processing algorithms.
3. Understand the basics of image-based object recognition.
4. Understand key types of features that can be extracted in images to aid in high-level image understanding tasks.
5. Understand the geometric model of a camera

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Fundamentals of digital image capturing and manipulation on a computer	1										
2	Basic image processing algorithms.	1										
3	Basics of image-based object recognition.	1	1									
4	Features that can be extracted in images to aid in high-level image understanding tasks.	1	1									
5	Understand the geometric model of a camera	1										

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

List of Topics

1) Image formation and capturing
2) Binary image generation and processing
3) Pattern recognition concepts and classifier design
4) Parametric and nonparametric techniques for classification
5) Color representation
6) Grayscale image processing (smoothing, edge detection)
7) Texture
8) Segmentation (k-means, graph-based clustering, Hough transform)
9) Least squares model fitting
10) 2D image mappings
11) Corner extraction
12) Geometric model of a camera
13) Depth estimation from images

EE 150 DIGITAL COMMUNICATION

Credits and Contact Hours
4.0 Units
Lecture: TR 2:10pm - 3:30 pm; WCH 142
Discussion: W 1:10 pm - 2:00 pm; PRCE 3374

Office Hours:
Instructor: W 4:00 – 5:00pm
TA: W 3:00 – 4:00pm

Instructor and TA
Ilya Dumer, Professor, Dept. of Electrical Engineering;
WCH 427
TA: Olga Kapralova, WCH 461

Textbooks and Related Materials
Textbooks:

1. B.P. Lathi, Modern Digital and Analog Comm. Systems, 3rd Ed.; Oxford, 1998 (ISBN 019511009-9) or :
2. B.P. Lathi and Zhi Ding. Modern Digital and Analog Comm. Systems, 4th ed. Oxford, 2009 (ISBN 0195331451)

References:
1. Simon Haykin, Communication Systems, Wiley, 4th Edition, 2001 (ISBN 0-471-17869-1).
2. Leon W. Couch, Digital and Analog Communication Systems, 4th ed. Macmillan Publ. Co., 1993

Course Description (Catalog Description)
Topics include modulation, probability and random variables, correlation and power spectra, information theory, errors of transmission, equalization and coding methods, shift and phase keying, and a comparison of digital communication systems.

Prerequisite(s)
EE114 and EE115

Course Type
Electrical Engineering, elective.

Course Objective

1. Analysis of the frequency response and power spectral density of low-pass and band-pass signals.
2. Analysis of frequency response of random signals (polar, Manchester, bipolar, duobinary signaling).
3. Analysis and design of pulse code modulation. Analysis of ISI and Nyquist criteria
4. Analysis of random variables, their sums and distributions in communication design
5. Analysis and design of PCM systems corrupted by both quantization and channel noise

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Analysis of the frequency response and power spectral density of low-pass and band-pass signals	3				1						
2	Analysis of frequency response of random signals (polar, Manchester, bipolar, duobinary signaling)	3				1						
3	Analysis and design of pulse code modulation. Analysis of ISI and Nyquist criteria	2				3						
4	Analysis of random variables, their sums and distributions in communication design	2				3						
5	Analysis and design of PCM systems corrupted by both quantization and channel noise	3				2						

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

EE 151: INTODUCTION TO DIGITAL CONTROL

Credits and Contact Hours
4.0 Units
Lecture: TR 6.40 pm – 8pm; SPTH 1222
laboratory: F 11:10 am – 2 pm; ENGR2 128

Office Hours:
Instructor: R 5:20 pm-6:30 pm ENGR2 411
TA: TR 4pm – 4:50 pm

Instructor and TA
Hossny El-Sherief, Adjunct Professor, Dept. of Electrical Engineering; ENGR2 411
TA: Stefan Pitzek, ENGR2 TA office

Textbooks and Related Materials
1. (Text) K Ogata, "Discrete Time Control Systems", 2nd Edition, Prentice Hall.

Course Description (Catalog Description)
Review of continuous-time control systems; review of Z-transform and properties; sampled-data systems; stability analysis and criteria; frequency domain analysis and design; transient and steady-state response; state-space techniques; controllability and observability; pole placement; observer design; Lyapunov stability analysis. Laboratory experiments complementary to these topics include simulations and design.

Prerequisite(s)
EE132 and EE141 or consent of instructor

Course Type
Electrical Engineering, elective.

Course Objectives
1. Understand and be able to explain the advantage of digital control systems.
2. Be able to perform Z-transform of control system transfer function.
3. Understand the different classical methods for designing digital control systems.
4. Understand the state space method for designing digital control systems.
5. Perform laboratory experiments to design and evaluate digital control systems.
6. Design a digital control system to meet desired gain and phase margin requirements.
7. Learn how to calculate the controllability and observability of digital control systems in the state space representation.

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Understand and be able to explain the advantage of digital control systems											
2	Be able to perform Z-transform of control system transfer function	1										
3	Understand the different classical methods for designing digital control systems	1										
4	Understand the state space method for designing digital control systems	1				1						
5	Perform laboratory experiments to design and evaluate digital control systems		1		1							
6	Design a digital control system to meet desired gain and phase margin requirements	1										
7	Learn how to calculate the controllability and observability of digital control systems in the state space representation	1		1		1						

A. Ability to apply knowledge of mathematics, science and engineering
B. Ability to design and conduct experiments, as well as, analyze and interpret data.
C. Ability to design a system, component, or process to meet desired needs.
D. Ability to function on multidisciplinary teams.
E. Ability to identify, formulate and solve engineering problems.
F. Understanding of professional and ethical responsibility.
G. Ability to communicate effectively.
H. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. Recognition of the need for and an ability to engage in lifelong learning.
J. Knowledge of contemporary issues.
K. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

EE 175A: Senior Design Project

Winter 2012

Credits and Contact Hours

4.0 Units
Lecture: F 03:10 p.m. - 04:00 p.m. ENGR2 143
Laboratory: Section 021 F 08:10am-11a.m. ENGR2 121
Section 022 W 04:10pm-7pm ENGR2 128

Instructors

Ping Liang, Assoc Prof, Electrical Engineering; ENGR2 323, 827-2261 liang@ee.ucr.edu
Roman Chomko, Lecturer, Electrical Engineering; ENGR2 411 827-7109 chomko@ee.ucr.edu
Elmar Palma, Assoc Development Engineer, EE Labs Manager, ENGR2 137 epalma@ee.ucr.edu

Textbook and Related Materials

No textbook required. All course materials are posted on iLearn.

Specific Course Information

A. Course Description (Catalog description)

The proposal and design of electrical engineering devices or systems under the direction of a faculty member. Emphasizes professional and ethical responsibilities, as well as the need to stay current on technology and its global impact on economics, society, and the environment.

B. Prerequisite(s)

ENGR 180W, senior standing in Electrical Engineering.

C. Course Type

Electrical Engineering, required.

Specific Objectives

A. Course Objectives

1. Ability to understand the engineering design process, working in teams.
2. Ability to formulate design specifications and evaluation criteria; determining methodologies and performing solution analyses
3. Develop skills in project management including organization, teamwork, planning, scheduling, and budgeting
4. Develop skills in library techniques such as literature and information searching
5. Develop technical writing and oral communication skills through proposal and report writing, as well as mid-course and final presentations
6. Ability to design and conduct experiments and analyze data
7. Understanding of professional and ethical responsibility
8. Obtain a general understanding of engineering economics, marketing, career strategies, and resume preparation.
9. Understand the impact of engineering solutions in a global and societal context
10. Knowledge of contemporary engineering issues

B. Student Outcomes Addressed

Item	OUTCOME-RELATED LEARNING OBJECTIVES	OUTCOMES										
		A	B	C	D	E	F	G	H	I	J	K
1	Ability to understand the engineering design process, working in teams.			1	1	1					1	1
2	Ability to formulate design specifications and evaluation criteria; determining methodologies and performing solution analyses	1	1	1		1						1
3	Develop skills in project management including organization, teamwork, planning, scheduling, and budgeting			1	1	1					1	1
4	Develop skills in library techniques such as literature and information searching							1		1	1	1
5	Develop technical writing and oral communication skills through proposal and report writing, as well as mid-course and final presentations					1		1				1
6	Ability to design and conduct experiments and analyze data	1	1	1								1
7	Understanding of professional and ethical responsibility						1					1
8	Obtain a general understanding of engineering economics, marketing, career strategies, and resume preparation.						1		1	1		1
9	Understand the impact of engineering solutions in a global and societal context								1			1
10	Knowledge of contemporary engineering issues									1	1	1

List of Topics

The Senior Design Project is the culmination of coursework in the bachelor's degree program in electrical engineering or computer engineering. In this comprehensive two-quarter course, students are expected to apply the concepts and theories of electrical engineering or computer engineering to an engineering design project. Detailed written reports, working demonstration, and oral presentations are required.

Project Elements: The senior design projects will include proposal and report writing, experiment design, hardware and software design, test plan and test, broad impact and ethical issues, among other things. Remember that this is a design course and students must define a *design* project, not a research, nor an evaluation or fabrication project. It is a balanced approach to encompass many of the elements stated above. Each design project must include the following components:

1. A Clear Technical Design Objective and the Project Contract
2. Experiment Design and Feasibility Study
3. A Detailed Design Specification
4. Global, Economic, Environmental and Societal Impact
5. Contemporary Engineering Issues
6. Test Plan
7. Understanding of Professional and Ethical Responsibility
8. Recognition of the need for and an ability to engage in lifelong learning
9. Design Review Presentation
10. Detailed Quantitative Design and Prototype
11. Test Report
12. Final Presentation
13. Working Demo and Final Report

EE 175B: Senior Design Project

Credits and Contact Hours

4.0 Units
Lecture: M 10:10 a.m. - 11:00 a.m. SPTH 1307
Laboratory: Section 021 W 03:10 p.m. - 06:00 p.m. CHUNG 128
Section 022 W 03:10 p.m. - 06:00 p.m. CHUNG 125

Instructors

Ping Liang, Assoc Prof, Electrical Engineering; ENGR2 323, 827-2261 liang@ee.ucr.edu
Roman Chomko, Lecturer, Electrical Engineering; ENGR2 411 827-7109 chomko@ee.ucr.edu
Elmar Palma, Assoc Development Engineer, EE Labs Manager, ENGR2 137 epalma@ee.ucr.edu

Textbook and Related Materials

No textbook required. All course materials are posted on iLearn.

Specific Course Information

C. Course Description (Catalog description)

The proposal and design of electrical engineering devices or systems under the direction of a faculty member. Emphasizes professional and ethical responsibilities, as well as the need to stay current on technology and its global impact on economics, society, and the environment.

B. Prerequisite(s)

ENGR 180W, senior standing in Electrical Engineering.

C. Course Type

Electrical Engineering, required.

Specific Objectives

A. Course Objectives

1. Ability to understand the engineering design process, working in teams.
2. Ability to formulate design specifications and evaluation criteria; determining methodologies and performing solution analyses
3. Develop skills in project management including organization, teamwork, planning, scheduling, and budgeting
4. Develop skills in library techniques such as literature and information searching
5. Develop technical writing and oral communication skills through proposal and report writing, as well as mid-course and final presentations
6. Ability to design and conduct experiments and analyze data
7. Understanding of professional and ethical responsibility
8. Obtain a general understanding of engineering economics, marketing, career strategies, and resume preparation.
9. Understand the impact of engineering solutions in a global and societal context
   Knowledge of contemporary engineering issues

D. Student Outcomes Addressed

Item	OUTCOME-RELATED LEARNING OBJECTIVES	OUTCOMES										
		A	B	C	D	E	F	G	H	I	J	K
1	Ability to understand the engineering design process, working in teams.			1	1	1					1	1
2	Ability to formulate design specifications and evaluation criteria; determining methodologies and performing solution analyses	1	1	1		1						1
3	Develop skills in project management including organization, teamwork, planning, scheduling, and budgeting			1	1	1					1	1
4	Develop skills in library techniques such as literature and information searching							1		1	1	1
5	Develop technical writing and oral communication skills through proposal and report writing, as well as mid-course and final presentations					1		1				1
6	Ability to design and conduct experiments and analyze data	1	1	1								1
7	Understanding of professional and ethical responsibility						1					1
8	Obtain a general understanding of engineering economics, marketing, career strategies, and resume preparation.						1		1	1		1
9	Understand the impact of engineering solutions in a global and societal context								1			1
10	Knowledge of contemporary engineering issues									1	1	1

List of Topics

The Senior Design Project is the culmination of coursework in the bachelor's degree program in electrical engineering or computer engineering. In this comprehensive two-quarter course, students are expected to apply the concepts and theories of electrical engineering or computer engineering to an engineering design project. Detailed written reports, working demonstration, and oral presentations are required.

Project Elements: The senior design projects will include proposal and report writing, experiment design, hardware and software design, test plan and test, broad impact and ethical issues, among other things. Remember that this is a design course and students must define a *design* project, not a research, nor an evaluation or fabrication project. It is a balanced approach to encompass many of the elements stated above. Each design project must include the following components:

1. A Clear Technical Design Objective and the Project Contract
2. Experiment Design and Feasibility Study
3. A Detailed Design Specification
4. Global, Economic, Environmental and Societal Impact
5. Contemporary Engineering Issues
6. Test Plan
7. Understanding of Professional and Ethical Responsibility
8. Recognition of the need for and an ability to engage in lifelong learning
9. Design Review Presentation
10. Detailed Quantitative Design and Prototype
11. Test Report
12. Final Presentation
13. Working Demo and Final Report

Appendix B – Faculty Vitae

Note to ABET evaluators.
Dr. Alvarado co-taught just one class at UCR as part of an NSF funded project.
However she is full time at Harvey Mudd

Christine Alvarado

Computer Science Department
Harvey Mudd College
1250 North Dartmouth Ave., Claremont, CA 91711

Education
A.B., 1998, Dartmouth College, Summa Cum Laude, high honors in Computer Science
S.M., 2000, Computer Science, Massachusetts Institute of Technology
Ph.D., 2004, Computer Science, Massachusetts Institute of Technology

Academic Appointments
Harvey Mudd College, Assistant Professor, 2005 – present
University of California, San Diego, Lecturer, 2005
University of San Diego, Postdoctoral Lecturer, 2004 – 2005
Massachusetts Institute of Technology, Research Assistant, 1998 – 2004

Related Publications:
Zach Dodds, Ran Libeskind-Hadas, Christine Alvarado, Geoff Kuenning. "Evaluating a Breadth-First CS 1 for Scientists." In *Proceedings of SIGCSE 2008*.

Zach Dodds, Christine Alvarado, Geoff Kuenning, and Ran Libeskind-Hadas, "Breadth-first CS 1 for Scientists: Curriculum and Assessment", In *Proc. of the 12th Annual Conference on Innovation in Technology in Computer Science Education (ITiCSE 2007)*. 2007.

Other Publications:
Paul Wais, Aaron Wolin and Christine Alvarado, "Designing a Sketch Recognition Front-End: User Perception of Interface Elements". In *Proc. of Eurographics Workshop on Sketch-Based Interfaces and Modeling (SBIM)*. Riverside, CA. 2007.

Aaron Wolin, Devin Smith and Christine Alvarado, "A Pen-based Tool for Efficient Labeling of 2D Sketches." In *Proc. of Eurographics Workshop on Sketch-Based Interfaces and Modeling (SBIM)*. Riverside, CA. 2007.

Christine Alvarado and Randall Davis, "Dynamically Constructed Bayes Nets for Multi-Domain Sketch Understanding," *Proceedings of International Joint Conference on Artificial Intelligence (IJCAI),* August2005.

Christine Alvarado and Randall Davis, "SketchREAD: A Multi-Domain Sketch Recognition Engine," *Proceedings of ACM Symposium on User Interface Software and Technology (UIST).* October 2004.

Jamie Teevan, Christine Alvarado, Mark S. Ackerman, and David R. Karger, "The Perfect Search Engine Is Not Enough: An Observational Study of Orienteering Behavior in Directed

Search," *Proceedings of ACM Conference on Human Factors in Computing Systems (CHI)*. March 2004.

Synergistic Activities:
Redesign of Harvey Mudd College CS5: Alvarado was part of the committee to redesign Harvey Mudd College's introductory computer science class to focus more on core computer science ideas and appeal to a broad range of scientists and engineers. This redesign serves as basis for the work proposed here.

AP Computing Commission and Advisory Group: In 2008 Alvarado participated as a member of the advisory group to help redesign the AP computer science exam. If the 2009 efforts are funded, Alvarado will participate as a member of the 10-person advisory group that will carry these redesign efforts forward.

High School Outreach: Alvarado has been involved with a number of high school outreach programs.

She was the founding computer science instructor in the MIT Women's Technology Program in the summer of 2002, and she has served as an instructor in the UCSD COSMOS program in 2005-2007.

First-Year Student Trips to GHC: In 2006-2008 Alvarado has organized and led trips for 10-25 undergraduates (mostly first year women) to attend the Grace Hopper Celebration of Women in Computing in San Diego, CA (06), Orlando, FL (07), and Keystone, CO (08).

Workshop and Program Chair for SBIM: Alvarado was the co-program chair for the Eurographics Sketch-based Interfaces and Modeling (SBIM) workshop in 2008. In 2007 she was the co-workshop chair for the same workshop. She has also served on the program committee for this workshop since its inception in 2004.

Collaborators and Other Affiliations
Collaborators: Eric Doi (Harvey Mudd College); Martin Field (Harvey Mudd College); Dr. Tracy Hammond (Texas A&M University); Michael Lazzareschi (current affiliation unknown); Scott Parkey (Harvey Mudd College); Eric Peterson (UC-Riverside); Devin Smith (Harvey Mudd College); Dr. Tom Stahovich (UC-Riverside); Paul Wais (UCLA); Aaron Wolin (Texas A&M University); Alice Zhu (Harvey Mudd College)

Graduate Thesis Advisor: Dr. Randall Davis, CSAIL, Dept of EECS, MIT.
Other Affiliations: Adjunct Professor of Computer Science, UC-Riverside

Bir Bhanu
Distinguished Professor of Electrical Engineering

Education
Ph.D., Elect. Engineering, University of Southern California, Image Processing Institute, 1981
S.M., Elect. Engg. & Comp. Sc., Massachusetts Inst. of Technology, Res. Lab Electronics, 1977
E.E., Elect. Engg., Massachusetts Inst. of Technology, Res. Lab Electronics 1977
M.B.A. Business Administration, University of California, Irvine, 1984
M.E. (Distinction), Electronics Engineering, Birla Inst. of Technology & Science, Pilani, 1974
B.S. (Honors), Electronics Engineering, Institute of Technology, BHU, Varanasi, 1972
Diploma in German, BHU, Varanasi, 1971

Academic Experience
2010 – Present. Distinguished Professor of Electrical Engineering, Cooperative Professor CSE, Mechanical Engg., Graduate Faculty Bioengineering, UC Riverside (UCR)
1998- Present. Director Center for Research in Intelligent Systems (CRIS), UCR
1991-2010. Professor of Electrical Engineering, Cooperative Professor of Computer Science & Engineering, Director - Visualization and Intelligent Systems Laboratory, UCR
1991-1994. Founding Chair, Electrical Engineering, UCR
1987-1990. Adjunct Faculty, Computer Science, University of Utah, Salt Lake City
1984-1987. Assistant Professor, Associate Professor of Computer Science, University of Utah,
1974-1975. Lecturer, Department of Electrical & Electronics Engineering, Birla Institute of Technology & Science, Pilani

Non-Academic Experience
1986-1991. Honeywell Inc. Senior Honeywell Fellow. Fellows are the top technical professionals (70 out of 130,000 employees), demonstrate extraordinary technical performance in key technologies and instrumental in developing corporate strategic plans. Technologies covered – Signal and Image Processing Science Area – Machine Vision Technology, Artificial Intelligence, Multisensor Fusion and Signal Processing Architectures (Full Time Position)
1981-1984. Ford Aerospace & Communications Corporation. Engineering Specialist in Digital Systems. Responsible for R&D work and providing a leadership role for the Aeronutronic Division in the areas of Computer Vision, Artificial Intelligence and Pattern Recognition as applied to defense problems. (Full Time Position)
12/80-3/81. INRIA, France. Research Fellow in 3-D Computer Vision. (Full Time Position)
1978. IBM San Jose Research Laboratory, Academic Associate. (Summer Full Time Position)

Current Memberships in Professional Organizations
Fellow SPIE 2003, Fellow IAPR 2000**,** Fellow AAAS 1997, Fellow IEEE 1995
Member ACM**,** Member AAAI Bhanu-2

Selected Recent Honors and Awards

Doctoral Dissertation/Mentor Award of the Graduate Council, UCR, June 2011.

Best Entry Award (with student Songfan Yang), International Competition on Facial Expression Recognition, held in conjunction with 9th IEEE International Conference on Automated Face and Gesture Recognition, Santa Barbara, March 21-25, 2011.

Bourns College of Engineering Research Excellence Award, UCR, November 2003.

Two Awards for Outstanding Papers Published in Pattern Recognition Journal 2000, 1990.

Award and plaque from the President and Chief Operating Officer of Honeywell Inc. on inertial-navigation sensor integrated image-based navigation, 1992.

Alpha Team Award on DARPA Scene Dynamics Program, 1989.

IBM Project Award for Outstanding Contribution, 1978.

Award for Securing First Position, Institute of Technology, BHU, Received Award from the Education Minister (Prof. Nurul Hasan), Govt. of India, 1971.

Selected Service Activities

IEEE Fellow Committee (2010, 2011, 2012)
Chair, IEEE Computer Society Workshop on Biometrics, June 2012.
UCR Senate, Planning and Budget Committee (2011- Present)
UCR Senate Education Policy Committee (2006-2010)

Selected Publications (Five from over 400)

1. Y. Sun and B. Bhanu, "Reflection symmetry integrated image segmentation," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 2012.
2. S. Yang and B. Bhanu, "Understanding discrete facial expressions using emotion avatar image," *IEEE Transactions on Systems, Man and Cybernetics-Part B*, 2012.
3. M. Kafai and B. Bhanu, "Dynamic Bayesian networks for vehicle classification in video," *IEEE Transactions on Industrial Informatics*, Vol. 8, No. 1, pp. 100-109, Feb. 2012.
4. Y. Li and B. Bhanu, "Utility-based camera assignment in a video network: A game theoretic framework," *IEEE Sensors Journal*, Special Issue on Cognitive Networks, Vol. 11(3), pp. 676-687, 2011.
5. N. Ghosh, R. Recker, A. Shah, B. Bhanu, S. Ashwal and A. Obenaus, "Automated ischemic lesion detection in a neonatal model of hypoxic ischemic injury," *Journal of Magnetic Resonance Imaging*, 33:772–781, 2011.

Selected Professional Development Activities

Sexual Harassment Prevention Training, UCR, 2012.
Leadership Development, Center for Creative Leadership, Eckerd College, FL
Participative Problem Solving, Honeywell Inc., Minneapolis, MN
Human Interaction Laboratory, NTL Institute, Bethel, ME
Presentation for Senior Executives, Minneapolis, MN
Dynamics of Leadership, Minneapolis, MN

Laxmi N. Bhuyan

Education

Ph.D., Computer Engineering, Wayne State University (WSU), Detroit, Michigan, 1982;
Distinguished Alumnus Award NIT, Rourkela, 2010;
Distinguished Alumnus Awards, **Hall of Fame**, College of Engineering, WSU, October 2010;
M.Sc., Engineering (Electrical), Sambalpur University, India, 1978;
B.Sc., Engineering (Hons) (Electrical), Sambalpur University, India, 1972.

Recent Professional Experience

July 2010-Present: Distinguished Professor, UC, Riverside
July 2007-Present: Chairman, Department of Computer Science and Engineering, UC, Riverside;
Jan. 2001-Present: Professor, Department of Computer Science and Engineering, UC, Riverside;
Sept. 1998-August 2000: Program Director, Computer Systems Architecture Program, NSF;
Sept. 1991-Dec. 2000: Professor of Computer Science, Texas A&M University;

Selected Research Publications

Most papers are available at *http://www.cs.ucr.edu/~bhuyan/#publications*.

Most Related:

[1] D. Guo, L. Bhuyan and B. Liu, "An Efficient Parallelized L7-Filter Design for Multicore Servers" *IEEE/ACM Transactions on Networking* (**TON**), Accepted for publication, Nov 2011
[2] K Pusukuri, R. Gupta and L. Bhuyan, "Thread Tranquilizer: Dynamically Reducing Performance Variation," *ACM Transactions on Architecture and Code Optimization* (**TACO**), Accepted for publication in November 2011
[3] K. Pusukuri, R. Gupta and L. Bhuyan, "No More Backstabbing... A Faithful Scheduling Policy for Multithreaded Programs", *Parallel Architectures and Compilation Techniques*, (**PACT**), October 2011
[4] J. Kuang, L.N. Bhuyan, H. Xie and D. Guo, "E-AHRW: An Energy-efficient Adaptive Hash Scheduler for Stream Processing on Multi-core Servers", Architecture for Networking and Communication Systems, (**ANCS)**, New York, October 2011
[5] D. Guo and L. Bhuyan, "A QoS Aware Multicore Hash Scheduler for Network Applications" IEEE **INFOCOM**, Shanghai, China, April 2011

Others:

[6] G. Laio, X. Zhu and L. Bhuyan, " A New Server I/O Architecture for High Speed Networks" *International Symposium on High-Performance Architecture* (**HPCA**), San Antonio, February 2011.
[7] G. Liao, H. Yi and L. Bhuyan, "A New IP Lookup Cache for High Performance IP Routers", *ACM Design Automation Conference*, (**DAC)**, Anaheim, June 2010, **Best Paper Nomination**
[8] J. Kuang and L. Bhuyan, "Optimizing Throughput and Latency under Given Power Budget for Network Packet Processing", IEEE **INFOCOM**, March 2010
[9] H. Yu, R. Mahapatra and L. Bhuyan, "A Scalable Hashing using Bloom and Fingerprint Filters for a Large Routing Table", **ICNP**, October 2009

[10] A. Banerjii, M. Faloutsos, and L. Bhuyan, "Is Someone Tracking P2P Users", *IFIP Networking*, 2007, Atlanta, GA, May 2007, **Best paper award**

Selected Professional Honors

- *Fellow of the ACM*, 2000;
- *Fellow of the IEEE*, 1998;
- *Fellow of the AAAS, 2002;*
- *ISI Highly Cited Researcher in Computer Science, 2002;*
- *Fulbright Senior Specialist, 2004;*
- *Fellow of the World Innovation Foundation (WIF), 2004;*
- *Senior Fellow*, Texas Engineering Experiment Station, 1996;
- *Outstanding Contribution Award*, IEEE Computer Society, 1996;
- *Halliburton Professorship Award*, TAMU College of Engineering, 1991

Selected Professional Activities

- Editor-in-Chief, *IEEE Transactions on Parallel and Distributed Systems (TPDS)*, January 2006-December 2009;
- General Chairman, ACM/IEEE ANCS, San Jose, December 2006;
- Editor, *IEEE Transactions on Computers*, January 2002-2005;
- Subject Area Editor, Performance Evaluation, *JPDC*, 1995-2005;
- Editor, *Parallel Computing*, North Holland, 1992-2005;
- Vice Chair, *IEEE Computer Society Publications Board*, 2003;
- General Co-Chair, *HPCA-9*, Anaheim, CA, February 2003;
- Member-at-Large, *IEEE CS Publications Board*, 2000-2001;
- Editor, *IEEE TPDS*, 1998
- Chairman, *IEEE CS TCCA*, 1995 - 1998;
- Area Editor, Systems Architecture, *IEEE Computer Magazine*, 1991- 1997;
- Program Co-Chairman, *IEEE SPDP*, San Antonio, October 1996;
- Founding Program Committee Chairman, *HPCA-1*, Raleigh, Jan. 1995;

Ph.D Students Completed (With Current Employment)

J. Kuang, December 2011, Samsung; ***G. Liao,*** June 2011, Intel; ***D. Guo,*** June 2010, Microsoft; ***A. Banerjee***, December 2008, Start-up; ***J. Yao (F),*** Aug 2007, Cisco; ***JiaYu, (F),*** June 2007, VMWare; ***Satya Mohanty,*** March 2007, Cisco; ***Jiani Guo (F),*** June 2006, Cisco; ***Li Zhao(F)***, June 2005, Intel Corporation, ***Y. Luo***, June 2005, University of Massachusetts at Lowell; ***X. Zhang***, June 2005, Qualcom; ***H. Wang,*** December 2001, IBM Corporation; ***N. Ni(F)***, December 2000, IBM Corporation; ***M. Pirvu***, December 2000, Compaq Corporation*;* ***R. Iyer***, August 1999, Intel Corporation; ***A. Kumar***, May 1996, Intel Corporation; ***P. Mannava***, August 1995, Intel Corporation; ***C. Feng***, August 1995, Motorola Inc.; ***Y. Chang***, May 1995, National University, Taiwan; ***J. Ding***, May 1994, Cisco; ***A. Nanda***, May 1993, IBM TJ Watson Research Center; ***C.H. Chen***, May 1993, University of Tuskegee; ***H. Jiang***, August 1991, University of Nebraska-Lincoln; ***D. Ghosal***, August 1988, University of California at Davis; ***Q. Yang***, August 1988, University of Rhode Island; ***C.R. Das***, August 1986, Pennsylvania State University.

Philip Brisk

Education
Doctor of Philosophy, Computer Science, UCLA, 2006
Master of Science, Computer Science, UCLA, 2003
Bachelor of Science, Computer Science, UCLA, 2002
Associate in Arts, General Science, Santa Monica College, 1999

Academic Experience
Assistant Professor, UC Riverside, Department of Computer Science and Engineering, 2009-present, Full-time
Postdoctoral Scholar, EPFL Switzerland, 2006-2009, Full-time

Non-Academic Experience: None

Certifications or professional registrations: None

Current membership in professional organizations
Member, IEEE and ACM

Honors and awards
Invited Papers: ARITH-19 2009, ASICON 2011
Best Paper Award Nominee: DAC 2007, HiPEAC 2010
Best Paper Award: CASES 2007, FPL 2009
HiPEAC Paper Award: FCCM 2009, DAC 2009

Service activities
Member, Computer Engineering Committee, UC Riverside
Judge: Intel ISEF Science Fair 2011, Los Angeles County Science Fair, 2011
General Chair: IEEE SIES 2009, IEEE SASP 2010, IWLS 2011
Program Chair: IEEE SASP 2011, IWLS 2012 (ongoing)
Finance Chair: IEEE ASAP 2011
Technical Program Committee Member: ARCS 2010-2012, DATE 2010-2012, IEEE SIES 2010-2012, RAW 2010, MOBICASE 2011, HiPEAC 2012, IWCMC 2012, HEART 2012, VLSI-SoC 2012

Recent Publications

Yehdhih Ould Mohammed Moctar, Nithin George, Hadi Parandeh-Afshar, Paolo Ienne, Guy Lemieux, and Philip Brisk, "Reducing the cost of floating-point mantissa alignment and normalization in FPGAs," 20th International Symposium on FPGAs, February, 2012.

Hadi Parandeh-Afshar, Arkosnato Neogy, Philip Brisk, and Paolo Ienne, "Compressor tree synthesis on commercial high-performance FPGAs, ACM Transactions on Reconfigurable Technology and Systems (TRETS), 4(4): article #39, December, 2011.

Philip Brisk, Ajay K. Verma, and Paolo Ienne, "An optimal linear-time algorithm for interprocedural register allocation in high level synthesis using SSA Form," IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD), 29(7): 1096-1109, July, 2010.

Hadi Parandeh-Afshar, Ajay K. Verma, Philip Brisk, and Paolo Ienne. "Improving FPGA performance for carry-save arithmetic," IEEE Transactions on Very Large Scale Integration (TVLSI) Systems, 18(4): 578-590, April, 2010.

Ajay K. Verma, Philip Brisk, and Paolo Ienne. "Fast, nearly optimal ISE identification with I/O serialization through maximal clique enumeration" IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD), 29(3):341-354, March, 2010.

Hadi Parandeh-Afshar, Philip Brisk, and Paolo Ienne. "An FPGA logic cell configurable as a 6:2 or 7:2 compressor," ACM Transactions on Reconfigurable Technology and Systems (TRETS), 2(3): article. #19, September, 2009.

Alessandro Cevrero, Panagiotis Athanasopoulos, H. Parandeh-Afshar, A. K. Verma, P. Brisk, Hosein Seyed Attarzadeh, Niaki, Chrysostomos Nicopoulos, Frank K. Gurkaynak, Yusuf Leblebici, and Paolo Ienne. "Field programmable compressor trees: acceleration of multi-input addition on FPGAs," ACM Transactions on Reconfigurable Technology and Systems (TRETS), 2(2): article. #13, June, 2009.

Recent Professional Development Activities
Attended Intel Embedded Systems Summit, 2011-2012

Marek Chrobak

Education

- 1982 - 1985: PhD in Computer Science, Department of Mathematics and Computer Science, Warsaw University
- 1976 -1981: Master's Degree in Computer Science, Department of Mathematics and Computer Science, Warsaw University

Academic Experience

- 1996 - 2012: Professor, University of California, Riverside
- 1991 - 1996, Associate Professor, University of California, Riverside
- 1989 - 1991, Assistant Professor, University of California, Riverside
- 1987 -1989,Visiting Assistant Professor, University of California, Riverside
- 1987 - 1987, Visiting Assistant Professor, Columbia University
- 1985 - 1987, Assistant Professor, Department of Mathematics and Computer Science, Warsaw University

Professional Organizations

Member of ACM (Association of Computing Machinery), SIGACT

Recent Professional Service

- Editorial Board Member, Int. Journal of Foundations of Computer Science, since 2008
- Editorial Board Member, Information Processing Letters, since 2012
- Editor, SIGACT News Column on Online Algorithms, 2004-2012
- Area Editor, Encyclopedia of Algorithms, 2008
- Program Committees for Conferences: WAOA'12, SWAT'12, WALCOM'12, TAMC11, ICALP'11, ISAAC'11
- Local Arrangements co-Chair for FOCS'11

Recent University Service

- 2001-2006, CSE Department Undergraduate Advisor
- 2006-2012, CSE Department Undergraduate Committee, Member
- 2008-2011, UCR Committee on Academic Personnel, Member
- 2011-2012, UCR Shadow CAP

Recent Publications

- M. Chrobak, J. Sgall, Three results on frequency assignment in linear cellular networks. Theoretical Computer Science 411 (2010) 131-137.
- Thermal management via task scheduling. ACM Transactions on Architecture and Code Optimization 7 (2010) 1–31.
- M. Chrobak, M. Hurand, Better bounds for incremental medians. Theoretical Computer Science 412 (2011) 594–601.
- P. Baptiste, M. Chrobak, C. Durr, Polynomial-time algorithms for minimum-energy

scheduling. To appear in ACM Transactions on Algorithms (2012).

- M. Bienkowski,M. Chrobak,L. Jez, Randomized algorithms for buffer management with 2-bounded delay. Theoretical Computer Science 412 (2011).
- M. Chrobak, C. Durr, F. Guınez, A. Lozano, N. Thang, Tile-packing tomography is NP-hard. Algorithmica (2011).
- M. Chrobak, G.J. Woeginger, K. Makino, H. Xu, Caching is hard - even in the fault model. Algorithmica (2011).
- M. Chrobak, L. Yan, Approximation algorithms for the fault-tolerant facility placement problem. Information Processing Letters 111 (2011) 545–549.
- M. Chrobak, C. Durr, M. Hurand, J. Robert, Algorithms for temperature-aware task scheduling in microprocessor systems. Sustainable Computing (2011).
- Y. He, M. Faloutsos, S.V. Krishnamoorthy, M. Chrobak, Obtaining provably legitimate Internet topologies. IEEE/ACM Transactions on Networking PP, 99 (2011).
- M. Chrobak, L. Jez, J. Sgall, Better bounds for incremental frequency allocation in bipartite graphs. Proc. European Symposium on Algorithms (ESA'11).
- M. Chrobak, J. Sgall, G. Woeginger, Two-bounded space bin packing revisited. Proc. European Symposium on Algorithms (ESA'11).

Gianfranco Ciardo
Professor and Graduate Advisor

Degrees
- Ph.D., Computer Science, Duke University, Durham, NC, 1989
- Laurea, Computer Science, Universita' di Torino, Italy, 1982

Academic Experience
- University of California at Riverside, CSE Department. Professor (7/1/2003-present).
- College of William and Mary, CS Department. Professor (2002-2004). Associate Professor (1997-2002). Assistant Professor (1992-97).
- Technical University of Berlin, Germany. Visiting Professor (Fall 1992).
- University of Torino, Italy. Visiting Professor (Fall 1999).

Non-Academic Experience
- HP Labs, Palo Alto, CA (Spring 2000). Visiting Researcher.
- Software Productivity Consortium, Herndon, VA. Member of Technical Staff (1988-92).

Current Membership in Professional Organizations
- Member, ACM. Senior member, IEEE (Computer Society)

Honors and Awards
- Keynote speaker at SEMISH 2012 (Pernanbuco, Brasil), PDMC 2009 (Eindhoven, The Netherlands), EPEW/WS-FM 2005 (Versailles, France), ATPN 2004 (Bologna, Italy), PNPM 2001 (Aachen, Germany).

Service Activities
- Graduate Advisor, CSE Department, UCR (2008-present).
- Member Editorial Board: Transactions on Petri Nets and Other Models of Concurrency (2007-present).
- Associate Editor: IEEE Transactions on Software Engineering (2001-05).
- Member of the Steering Committee: Petri Nets, QEST, PMCCS.
- General Chair: QEST 2006, Riverside, CA; ICATPN 1999, Williamsburg, VA.
- Program Chair: IEEE PRDC 2006, Riverside, CA; ATPN 2005, Miami, FL; PNPM 2003, Urbana-Champaign, IL; IEEE IPDS, Chicago, IL, 1998; PNPM 1995, Durham, NC.

Recent publications (over 100 refereed publications in top journals and conferences)

Andy Jinqing Yu, Gianfranco Ciardo, and Gerald Luttgen. Decision-diagram-based techniques for bounded reachability checking of asynchronous systems. Software Tools for Technology Transfer, 11(2):117–131, 2009.

Ming-Ying Chung and Gianfranco Ciardo. Speculative image computation for distributed symbolic reachability analysis. Journal of Logic and Computation, 21(1):63–83, 2011.

Min Wan, Gianfranco Ciardo, and Andrew S. Miner. Approximate steady-state analysis of large Markov models based on the structure of their decision diagram encoding. Perf. Eval., 68:463–486, 2011.

Yang Zhao and Gianfranco Ciardo. Symbolic computation of strongly connected components and fair cycles using saturation. Innovations in Systems and Software Engineering, 7(2):141–150, 2011.

Gianfranco Ciardo, Yang Zhao, and Xiaoqing Jin. Ten years of saturation: a Petri net perspective. Transactions on Petri Nets and Other Models of Concurrency, V:51–95, 2012.

Min Wan and Gianfranco Ciardo. Symbolic reachability analysis of integer timed Petri nets. In Proc. SOFSEM, LNCS 5404, pages 595–608. Springer, 2009.

Min Wan and Gianfranco Ciardo. Symbolic state-space generation of asynchronous systems using extensible decision diagrams. In Proc. SOFSEM, LNCS 5404, pages 582–594. Springer, 2009.

Gianfranco Ciardo, Galen Mecham, Emmanuel Paviot-Adet, and Min Wan. P-semiflow computation with decision diagrams. In Proc. ICATPN, LNCS 5606, pages 143–162. Springer, 2009.

Yang Zhao and Gianfranco Ciardo. Symbolic CTL model checking of asynchronous systems using constrained saturation. In Proc. ATVA, LNCS 5799, pages 368–381. Springer, 2009.

Yang Zhao and Gianfranco Ciardo. Symbolic computation of strongly connected components using saturation. In Proc. 2nd NASA Formal Methods Symposium (NFM 2010), NASA/CP-2010-216215, pages 201–211. NASA, 2010.

Yang Zhao, Jin Xiaoqing, and Gianfranco Ciardo. A symbolic algorithm for shortest EG witness generation. In Proc. TASE, pages 68–75. IEEE Comp. Soc. Press, 2011.

Malcolm Mumme and Gianfranco Ciardo. A fully symbolic bisimulation algorithm. In Giorgio Delzanno and Igor Potapov, editors, Proc. Reachability Problems, LNCS 6945, pages 218–230, Genoa, Italy, September 2011. Springer.

Xiaoqing Jin, Gianfranco Ciardo, Tae-Hyong Kim, and Yang Zhao. Symbolic verification and test generation for a network of communicating FSMs. In Tevfik Bultan and Pao-Ann Hsi- ung, editors, Proc. ATVA, LNCS 6996, pages 432–442, Taipei, Taiwan, October 2011. Springer.

United States Patent 6,546,473 “Method for cache replacement of web documents”, April 8, 2003. Inventors: Ludmila Cherkasova and Gianfranco Ciardo. Assignee: Hewlett-Packard Company.

Ilya Dumer

Education
Ph.D. (Information Theory), Russian Academy of Sciences, Moscow, 1981
M.S. (Electrical Engineering), Moscow Institute of Physics and Technology, 1976
B.S. (Electrical Engineering), Moscow Institute of Physics and Technology, 1974

Academic Experience
1995 – present Professor, Electrical Engineering, University of California at Riverside
1987 – 1995 Senior Researcher, Institute for Information Transmission Problems (IIPT), Russian Academy of Sciences, Moscow, Russia
1983 – 1987 Researcher, Institute for Information Transmission Problems, Russian Academy of Sciences, Moscow, Russia

Honors and Awards
IEEE Fellow, 2007

Alexander von Humboldt Research Fellow, Institute for Experimental Mathematics, Essen, Germany, 1993-1994

Royal Society Guest Research Fellow, Manchester University, UK, 1992-1993

Professional Activities
Associate Editor for Coding Theory: IEEE Transactions on Information Theory, 2006-2009

Member of the Program Committees: IEEE International Symposia (1997, 2003, 2005, 2006, 2007, 2008, 2010, 2011), IEEE International Workshop (2010), Workshops on Codes and Cryptography (2005, 2007); Program Co-Chair, International Conference on Coding Theory (2008)

Referee : IEEE Transactions on Information Theory, Problems of Information Transmission; Codes, Designs, and Cryptography; Finite Fields and Their Applications

Panel Member: NSF Directorate ― Theoretical Foundations - Communications Research" (2000, 2002, 2004, 2005, 2007)

Chair of Graduate Council at UCR, 2007-2008

Selected Publications
1. A. A. Kovalev, I. Dumer, and L. P. Pryadko, ―Design of additive quantum codes via the code-word-stabilized framework‖, Phys. Rev. A 84, 062319, pp. 1-11, 2011.

2. Y. Li, I. Dumer, and L. Pryadko, ―Clustered error correction of codeword-stabilized quantum codes,‖ *Physical Review Letters*, vol. 104, 190501, pp. 1-4, 2010.

3. Y. Li, I. Dumer, M. Grassl, and L. Pryadko, ―Structured error recovery for codeword-stabilized quantum codes,‖ *Physical Review A,* vol. 81, 052337, pp. 1-12, 2010.

4. M.Burnashev and I. Dumer, "Error exponents for two soft decision decoding algorithms of Reed—Muller codes," IEEE Trans. Info. Theory, 55, no. 9, pp. 4108-4118, 2009.

5. I. Dumer, "Equal-weight fingerprinting codes," Lecture Notes Computer Science, vol. 5557, pp. 43-51, 2009.

6. I. Dumer, G. Kabatiansky, C. Tavernier, "List decoding of biorthogonal codes and the Hadamard transform with linear complexity, " IEEE Trans. Info. Theory, 54, no. 10, pp. 4488-4492, 2008.

7. N. P. Anthapadmanabhan, A. Barg, and I. Dumer, ―Fingerprinting Capacity Under the Marking Assumption,‖ IEEE Trans. Info. Theory, 54, no. 6, pp. 2678-2689, 2008.

Michalis Faloutsos

Education

PhD, Computer Science, University of Toronto	1999
MS, Computer Science, University of Toronto	1995
BE, Electrical Engineering, National Technical University of Athens	1993

Academic Positions

1999-2005	Asst Professor of Comp. Sci., U.C. Riverside
2005-2008	Assoc. Professor of Comp. Sci., U.C. Riverside
2008-Present	Professor of Comp. Sci., U.C. Riverside

Honors and Awards

2010 ACM Test of Time award for the paper ”On Power-Law Relationships of the Internet Topology” 1998
2010 Best paper award at IEEE SECON
2008 Best paper award for the paper “Is Someone Tracking P2P Users” IFIP Networking
2004 Excellence in Teaching Award, 2003-2004, from the College of Engineering, UCR

Certifications or Professional Registrations

Member of the Engineering Chamber of Greece

Current membership in professional organizations

IEEE and ACM member

Service activities

Technology transfer
Co-founder StopTheHacker, Inc, www.stopthehacker.com , which received two awards from the National Science Foundation, and institutional funding in Dec 2011.
TPC co-chair for IEEE NetSciCom 2012
TPC member for IEEE NetSciCom 2011
Guest Editor for IEEE Network, special issue on Online Social Networks, Sep 2010
TPC for poster and demos in ACM SIGCOMM 2008
TPC Co-Chair for IEEE Global Internet 2007

Selected Publications

“iDispatcher: A Unified Platform for Secure Planet-Scale Information Dissemination”, Md Sazzadur Rahman, Guanhua Yan, Harsha Madhyastha, M. Faloutsos, Stephan Eidenbenz, and Michael Fisk, to appear in Journal of Peer-to-Peer Networking and Applications, Springer, 2012.

“Threshold Conditions for Arbitrary Cascade Models on Arbitrary Networks”, B. Aditya Prakash, Deepayan Chakrabarti, Michalis Faloutsos, Nicholas Valler, and Christos Faloutsos, ICDM 2012. (8%)

“Analyzing interaction communication networks in enterprises and identifying hierarchies”,YiWang, M. Iliofotou, M. Faloutsos, Bin Wu, IEEE Network Science Workshop (NSW), 2011.

"SUT: Quantifying and mitigating URL typosquatting", Anirban Banerjee, Md Sazzadur Rahman, Michalis Faloutsos, Computer Networks Journal (COMNET) by Elsevier, Vol. 55, No. 13, Sep 2011.

"Non-Binary Information Propagation: Modeling BGP Routing Churn", Nicholas Valler, M. Butkiewicz, B. Aditya Prakash, Michalis Faloutsos, Christos Faloutsos In Network Sci- ence for Communication Networks, NetSciCom 2011, (colocated with INFOCOM 2011)

"Virus Propagation on Time-Varying Networks: Theory and Immunization Algorithms", B. Aditya Prakash, Hanghang Tong, Nicholas Valler, Michalis Faloutsos, Christos Faloutsos, ECML-PKDD 2010, Barcelona

"Network Monitoring Using Traffic Dispersion Graphs (TDGs)", M. Iliofotou , P. Pappu, M. Faloutsos, M. Mitzenmacher, S. Singh, G. Varghese ACM/USENIX Internet Measure- ment Conference (IMC 07), San Diego, CA, 2007 (short paper).

" A systematic framework for unearthing the missing links: Measurements and Impact", Y. He, M. Faloutsos, S.V. Krishnamurthy, Symposium on Networked Systems Design and Implementation (NSDI '07), Boston, MA, 2007 (27/113).

"BLINC: Multilevel Traffic Classification in the Dark" T. Karagiannis, D. Papagiannaki, M. Faloutsos. ACM SIGCOMM 2005.

"Clustering by common friends finds locally significant proteins mediating modules", B. Andreopoulos and A. An and M. Faloutsos and X. Wang and M. Schroeder Bionformatics, Oxford Journals, 23 (9): 1124-1131, 2007.

"Policy-Aware Topologies for Efficient Inter-Domain Routing Evaluations", Yihua He and Srikanth V. Krishnamurthy and M. Faloutsos and Marek Chrobak IEEE INFOCOM 2008 Mini-Conference, Phoenix, AZ, (9.3% 85/900)

"Network Monitoring Using Traffic Dispersion Graphs (TDGs)", M. Iliofotou , P. Pappu, M. Faloutsos, M. Mitzenmacher, S. Singh, G. Varghese ACM/USENIX Internet Measure- ment Conference (IMC 07), San Diego, CA, 2007 (short paper).

" A systematic framework for unearthing the missing links: Measurements and Impact", Y. He, M. Faloutsos, S.V. Krishnamurthy, Symposium on Networked Systems Design and Implementation (NSDI '07), Boston, MA, 2007 (27/113).

"Neighborhood Watch for Internet Routing: Can we improve the Robustness of Internet Routing Today? " G. Siganos, M. Faloutsos, IEEE INFOCOM 2007, Anchorage, Alaska.

"Evolution versus Intelligent Design: Comparing the Topology of Protein-Protein Interac- tion Networks to the Internet", Q. Yang, G. Siganos, M. Faloutsos, S. Lonardi, Computa- tional Systems Bioinformatics Conference (CSB'06), Stanford, August 2006.

"SubFlow: Towards Practical Flow-Level Traffic Classification.", Guowu Xie, Marios Iliofotou, R. Keralapura, A. Nucci, and M. Faloutsos, to appear at IEEE INFOCOM (mini-conference), March 2012. (24%)

"SyFi: A Systematic Approach for Estimating Stateful Firewall Performance", Yordanos Beyene, Harsha Madhyastha, Michalis Faloutsos, to appear at Passive and Active Measurements Con- derence (PAM) 2012 Vienna, Austria, March 12-14, 2012 (30%)

"Network-level characteristics of Spamming: An empirical analysis, Marios Kokkodis, Michalis Faloutsos and Athina Markopoulou, IEEE ICNP FIST Workshop (Future Inter- net Security and Trust), Vancouver, October, 2011. (7/19)

Rajiv Gupta

Research Interests

High-Performance Architectures; Optimizing Compilers; and Software Tools for Debugging.

Education

- **Ph.D.** in Computer Science**,** University of Pittsburgh, August 1987.
- **M.S.** in Computer Science**,** University of Pittsburgh, April 1984.
- **B.Tech** in Electrical Engineering, Indian Institute of Technology, New Delhi, 1982.

Professional Experience

- **Professor,** Dept. of Computer Science & Engineering, UC Riverside, 2007-present.
- **Professor,** Dept. of Computer Science, University of Arizona, 1999-2007.
- **Professor,** Dept. of Computer Science, University of Pittsburgh, 1998-1999.
- **Associate Professor,** Dept. of Computer Science, University of Pittsburgh, 1994-1998.
- **Assistant Professor,** Dept. of Computer Science, University of Pittsburgh, 1990-1994.
- **Visiting faculty,** Microprocessor Research Lab, Intel Corp., Sept. 1996- Dec. 1996.
- **Senior Member Research Staff,** Philips Laboratories, Briarcliff Manor, NY, 1987-1990.

Memberships

- ACM, IEEE, and AAAS.
- SIGPLAN, SIGARCH, SIGMICRO, SIGSOFT.

Honors and Awards

- Fellow of the ACM, Fellow of the IEEE; and Fellow of the AAAS.
- Best Paper Award, PACT 2010; Paper selected for inclusion in 20 Years of PLDI.
- Distinguished Paper Award, ICSE 2003; Most Original Paper Award, ICPP 2003.
- NSF Presidential Young Investigator Award, 1991; Supervised SIGPLAN Outstanding Doctoral Dissertation Award Recipients: 2000 & 2006.

Selected Service Activities

- Associate Editor: ACM TACO, IEEE TC, Parallel Computing, Computer Languages.
- General Chair: ASPLOS'11, PLDI'08, CGO'05.
- Program Chair: CC'10, HiPEAC'08, LCTES'05, PLDI'03, HPCA'03.
- Program Committee Member: ISCA'12, PPoPP'12, CGO'10, PACT'10'09, HPCA'08.
- Member, UCR Privilege and Tenure Committee, 2011-present.
- Member, CSE Graduate Admissions Committee, 2010-present.
- Member, CSE Faculty Recruiting Committee, 2008-2009, 2010-2012.
- Chair, BCoE Research Committee, BCoE Retreat, 2008.

Selected Publications

1. C. Lin, V. Nagarajan, R. Gupta, and B. Rajaram, "Efficient Sequential Consistency via Conflict Ordering," ACM International Conference on Architectural Support for Programming Languages and Operating Systems (**ASPLOS**), London, UK, March 2012.

2. M. Feng, R. Gupta, and I. Neamtiu, "Effective Parallelization of Loops in the Presence of I/O Operations," ACM SIGPLAN Conference on Programming Language Design and Implementation **(PLDI)**, Beijing, China, June 2012.
3. M. Feng, C. Lin, and R. Gupta, "PLDS: Partitioning Linked Data Structures for Parallelism," ACM Transactions on Architecture and Code Optimization **(TACO)** pages 38:1-38:21, volume 8, issue 4, Jan 2012.
4. K.K. Pusukuri, R. Gupta, and L.N. Bhuyan, "Thread Tranquilizer: Dynamically Reducing Performance Variation," ACM Transactions on Architecture and Code Optimization **(TACO)** pages 46:1-46:21, volume 8, issue 4, Jan 2012.
5. M. Feng, C. Tian, C. Lin, and R. Gupta, "Dynamic Access Distance Driven Cache Replacement", ACM Transactions on Architecture and Code Optimization **(TACO)**, pages 14:1-14:30, volume 8, issue 3, Oct 2011.
6. M. Feng, R. Gupta, and Y. Hu, "SpiceC: Scalable Parallelism via Implicit Copying and Explicit Commit", 16th ACM SIGPLAN Annual Symposium on Principles and Practice of Parallel Programming **(PPoPP)**, pages 69-80, San Antonio, TX, Feb 2011.
7. C. Tian, C. Lin, M. Feng, and R. Gupta, "Enhanced Speculative Parallelization Via Incremental Recovery", 16th ACM SIGPLAN Annual Symp. on Principles and Practice of Parallel Programming **(PPoPP)**, pages 189-200, San Antonio, TX, Feb 2011.
8. C. Tian, M. Feng, and R. Gupta, "Supporting Speculative Parallelization in the Presence of Dynamic Data Structures", ACM SIGPLAN 2010 Conference on Programming Language Design and Implementation **(PLDI)**, pages 62-73,Toronto, Canada, June 2010.
9. D. Jeffrey, V. Nagarajan, R. Gupta, and N. Gupta, "Execution Suppression: An Automated Iterative Technique for Locating Memory Errors," ACM Transactions on Programming Languages and Systems **(TOPLAS)**, pages 17:1-17:32, volume 32, issue 5, May 2010.
10. V. Nagarajan and R. Gupta, "ECMon: Exposing cache Events for Monitoring," 36th ACM/IEEE International Symposium on Computer Architecture (**ISCA**), pages 349-360, Austin, TX, June 2009.
11. C. Tian, M. Feng, V. Nagarajan, and R. Gupta, "Copy Or Discard Execution Model For Speculative Parallelization On Multicores", IEEE/ACM 41th International Symposium on Microarchitecture **(MICRO)**, pages 330-341, Lake Como, Italy, November 2008.

Tao Jiang

Education

University of Minnesota	Computer Science	Ph.D. 1988
University of Science and Technology of China	Computer Science	B.S. 1984

Academic Experience

2007-2010 Presidential Chair Professor, Univ. of California, Riverside
1999-present Professor, Computer Science, Univ. of California, Riverside
2006-2009 Changjiang Visiting Professor, Tsinghua University, Beijing, China
1998-2001 Professor, Computing and Software, McMaster Univ., Hamilton, Ontario, Canada
1995-1996 Visiting Associate Professor, Comp. Sci. and Eng., University of Washington
1993-1998 Associate Professor, Computer Science, McMaster Univ., Hamilton, Ontario, Canada
1989-1993 Assistant Professor, Computer Science, McMaster Univ., Hamilton, Ontario, Canada

Non-Academic Experience

2002-present Principal Scientist, Shanghai Center for Bioinformation Technology, Shanghai, China. This is basically a consulting position.

Professional Membership and Honors

1983 Guo Muo-Ruo Prize, University of Science and Technology of China
1996 Japan Society for the Promotion of Science Research Fellowship
2004 Best paper award, Int'l Conf. on Genome Informatics (GIW), 2004, Yokohama, Japan
2006 Fellow, American Association for the Advancement of Science (AAAS)
2007 Fellow, Association for Computing Machinery (ACM)
2008 Best paper, Int'l Conf. on Genome Informatics (GIW), 2008, Gold Coast, Australia
2010 Best paper, LSS Conf. on Comp. Systems Bioinformatics (CSB), 2010, Stanford, CA

Professional Service Activities

1999-2005 Member of editorial board for International Journal of Foundations of Computer Science
2000-present Member of editorial boards for Journal of Combinatorial Optimization, Journal of Bioinformatics and Computational Biology, BMC Bioinformatics, Algorithmica, and Journal of Computer and System Sciences
2000-2011 Member of editorial boards for Journal of Computer Science and Technology
2004-2012 Member of editorial boards for IEEE/ACM Transactions on Computational Biology and Bioinformatics
2009-2012 Member of the steering committee for IEEE/ACM Transactions on Computational Biology and Bioinformatics
1990-present I have served on numerous program committees for various research conferences in theoretical computer science, combinatorial algorithms and computational biology. I have also served on many review panels for NSF.

Service Activities at UCR

I have served on many committees at campus, college and departmental levels. Presently, I serve on the Academic Senate Committee on Academic Computing and Information Technology and CSE Graduate Advisory Committee. I also chair the CSE Graduate Admissions Committee.

Recent Publications

J. Xiao, L. Liu, L. Xia, and T. Jiang. Fast elimination of redundant linear equations and reconstruction of recombination-free Mendelian inheritance on a pedigree. Proc. 18th ACM-SIAM Symposium on Discrete Algorithms (SODA), 2007, New Orleans, LA, pp. 655-664; full version appears in SIAM Journal on Computing; also in SIAM Journal on Computing 38(6), pp. 2198-2219, 2009.

J. Xiao, L. Wang, X. Liu, and T. Jiang. Finding additive biclusters with random background. Proc. 9th Symposium on Combinatorial Pattern Matching (CPM), pp. 263-276, Pisa, Italy, June, 2008; also in Journal of Computational Biology 15(10):1275-93, 2008.

X. Chen, L. Guo, Z. Fan, and T. Jiang. W-AlignACE: An improved Gibbs sampling algorithm based on more accurate position weight matrices. Bioinformatics 24(9):1121-1128, 2008.

E. Bolotin, H. Liao, T. Ta, C. Yang, W. Hwang-Verslues, J. Evans, T. Jiang, and F.M. Sladek. Integrated approach for identification of Human HNF4 target genes using protein binding microarrays. Journal of Hepatology 51(2):642-53, 2010.

J. Feng, R. Jiang and T. Jiang. A max-flow based approach to the identification of protein complexes using protein interaction and microarray data. IEEE/ACM Transactions on Computational Biology and Bioinformatics (TCBB) 8(3), pp. 621-634, 2011.

J. Feng, W. Li and T. Jiang. Inference of isoforms from short sequence reads. Proc. 14th Annual International Conference on Research in Computational Molecular Biology (RECOMB), Lisbon, Portugal, April, 2010, pp. 138-157; also in Journal of Computational Biology 18(3), pp. 305-321, 2011.

W. Li, J. Feng and T. Jiang. IsoLasso: A LASSO regression approach to RNA-Seq based transcriptome assembly. To appear in Proc. 15th Annual International Conference on Research in Computational Molecular Biology (RECOMB), Vancouver, BC, Canada, March 28-31, 2011; also to appear in Journal of Computational Biology.

Y. Chen, T. Jiang and R. Jiang. Uncover disease genes by maximizing information flow in the phenome-interactome network. Bioinformatics 27(13), pp. i167-i176; also presented at the 19th Annual International Conference on Intelligent Systems for Molecular Biology (ISMB), 2011, Vienna, Austria.

O. Tanaseichuk, J. Borneman and T. Jiang. Separating metagenomic short reads into genomes via clustering (extended abstract). Proc. 11th Workshop on Algorithms in Bioinformatics (WABI), Saarbruken, Germany, Sept., 2011, pp. 298-313.

E. Bao, T. Jiang, I. Kaloshian, and T. Girke. SEED: Efficient clustering of next generation sequences. Bioinformatics 27, 2502-2509, 2011.

P.M. Ruegger, G. Della Vedova, T. Jiang, and J. Borneman. Improving probe set selection for microbial community analysis by leveraging taxonomic information of training sequences. BMC Bioinformatics 12:394, 2011.

M. Xie, J. Li and T. Jiang. Detecting genome-wide epistases based on the clustering of relatively frequent items. Bioinformatics 28(1), pp. 5-12, 2012.

B. Fang, D. Mane-Padros, E. Bolotin, T. Jiang, and F. Sladek. Identification of a binding motif specific to HNF4 by comparative analysis of multiple nuclear receptors. Nucleic Acids Research, accepted Feb 8, 2012.

Eamonn Keogh
Department of Computer Science and Engineering
University of California, Riverside

EDUCATION

1995	B.S.	Computer Science	California State University, San Marcos
1998	M.S.	Computer and Information Science	University of California, Irvine
2001	Ph.D.	Computer and Information Science	University of California, Irvine

ACADEMIC AND PROFESSIONAL

July 2009-present. University of California, Riverside. Full Professor, Dept. of Computer Science.

July 2006-June 2009. University of California, Riverside. Associate Professor, Dept. of Computer Science.

2001-June 2006. University of California, Riverside. Assistant Professor, Dept. of Computer Science.

SYNERGISTIC ACTIVITIES

Curator of the UCR Time Series Data Mining Archive: http://www.cs.ucr.edu/~eamonn/time_series_data/. More than 1,000 researchers worldwide have downloaded some data from this archive.

Tutorials at SIGKDD 2004/2007/2009, SDM 2008, VLDB 2006, ACM Multimedia 2006, INFOVIS 2005, CBMS 2005, IEEE ICDM 2001/2004/2010, SBBD 2002/2003, PKDD 2003.

Curriculum Development for the California statewide COSMOS program (for high school students).

Faculty mentor/ research leader for students participating in the California Alliance for Minority Participation in Science, Engineering and Mathematics.

Co-founder of The Keogh-Yoshii Scholarship for underrepresented students in computer science.

SELECTED CURRENT RESEARCH SUPPORT

NSF Career Award, *Efficient Discovery of Previously Unknown Patterns and Relationships in Massive Time Series Databases*. 2003-2008. The Aerospace Corp: $25,000 for *Finding Anomalous Patterns in Streaming Time Series*, 2004. Army SBIR $50,000 2007 (UCR share). Navy STTR $30,000 2008 (UCR share). NSF, *Tools to Mine and Index Trajectories of Physical Artifacts* $800,000.

AWARDS

UCR University Scholar 2008 to 2011 (sole recipient)
Bill and Melinda Gates Foundation, Grand Challenge Winner 2010.
UCSD Mentor Recognition Award. 2005
Outstanding Teacher of the Year, UCR College of Engineering. 2002-2003
Best Paper SIGMOD 2001, Best Paper KDD97, Best Paper IEEE ICDM 2007
Joseph J. Fischer Memorial Fellowship Award for 1998.
Award for Teaching Excellence, 5th Annual Celebration of Teaching, UCI.

10 SAMPLE PUBLICATIONS

Eamonn J. Keogh, Jessica Lin, Ada Wai-Chee Fu, Helga Van Herle: Finding Unusual Medical Time-Series Subsequences: Algorithms and Applications. IEEE Transactions on Information Technology in Biomedicine 10(3): 429-439 (2006).

Abdullah Mueen, Eamonn J. Keogh: Online discovery and maintenance of time series motifs. KDD 2010: 1089-1098

Keogh, E., Lonardi, S. Ratanamahatana, C. (2004). Towards Parameter-Free Data Mining. In *proceedings of the 10th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*. Seattle, WA, Aug 22-25, 2004. (Expanded version appears as a DMKD Journal paper).

Lin, J., Keogh, E., Lonardi, S., Lankford, J. P. & Nystrom, D. M. (2004). Visually Mining and Monitoring Massive Time Series. *In proceedings of the 10th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining. Seattle*, WA, Aug 22-25, 2004. (Expanded version appears as a Visualization Journal paper).

Li Wei, Nitin Kumar, Venkata Nishanth Lolla, Eamonn J. Keogh, Stefano Lonardi, Chotirat (Ann) Ratanamahatana, Helga Van Herle: A Practical Tool for Visualizing and Data Mining Medical Time Series. CBMS 2005: 341-346T. Palpanas, M. Vlachos, E. Keogh, D. Gunopulos, W. Truppel (2004). Online Amnesic Approximation of Streaming Time Series. In *ICDE* . Boston, MA, USA, March 2004.

Abdullah Mueen, Eamonn J. Keogh, Nima Bigdely Shamlo: Finding Time Series Motifs in Disk-Resident Data. ICDM 2009: 367-376

Keogh, E. & Kasetty, S. (2002) On the need for time series data mining benchmarks: A survey and empirical demonstration. In *the 8th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*. Edmonton, Alberta, Canada. pp 102-111. (Also appears in Data Mining and Knowledge Discovery Journal, and in a "best of KDD" session at Interface 2003).

Keogh, E. (2002) Exact indexing of dynamic time warping. In *28th International Conference on Very Large Data Bases* (VLDB). *Hong Kong*. pp 406-417. (Expanded version appears as a KAIS Journal paper).

Keogh, E. Chakrabarti, K. Pazzani, M. and Mehrotra, S. (2001) Locally adaptive dimensionality reduction for indexing large time series databases. In *proceedings of ACM SIGMOD Conference on Management of Data*. pp. 151-162. (Best Paper: Expanded version appears as in TODS Journal).

Invited Talks and Keynotes: NASA Ames, Google, The 16th European Conference on Machine Learning, IBM Watson, Yahoo Inc, Microsoft, Stanford University, University of Maryland, University of Toronto, Queensland Institute of Technology, The Australasian Workshop on Data Mining and Web Intelligence, Norwegian University of Science and Technology, ISCA Technologies, Aerospace Corporation, ChevronTexaco, Institute for Scientific Computing Research Lawrence Livermore Lab, University of Aberdeen, UCSD AI Research Seminar, NASA Jet Propulsion Laboratory, UCI/USC Pre-neuroscience Joint Symposium.

Srikanth V. Krishnamurthy

Education

PhD, Electrical and Computer Engineering: *University of California at San Diego, La Jolla, CA, 1997*
MS, Electrical and Computer Engineering: *Concordia University, Montreal, CANADA, 1994*
BS, Electrical and Electronics Engineering: *Birla Institute of Technology and Science, Pilani, INDIA, 1992*
M.Sc in Physics: *Birla Institute of Technology and Science, Pilani, INDIA, 1992.*

Academic Positions

Professor of Computer Science and Engineering,
University of California, Riverside, July 2009 – present.
Associate Professor of Computer Science and Engineering : July 2005 – June 2009
Assistant Professor of Computer Science and Engineering: January 2004-June 2005.

- **Research**

Wireless Systems and Networks, Internet Technology, Social Networks, Network Security, Privacy and Trust.

- **Teaching**

CS 164 Computer Networks, CS 257 Wireless Networks and Mobile Computing, CS 239 Performance Evaluation of Computer Networks, CS 260 Seminar on Wireless Ad Hoc Networks, CS 179 Undergraduate Senior Design Project in Networking CS 165 Computer Security, CS 169 Mobile Wireless Networks.

Previous Positions

Research Staff Scientist, HRL Laboratories, LLC, Malibu, CA, December 1999 – December 2000
Research Staff Member, HRL Laboratories, LLC., Malibu, CA, January 1998 – December 1999.

Professional Activites:

- Technical Co-Chair IEEE SECON 2008, IEEE ICNP 2009, IEEE WoWMoM 2010
- Technical Vice-Chair ACM MOBICOM 2007
- Editor-in Chief: ACM MC2R 2007-2009.
- Editorial Board of IEEE Transactions on Mobile Computing.
- On the Technical Program Committee for MOBIHOC 2002-2006, INFOCOM 2004-2006, 2008, 2010 MOBICOM 2005, 2008 2009, 2010, SIGCOMM 2010, CoNEXT 2010,2012.

Honors and Awards

- Fellow of the IEEE
- NSF CAREER Award 2003.
- Technology Achievement Award from HRL Laboratories 1999.
- Best Paper Award, IEEE SECON 2010.
- PI on DARPA Fault Tolerant Networks and Next Generation Internet Programs.

- Co-PI on ARL CTA and ARO MURI on Space-Time Communications and MURI on Resilient and Robust MANETs.

Selected Publications

1. I Broustis, K. Papagiannaki, S. Krishnamurthy, M. Faloutsos and V. Mhatre., -- "Measurement Driven Guidelines for 802.11 WLAN Design", IEEE/ACM Transactions on Networking, June 2010.
2. He, Y., Faloutsos M., Krishnamurthy S., and Chrobak M., "Obtaining provably legitimate Internet topologies," IEEE/ACM Transactions on Networking (to appear)
3. He, Y., Signaos G., Faloutsos M., and Krishnamurthy S.V., "Lord of the Links: A Framework for Discovering Missing Links in the Internet Topology," IEEE/ACM Transactions on Networking, April 2009.
4. G. Jakllari, S. Eidenbenz, N.Hengartner, S. Krishnamurthy and M. Faloutsos, "Link Positions Matter: A Non-commutative Routing Metric for Wireless Mesh Networks," IEEE Transactions on Mobile Computing, January 2012.
5. J. Eriksson, M. Faloutsos and S. Krishnamurthy, "DART: Dynamic Address Routing for Scalable Ad hoc and Mesh Networks," IEEE/ACM Transactions on Networking, February 2007.

Selected Conference/Workshop Paper Publications:

1. M.Arslan, J.Yoon, K.Sundaresan, S. Krishnamurthy and S. Banerjee, "FERMI: A Femtocell Resource Management Systemm for Interference Mitigation in OFDMA Networks," ACM MobiCom 2011, Las Vegas.
2. M. Arslan, K.Pelechrinis, I.Broustis, S. Krishnamurthy, S. Addepalli and K.Papagiannaki, "Auto-Configuration of 802.11n WLANs," ACM CoNEXT 2010, Philadelphia.
3. K. Pelechrinis., I. Broustis, S. Krishnamurthy., and C. Gkantsidis., "ARES: An Anti Jamming Reinforcement System for 802.11 Networks", ACM CoNEXT 2009, Rome.
4. He, Y., Signaos G., Faloutsos M., and Krishnamurthy S.V., "A Systematic Framework for Unearthing the Missing Links: Measurements and Impact," Usenix NSDI 2007, Cambridge.

List of persons who have collaborated with Dr. Krishnamurthy in the last 48 months: Prof. Michalis Faloutsos, UCR, Prof..Prasant Mohapatra, UC Davis, Prof.. Sneha Kasera Univ of Utah, Dr. Theodoros Salonidis, Technicolor, Prof. Tom La Porta, Penn State, Prof. Guohong Cao, Penn State, Prof. Sencun Zhu, Penn State, Dr. Christos Gkantsidis, Microsoft Research, Cambridge , Dr. B.Rao, UCSD, Prof. Harsha Madhyastha, UC Riverside, Dr. Konstantina Papagiannaki, Intel, Dr. Sateesh Addepalli, Cisco, Prof. Prashant Krishnamurthy, Pitt, Dr. Karthikeyan Sundaresan, NEC Labs, Prof. Suman Banerjee, U. Wisconsin

List of Student Interns Mentored by Dr. Krishnamurthy at HRL Laboratories: Tamer ElBatt (Univ. of Maryland), Ozgur Ercetin (Univ. of Maryland), Prasun Sinha (UIUC), George Kondylis (UCLA), Neeraj Poojary (UCSD), Sharad Agarwal (UCB), Youngbae-Ko (Texas A & M), Mohin Ahmed (UCLA).

Roger Lake

Education
Ph.D., Electrical Engineering, Purdue University, 1992
M.S.E.E, Electrical Engineering, Purdue University, 1988
B.S.E.E., Electrical Engineering, Purdue University, 1986

Academic Experience
2000-2006. Associate Professor, Department of Electrical Engineering UCR.
2001-2006 Graduate Advisor, Department of Electrical Engineering UCR.
2006-. Professor, Department of Electrical Engineering, UCR.
2006-2011 Chair, Department of Electrical Engineering UCR.
2007 – Faculty Member, Material Science and Engineering, UCR.
2008 – Cooperating Faculty Member, Computer Science and Engineering, UCR.

Non-Academic Experience
1993–1997, Texas Instruments, Central Research Labs, Member Technical Staff, Research position. Full-time. Dallas, TX.
1997-2000, Raytheon Systems, Applied Research Lab, Sr. Physics Engineer, Research Position. Full-time. Dallas, TX.

Current Memberships in Professional Organizations
Member, MRS, APS, AAAS
Senior Member, IEEE

Honors and Awards
Semiconductor Research Corporation Fellowship, 1988-1992.

Service Activities
Associate Editor, IEEE Transactions on Nanotechnology, 2/2006 – 2/2012.
Editor, IEEE Transactions on Electron Devices, 2/2012 -
California Nanotechnology Collaborative (CNC) Advisory Board Member
Session Chair, Spring Meeting of the MRS, San Francisco, CA, April 29, 2011.

Selected Publications, Past 5 Years

1. M. Khayer, R. Lake, "Performance analysis of InP nanowire band-to-band tunneling field-effect transistors," Applied Physics Letters, 95, 9, 073504(1-3), (2009).
2. M. Ashraf, R. Pandey, R. Lake, B. Millare, A. Gerasimenko, D. Bao, V. Vullev, "Theoretical design of bioinspired macromolecular electrets based on anthranilamide derivatives," Biotechnology Progress, 25, 4, 915 - 922, (2009).
3. M. Khayer, R. Lake, "Drive Currents and Leakage Currents in InSb and InAs Nanowire and Carbon Nanotube Band-to-Band Tunneling FETs," IEEE Electron Device Letters, 30, 12, 1257 - 1259, (2009).
4. N. Bruque, M. Ashraf, G. Beran, T. Helander, R. Lake, "Conductance of a Conjugated Molecule with Carbon Nanotube Contacts," Phys. Rev. B, 80, 155455(13), (2009).

5. M. Khayer, R. Lake, "Diameter Dependent Performance of High-Speed, Low-Power InAs Nanowire Field-Effect Transistors," Journal of Applied Physics, 107, 1, 014502(7), (2010).
6. J. Lin, D. Teweldebrhan, K. Ashraf, G. Liu, X. Jing, Z. Yan, R. Li, M. Ozkan, R. Lake, A. Balandin, C. Ozkan, "Gating of Single-Layer Graphene with Single-Stranded Deoxyribonucleic Acids," Small, 6, 10, 1150-1155, (2010).
7. M. A. Khayer and R. K. Lake, "Modeling and performance analysis of GaN nanowire field-effect transistors and band-to-band tunneling field-effect transistors," J. Appl. Phys. 108(10), 104503(7) (2010).
8. F. Zahid and R. K. Lake, "Thermoelectric properties of Bi2Te3 atomic quintuple thin films," Appl. Phys. Lett., 97, 212102 (2010).
9. M. K. Ashraf, N. A. Bruque, J. L. Tan, G. J. O. Beran, and R. K. Lake, "Conductance switching in diarylethenes bridging carbon nanotubes," J. Chem. Phys., 134, 024524(9) (2011).
10. K. M. M. Habib, F. Zahid, R. K. Lake, "Negative differential resistance in bilayer graphene nanoribbons," Applied Physics Letters, 98, 192112(3), 2011.
11. with TiTe2 semimetal thin-film channels," Appl. Phys. Lett., 100, 4, 043109(4), 2012.

Selected Professional Development Activities

Participation in Conferences:

1. 2008 March Meeting of the American Physical Society, New Orleans, March 10-14, 2008.
2. International Electron Devices Meeting, San Francisco, CA Dec. 15-17, 2008.
3. Nanoelectronic Devices for Defense and Security Conference, Fort Lauderdale, FL, Sept. 28 - Oct. 2, 2009.
4. 37th Conference on the Physics and Chemistry of Surfaces and Interfaces, Sante Fe, NM, Jan. 10, 2010 - Jan. 14, 2010.
5. MRS Spring Meeting, San Francisco, CA, April 6-8, 2010.
6. Gordon Research Conference Electron Donor-Acceptor Interactions, Salve Regina University, Newport, RI, Aug 8 - 13, 2010.
7. 2011 March Meeting of the American Physical Society, Dallas, TX, March 21-25, 2011.
8. Spring Meeting of the MRS, San Francisco, CA, April 25-29, 2011.
9. International Symposium on Advanced Nanodevices and Nanotechnology, Dec. 4-9, 2011, Kaanapali, HI.

Michel L. Lapidus

Education
Ph.D. & Doctorat d'Etat ès Sciences (Mathematics), *'Summa Cum Laude'*, Université Pierre et Marie Curie (Paris VI), France, 1980 & 1986. Habilitation to Direct Research (Paris VI), 1987.

Experience:
- Professor, University of California, Riverside, 1990-Present
- Member, Mathematical Sciences Research Institute (MSRI), Berkeley, Spring 1999 and Spring 2001 & Institut Henri Poincaré (IHP), Paris, Spring 2003.
- Member of the Newton Institute for Mathematical Sciences, Cambridge University, UK, (part of) Spring 1999
- Member, Institut des Hautes Etudes Scientifiques (IHES), Bures-sur-Yvette, France, 1994-95 and for several parts of 1995-98
- Visiting Professor, Yale University, New Haven, 1990-91
- Associate Professor, University of Georgia, Athens, 1986-90
- Visiting Assistant Professor, University of Iowa, Iowa City, 1985-86
- Member, Mathematical Sciences Research Institute (MSRI), Berkeley, 1984-85
- Assistant Professor, University of Southern California, Los Angeles, 1980-85
- Research Associate, University of California, Berkeley, 1979-80
- Research Associate, Université Paris VI, France, 1978-80

Fellowships, Awards and Honors
Research Fellowship D.G.R.S.T., Université Paris VI, 1978-80; George Lurcy Fellowship, University of California, Berkeley, 1979-80; My research on "Spectral and Fractal Geometry" was one of the two mathematical works presented by NSF to the "Office of the President" and to the U.S. Congress in the "National Science Foundation 1990 Fiscal Year Budget Proposal to Congress". Award of a university-wide "Creative Research Medal", Univ. of Georgia, Athens, 1989; Recipient of the M. G. Michael Award for Excellence in Research, Univ. of Georgia, Athens, 1989; Honorary Member, Research Board of Advisors, American Biography Institute (ABI), 1997-; Twentieth Century Award for Achievement, International Biographical Institute (IBC), Cambridge, UK, 1998; Outstanding Man of the 20th Century, ABI, 1999; nomin. "100 Geniuses of the 21st Century" (IBC, 2006). Elected Fellow of the American Association for the Advancement of Science (AAAS), Sept. 2000 [for *"Distinguished Research Contributions to Mathematical Physics and Fractal Geometry"*]; Member, AMS Council, and Associate Secretary of the American Mathematical Society (AMS), Western Section, Feb. 2002-. (Renominated and reconfirmed three times, now through Jan. 2010.) Nominated for membership in the American Academy of Arts and Sciences, 2004-05 &.2006-07.
Discussion in the general scientific press of my (joint) work on the "vibrations of fractal drums" and "the Weyl-Berry conjecture". Please see the articles by Ian Stewart in *Nature* (vol. 333, 5/19/88), Jean-Pierre Fabre in *La Recherche* (vol. 202, 9/88), Barry Cipra in *Science* (vol. 259, 2/12/93), as well as the cover article by Ivars Peterson in *Science* News (vol. 146, No. 12, 9/17/94) and the book by the same author, entitled *"The Jungles of Randomness:*

A Mathematical Safari" (Wiley, 1998). Also see the article by Ian Stewart in *New Scientist* (vol. 156, 12/20/97) and the recent article in *La Recherche* (vol. 383, 2/05).

Research Grants (over the last twenty years): National Science Foundation Research Grants, DMS-8703138 (6/87- 6/89), DMS-8904389 (6/89-6/92), DMS-9207098 (7/92-7/96), DMS-9623002 (9/96-8/99), and DMS-0070497 (7/00-7/05). (Sole P.I.)

Selected Publications

1. *"The Feynman Integral and Feynman's Operational Calculus",* Oxford Mathematical Monographs, Oxford Univ. Press, Oxford and New York,
2000, approx. 800 pp. (precisely, 771+(xviii) pp.), (with G. W. Johnson.) (Paperback edition: 2002, OUP).
2. *"Fractal Geometry and Number Theory: Complex dimensions of fractal strings and zeros of zeta functions",* Birkhäuser, Boston, 2000, 268+(xii) pp., (with M. van Frankenhuysen).
3. "*A Koch Tube Formula for the Koch Snowflake Curve, with Applications to Complex Dimensions",* J. London Math. Soc. No.2, **74**(2006), 397-414, (with E. P. J. Pearse).
4. *"Fractal Geometry, Complex Dimensions and Zeta Functions: Geometry and spectra of fractal strings",* Springer Monographs in Mathematics, Springer-Verlag, New York, 2006, approx. 500 pp. (precisely, 460+(xxiv) pp.), (with M. van Frankenhuijsen).
5**.** *"In Search of the Riemann Zeros: Strings, fractal membranes and noncommutative spacetimes",* Amer. Math. Soc., Providence, R I, 2008, 600 pages (precisely, 558+(xxix) pp.), February, 2008. ISBN-10: 0-8218-422-5. US Library of Congress Classification: QA333.L37 2007.
6. *"Generalized Dyson Series, Generalized Feynman Diagrams, the Feynman Integral and Feynman's Operational Calculus",* Memoirs of the American Mathematical Society No. *351*, **62** (1986), pp. 1-78, (with G. W. Johnson).
7. *"Remainder Estimates for the Asymptotics of Elliptic Eigenvalue Problems with Indefinite Weights"*, Archives for Rational Mechanics & Analysis **98**(1987), pp. 329-356, (with J. Fleckinger).
8. *"Counterexamples to the Modified Weyl-Berry Conjecture",* Mathematical Proceedings of the Cambridge Philosophical Society, **119**(1996), pp. 167-178, (with C. Pomerance).
9. *"Towards a Noncommutative Fractal Geometry? Laplacians and Volume Measures on Fractals"*, Contemporary Mathematics, American Mathematical Society **208**(1997), pp. 211-252.
10. *"Self-Similarity of Volume Measures for Laplacians on P.C.F. Self-Similar Fractals",* Communications in Mathematical Physics **217**(2001), pp. 165-180, (with J. Kigami).

Stefano Lonardi

Education

2001	Ph.D.	Computer Science	Purdue University, West Lafayette
1999	Dottorato	Electrical & Computer Engineering	University of Padova, Italy
1994	Laurea	Computer Science	University of Pisa, Italy

Academic Experience

2011-present	Professor	University of California, Riverside CA
2007– 2011	Associate Professor	University of California, Riverside CA
2001– 2007	Assistant Professor	University of California, Riverside CA

Non-academic Experience

1999	Intern	Celera Genomics, Rockville, MD

Certifications or professional registrations
N/A

Current membership in professional organizations
ACM, IEEE Computer Society

Honors and awards
NSF Career Award 2005

Service activities (within and outside of the institution)

- Vice Chair, Department of Computer Science and Engineering, UC Riverside
- Served in over 40 Program Committees since 2003
- Program committee co-chair: SPIRE'10 (Los Cabos, Mexico), BIOKDD'08 (Las Vegas, NV) and BIOKDD'07 (San Jose, CA)
- Steering Committee, IEEE/ACM Transactions on Computational Biology and Bioinformatics (2012 - present)
- Reviewer/Panelist for NSF, NSERC, NASA and many other funding agencies

Recent Publications

- H. Jin, V. Vacic, T. Girke, S. Lonardi, J.-K. Zhu, "Small RNAs and the regulation of cis-natural antisense transcripts in Arabidopsis", **BMC Molecular Biology**, 9:6, 2008.
- Y. Wu, L. Liu, T. Close, S. Lonardi, "Deconvoluting BAC-gene relationships using a physical map", **Journal of Bioinformatics and Computational Biology**, 6:3, 603–622, 2008. Also, in Proceedings of LSS **Computational Systems Bioinformatics Conference** (CSB'07), 203-214, 2007.
- V. Vacic, H. Jin, J.-K. Zhu, S. Lonardi, "A probabilistic method small RNA flowgram matching", Proceedings of **Pacific Symposium on Biocomputing** (PSB'08), 75-86, 2008.
- Y. Wu, P. Bhat, T. J. Close, S. Lonardi, "Efficient and accurate construction of genetic linkage maps from noisy and missing genotyping data", **PLoS Genetics**, 4(10):e1000212,

2008. Also in Proceedings of the **Workshop on Algorithms in Bioinformatics** (WABI'07), LNBI 4645, 395-406, 2007.

- S. Bozdag, T. Close, S. Lonardi, "Computing the Minimal Tiling Path from a Physical Map by Integer Linear Programming", Proceedings of the **Workshop on Algorithms in Bioinformatics** (WABI'08), LNBI 5251, 148-161, 2008.
- L. Liu, Y. Wu, S. Lonardi, T. Jiang, "Efficient Algorithms for Genome-Wide TagSNP Selection across Populations via the Linkage Disequilibrium Criterion", **Journal Computational Biology**, 17(1): 21-37, 2010. Also in Proceedings of LSS **Computational Systems Bioinformatics Conference** (CSB'07), pp.67-78, 2007.
- D. Bogunovic, D. W. O'Neill, …, S. Lonardi, J. Zavadil, I. Osman and N. Bhardwaj, "Immune profile and mitotic index of metastatic melanoma lesions enhance TNM staging in predicting patient survival", **Proceedings of the National Academy of Sciences (PNAS)**, 106:48, 20429-20434, 2009.
- N. Ponts, E. Y. Harris, J. Prudhomme, I. Wick, C. Eckhardt-Ludka, G. Hicks, G. Hardiman, S. Lonardi, and K. Le Roch, "Nucleosome landscape and control of transcription in the human malaria parasite", **Genome Research**, 20: 228-238, 2010.
- T.J. Close, P.R.Bhat, S. Lonardi, Y. Wu, N. Rostoks, … R. Waugh, "Development and Implementation of High-Throughput SNP Genotyping in Barley", **BMC Genomics**, 10:582, 2009.
- Y. Wu, T. J. Close, S. Lonardi, "On the accurate construction of consensus genetic maps", **IEEE Transactions on Computational Biology and Bioinformatics**, 2010, in press. Also in Proceedings of **LSS Computational Systems Bioinformatics Conference** (CSB'08), 285–296, Stanford, CA, 2008.
- E. Y. Harris, N. Ponts, A. Levchuk, K. Le Roch, S. Lonardi, "BRAT: Bisulfite-treated Reads Analysis Tool", **Bioinformatics**, 26:4, 572-573, 2010.
- Y. Wu, T. J. Close, S. Lonardi, "Accurate Construction of Consensus Genetic Maps via Integer Linear Programming", **IEEE/ACM Transactions on Computational Biology and Bioinformatics**, vol.8, no.2, pp.381-394, 2011.
- E. Fernandez, W. Najjar, S. Lonardi, "String Matching in Hardware using the FM Index", **Proceedings of IEEE International Symposium on Field-Programmable Custom Computing Machines** (FCCM'11), pp.218-225, Salt Lake City, Utah, 2011
- E. Y. Harris, N. Ponts, K. G. Le Roch, S. Lonardi, "Chromatin-driven de novo discovery of DNA binding motifs in the human malaria parasite", **BMC Genomics**, 12:601, 2011.

Professional Development

Author of the book "Biological Data Mining" with J.Chen (Chapman and Hall/CRC Press, 2009)

Harsha V. Madhyastha

Education

University of Washington	Computer Science	PhD, 2008; MS, 2003
Indian Institute of Technology, Madras	Computer Science and Engineering.	B.Tech, 2003

Academic experience

July 2007-present	Assistant Professor	University of California, Riverside, CA
Sept 2008-August 2010	Postdoctoral Scholar	University of California, San Diego, CA
Sept 2003-August 2008	Graduate Research Asst.	University of Washington

Non-academic experience

June 2005-Sept 2005	Intern	Research Intern. AT&T Labs Research
June 2004-Sept 2004	Mentor: Balachander Krishnamurthy	
June 2003-Sept 2003	Intern	Intern. Tejas Netwarks, Bangalore
June 2002-Sept 2002	Mentor: Sarath Kumar	

Service

Departmental faculty search committee, 2011–12
Program committee member for ICNP 2012, IMC 2012, and ICNP 2011
Reviewer for IEEE/ACM Transactions on Networking, ACM Computer Communication Review, USENIX OSDI 2010, USENIX NSDI 2009, and USENIX NSDI 2008

Selected Recent Publications

Masoud Akhoondi, Curtis Yu, and Harsha V. Madhyastha. LASTor: A Low-Latency AS-Aware Tor Client, IEEE Symposium on Security and Privacy, 2012.
Michael Butkiewicz, Harsha V. Madhyastha, and Vyas Sekar, Understanding Website Complexity: Measurements, Metrics, and Implications, ACM SIGCOMM IMC, 2011.
Alexander Rasmussen, George Porter, Michael Conley, Harsha V. Madhyastha, Radhika Niranjan Mysore, Alexander Pucher, and Amin Vahdat, Tritonsort: A Balanced Large-Scale Sorting System, USENIX NSDI, 2011.
Ethan Katz-Bassett, Harsha V. Madhyastha, Vijay Adhikari, Colin Scott, Justine Sherry, Peter van Wesep, Tom Anderson, and Arvind Krishnamurthy, Reverse Traceroute, USENIX NSDI, 2010.
Rupa Krishnan, Harsha V. Madhyastha, Sridhar Srinivasan, Sushant Jain, Arvind Krishnamurthy, Tom Anderson, and Jie Gao, Moving Beyond End-to-End Path Information to Optimize CDN Performance, ACM SIGCOMM IMC, 2009.
Harsha V. Madhyastha, Ethan Katz-Bassett, Tom Anderson, Arvind Krishnamurthy, and Arun Venkataramani, iPlane Nano: Path Prediction for Peer-to-Peer Applications, USENIX NSDI, 2009.
Ethan Katz-Bassett, Harsha V. Madhyastha, John P. John, Arvind Krishnamurthy, David Wetherall, and Tom Anderson, Studying Black Holes in the Internet with Hubble, USENIX NSDI, 2008.
Harsha V. Madhyastha, Tomas Isdal, Michael Piatek, Colin Dixon, Tom Anderson, Arvind Krishnamurthy, and Arun Venkataramani, iPlane: An Information Plane for Distributed Services, USENIX OSDI, 2006.

Awards and Honors
NSF CAREER, 2012
NetApp Faculty Fellowship, 2011
World records in Indy Graysort and Indy Minutesort categories, 2010
Best Paper at USENIX NSDI, 2010
Best Paper at ACM SIGCOMM IMC, 2009
Silver medal at the International Physics Olympiad, 1999

Selected Invited Research Talks
April 2010 State University of New York, Stonybrook, NY, USA.
April 2010 University of Chicago, Chicago, IL, USA..
March 2010 University of Southern California, Los Angeles, CA, USA.
March 2010 University of Toronto, Toronto, Canada.
March 2010 Cornell University, Ithaca, NY, USA.
February 2010 Yale University, New Haven, CT, USA.
December 2008 Microsoft Research India, Bangalore, India.
June 2008 University of California, San Diego, CA, USA.
May 2008 Max Planck Institute for Software Systems, Saarbrucken, Germany.
February 2007 Google, Mountain View, CA, USA.

Mart Molle
Professor

Degrees

Ph.D., Computer Science, University of California, Los Angeles, 1981
M.S., Computer Science, University of California, Los Angeles, 1978
B.Sc. (Hons), Mathematics and Computer Science, Queen's University at Kingston, Canada, 1976

University of California, Riverside, Service

Professor, II, 7/1/1994
Professor, III, 7/1/1997
Chair, Department of Computer Science & Engineering, 7/1/1999 – 7/1/2002
Professor, IV, 7/1/2003
Professor, V, 7/1/2005

Other Professional Experience

1981-1994. University of Toronto. Professor, Department of Computer Science (1991-94). Associate Professor (1985-1991). Assistant Professor (1981-1985).
1987-1988. University of California, Irvine. Visiting Associate Professor, Information and Computer Science.

Consulting and Patents

IEEE Registration Authority, New York, 1998 – present, consultant, technical review of applications to assign a unique EtherType reserved number to new network protocols.
Finnegan, Henderson, Farabow, Garrett & Dunner, LLP, Washington, DC, 2001, expert witness, on Ethernet-related intellectual property rights for an International Trade Commission hearing.
Arnold & Porter LLP, Los Angeles, CA, 2007-2008, expert witness, on intellectual property rights for software systems for network monitoring and management.
Wilson Sonsini & Rosati, Menlo Park, CA, 2000, expert witness, on Ethernet-related intellectual property rights.
Technical Management Consultants, Woodland Hills, CA, 1999, consultant, evaluated a high speed modem for an investment group.
San Bernardino County Office of Education, San Bernardino, CA, 1998, consultant, technical expert on a review panel for a major Information Technology upgrade plan.
Metricom, Inc., San Jose, CA, 1996, consultant, technical review of a new wireless network protocol.

Patent Number	Date Issued	Title
5,978,383	11/02/1999	Repeaters for reducing collisions in an Ethernet network
5,600,651	02/04/1997	Binary logarithmic arbitration method for carrier sense multiple access with collision detection network medium access control protocols

Registrations

N/A

Publications

Controlling Spam E-mail at the Routers. *Agrawal, B.; Kumar, N.; Molle, M.;* Proc. IEEE International Conference on Communcations (ICC '05), May 2005

Can We Use Product Form Solution Techniques for Networks with Alternate Paths? *Elhafsi, E.; Molle, M.; Manjunath, D.;* Proc. International Symposium on Performance Evaluation of Computer and Telecommunications Systems, July 2005

Short-Circuiting the Congestion Signaling Path for AQM Algorithms using Reverse Flow Matching *Molle, M.; Xu, Z.;* Computer Communications, Special Issue on End-to-End Quality of Service Differentiation. Hassanein, H. and Lutfiyya, H. (eds.), Vol. 28(18), 2005 pp. 2082-2093.

Optimal routing between alternate paths with different network transit delays. Elhafsi, E. H.; Molle, M.; Proc. IEEE Global Telecommunications Conference, GLOBECOM San Fransisco California, November 2006.

Localization with Witnesses. Saha, A.; Molle, M.; Proc. 1st International Conference on New Technologies, Mobility and Security (NTMS 2008), Paris, France, May 2007

Multi-band Media Access Control in Impulse-Based UWB Ad hoc Networks. Broustis, I.; Krishnamurthy, S.V.; Faloutsos, M.; Molle, M.; Foerster, J.; IEEE Transactions on Mobile Computing, Volume: 5, Issue: 4, April 2007, Page(s) 351-366. (abstract).

On the Solution to QBD Processes with Finite State Space. Elhafsi, E. H.; Molle, M.; Journal of Stochastic Analysis and Applications (Taylor & Francis), Volume: 25, Issue: 4, July 2007, Page(s) 763-779.

On the application of forking nodes to product-form queueing networks. Elhafsi, E. H.; Molle, M.; Manjunath, D.; International Journal of Communication Systems (Wiley), Volume: 21, Issue: 2, February 2008, Page(s): 135-165

Localization and Clock Synchronization Need Similar Hardware Support in Wireless LANs. Parichha, S.; Molle, M.; Proc. 2008 International IEEE Symposium on Precision Clock Synchronization for Measurement, Control and Communication (ISPCS 2008), Ann Arbor, MI, September 2008.

Efficient Computation of Queueing Delay at a Network Port from Output-Link Traces. Habib, M. F.; Molle, M; Proc. 22nd International Teletraffic Congress (ITC 22), Amsterdam, Netherlands, September 2010.

More (messages) is less (accuracy) in localization. Parichha, S.; Molle, M.; Military Communications Conference (MILCOM 2011), Baltimore, MD, 7-10 Nov. 2011

Professional Societies

Fellow, American Association for the Advancement of Science
Member, Institute of Electrical and Electronic Engineers

Honors and awards

Major James A. Rattray M.C. Scholarship in Science, Queen's University, 1975 – 1976
Chancellor's Intern Fellowship, UCLA, 1976 – 1980
Best Paper, International Conference on Communications, Toronto, Canada, 1986
Award Paper, International Seminar on Performance of Distributed and Parallel Systems, Kyoto, Japan, 1988

Walid A. Najjar

Education

Ph.D. in Computer Engineering (August 1988), University of Southern California.
M.S. in Computer Engineering (June 1985), University of Southern California.
B.E. in Electrical Engineering (July 1979), American University of Beirut, Lebanon.

Academic Experience

Professor/Associate Professor, UC Riverside, Computer Science & Engineering, (2000 – present)
Associate/Assistant Professor, Colorado State U., Dept. of Computer Science, (1989 –2000).
Computer Scientist, USC/Information Sciences Institute, Marina del Rey, CA (88-89).

Non-Academic Experience

Founder Jacquard Computing Inc. (http://www.jacquardcomputing.com)

Professional Organizations

IEEE (Fellow), ACM, AAAS (Fellow)

Honors and Awards

Elected Fellow AAAS, 2010 • Elected Fellow of the IEEE, 2007 • 1996 Graduate Teaching Award, College of Natural Sciences, Colorado State University.

Service Activities

- University Service
  - Director, BCOE Computer Engineering Program (2009 - present).
  - UCR Eminent Scholar Ad-Hoc Committee (2006 – 2009).
  - CSE Graduate Committee (2008 - present).
  - CSE Faculty Search Committee (2008 - 09).
  - Chair, Computer Engineering Program Ad-Hoc Committee (2008-2009).
  - Graduate Advisor (2007- 2008).
  - Department Vice Chair (2003 – 05).
  - UC Micro Executive Committee (2001 – 07).
- External Service
  - Editorial Board: IEEE Transactions on Computers (2007 – 2011) • IEEE Computer Architecture Letters (2004 – 2011) • Parallel Computing, Elsevier, (2001 – 2008).
  - General or Program Committee Chair or Co-Chair: 16 conferences, conference tracks or workshops (1998 – present).
  - Member Program Committee: 70 conferences, workshops or symposia (1994 – present).
- Refereeing and Reviewing
  - External Ph.D. Thesis Examiner (8 times).
  - Funding Reviews: US National Science Foundation, Swiss National Science Foundation, National Research Council of Canada.

- Journal Reviews: ACM Trans. On Design Automation of Electronic Systems (TODAES), ACM Trans. On Architectures and Compiler Optimizations (TACO), ACM Trans. On Embedded Computing Systems (TECS), ACM Trans. On Reconfigurable Technology and Systems (TRETS), Computing Surveys. IEEE Trans. On Computers, Trans. On Parallel and Distributed Systems (TPDS), Micro, Design and Test, Trans on VLSI, Trans. On Signal Processing, Trans. On Reliability. Journal of Parallel and Distributed Computing. Parallel Computing. Int. Journal of Parallel Processing. VLSI Design. Journal of Computer and Software Engineering.

Recent Publications

1. B. Buyukkurt, J. Villarreal, W. A. Najjar. Impact of High Level Transformations within the ROCCC Framework, in ACM Trans. on Architecture and Code Optimization, Vol.7, N0. 4, December 2010.
2. D. Suresh, B. Agrawal, W. Najjar and J. Yang. Tunable and Energy Efficient Bus Encoding Techniques. In IEEE Transactions on Computers, Vol. 58, No. 8, August 2009 (pp. 1049-1062).
3. D. Suresh, B. Agrawal, J. Yang, W. Najjar. Energy Efficient Encoding Techniques for Off-Chip Data Busses, in ACM Transactions on Embedded Computing Systems (TECS) Vol. 8 No. 2, Article 9, 23 pages.
4. Z. Guo, W. Najjar, A. B. Buyukkurt. Efficient Hardware Code Generation for FPGAs, in ACM Trans. on Architecture and Code Optimizations (TACO) Vol. 5, No. 1, Article 6, May 2008, 26 pages.
5. R. Halstead, J. Villarreal and W. A. Najjar. Exploring Irregular Memory Accesses on FPGAs, IAAA - Workshop on Irregular Applications: Architectures & Algorithms, held in conjunction with Supercomputing 2011 (SC'11) November, 2011, Seattle, WA.
6. R. Moussalli, R. Halstead, M. Salloum, W. Najjar, V. J. Tsotras. Efficient XML Path Filtering Using GPUs, in Proc. Sec. Int. Workshop on Accelerating Data Management Systems (ADMS 2011), Seattle, WA, Sept. 2011.
7. E. B. Fernandez, W. A. Najjar and S. Lonardi. String Matching in Hardware using the FM index, in Proc. 19th Ann. IEEE Int. Symp. on Field-Programmable Custom Computing Machines (FCCM 2011), Salt Lake City, UT, May 2011.
8. D. Sart, A. Mueen, W. Najjar, V. Niennattrakul, and E. Keogh. Accelerating Dynamic Time Warping Subsequence Search with GPUs and FPGAs, in Int. Conf. on Data Mining, Sydney, Australia, Dec. 2010. PDF
9. E. Fernandez, W. Najjar and S. Lonardi. Exploration of Short Reads Mapping in Hardware in Proc. 20th Int. Conf. on Field Programmable Logic and Applications (FPL), Milano, ITALY, Aug. 2010.
10. J. Villarreal, A. Park, W. Najjar and R. Halstead. Designing Modular Hardware Accelerators in C With ROCCC 2.0, in 18th An. Int. IEEE Symp. on Field-Programmable Custom Computing Machines (FCCM), Charlotte, NC, May 2010.

A total of 126 publications including 28 journal papers and five book chapters

Iulian Neamtiu

Education

University of Maryland at College Park	Computer Science	PhD, 2008; MS, 2005
Technical University of Cluj-Napoca, Romania	Computer Science and Eng.	B.Sc, 1999

Academic experience

July 2008-present	Assistant Professor	University of California, Riverside, CA

Non-academic experience

May 2006-August 2006	Intern	Microsoft Research, Redmond, WA
June 2005-August 2005	Intern	IBM Research, Yorktown Heights, NY
Sept 2000-August 2002	SW Design Engineer (full-time)	Nokia Ntwks., Düsseldorf, Germany
April 1999-August 2000	Visiting Researcher (full-time)	Technical University Munich, Germany

Certifications or professional registrations: none
Current membership in professional organizations: Association for Computing Machinery (ACM), since 2003

Honors and Awards

NSF CAREER Award, 2012
Regents' Faculty Fellowship Award, University of California, Riverside, 2009-2010
Dean's Fellowship Award, College of Computer, Mathematical and Physical Sciences, University of Maryland, 2006
Diploma Thesis Fellowship, Technical Univ. of Munich, Germany, April 1999–June 1999

Service Activities

Within UCR

Military Veterans support team, 2010--present
Undergraduate education committee, 2008—2011
ACM faculty liaison, 2009--present

Outside UCR

Finance and sponsorship chair, PLDI 2012
Poster session chair, ASPLOS 2011
Program committee member, Early Research Acvmt. Track at ICSM 2010, 2011, 2012
Program committee member, RAM-SE workshops: 2009, 2010, 2011
Co-chair ACM Workshop on Hot Topics in Software Upgrades (HotSWUp): 2008, 2009; program committee member, 2008, 2009, 2012.

Most important publications in the past five years

PLDI Min Feng, Rajiv Gupta, and Iulian Neamtiu "Effective Parallelization of Loops in the Presence of I/O Operations". Proceedings of the ACM Conference on Programming Language Design and Implementation (PLDI 2012), June 2012, Beijing, China.

ICSE Pamela Bhattacharya, Marios Iliofotou, Iulian Neamtiu, and Michalis Faloutsos. "Graph-based Analysis and Prediction for Software Evolution ", International Conference on Software Engineering (ICSE 2012), June 2012, Zurich Switzerland.

ICSE Pamela Bhattacharya, Iulian Neamtiu. "Assessing Programming Language Impact on Development and Maintenance: A Study on C and C++". Proceedings of the International Conference on Software Engineering (ICSE'11), May 2011

PLDI Iulian Neamtiu, Michael Hicks. "Safe and Timely Dynamic Updates for Multi-threaded Programs", Proceedings of the ACM Conference on Programming Language Design and Implementation (PLDI'09), June 2009

POPL Iulian Neamtiu, Michael Hicks, Jeffrey S. Foster, Polyvios Pratikakis. "Contextual Effects for Version-Consistent Dynamic Software Updating and Safe Concurrent Programming", Proceedings of the ACM Conference on Principles of Programming Languages (POPL'08), January 2008

JSME Iulian Neamtiu, Guowu Xie, Jianbo Chen. "Towards a Better Understanding of Software Evolution: An Empirical Study on Open Source Software". Journal of Software Maintenance and Evolution: Research and Practice, 2011.

ICSM Pamela Bhattacharya, Iulian Neamtiu. "Fine-grained Incremental Learning and Multi-feature Tossing Graphs to Improve Bug Triaging". Proceedings of the IEEE Conference on Software Maintenance (ICSM'10), September 2010

OSDI Madanlal Musuvathi, Shaz Qadeer, Tom Ball, Gerard Basler, Arumuga Nainar, Iulian Neamtiu. "Finding and Reproducing Heisenbugs in Concurrent Programs", Proceedings of the Eighth Symposium on Operating Systems Design & Implementation (OSDI'08), USENIX, December 2008

TOPLAS Gareth Stoyle, Michael Hicks, Gavin Bierman, Peter Sewell, Iulian Neamtiu. "Mutatis Mutandis: Safe and Flexible Dynamic Software Updating". ACM Transactions on Programming Languages and Systems (TOPLAS), Volume 29, Issue 4 (August 2007)

ASWEC Steve Suh, Iulian Neamtiu. "Studying Software Evolution for Taming Software Complexity". 22nd Australian Software Engineering Conference (ASWEC 2010), April 2010.

SEAMS Iulian Neamtiu. "Elastic Executions from Inelastic Programs". 6th International Symposium on Software Engineering for Adaptive and Self-Managed Systems (SEAMS'11), May 2011.

Most recent professional development activities: none

Thomas H. Payne

Education
Ph.D. in Mathematics, 1967, University of Notre Dame.
M.S. in Mathematics, 1966, University of Notre Dame.
B.S. in Mathematics, 1964, Marquette University.

Professional Experience
1967-75, UC, Riverside, Assistant Professor of Mathematics.
1975-90, UC, Riverside, Associate Professor of Mathematics.
1972-76, UC, Riverside, Acting Director, Computer Science Institute.
1990-2008, UC, Riverside, Associate Professor of Computer Science.
2008-present, UC, Riverside, Associate Professor of Computer Science Emeritus.
1993-95, UC, Riverside, Director, College of Engineering Systems Clinic.
1994-99, UC, Riverside, Chair, Department of Computer Science and Engineering
Spring 2002, UC, Riverside, Acting Associate Dean of Engineering
2002-2007, UC, Riverside, Chair, Department of Computer Science and Engineering
2009-2012, UC, Riverside, Director, Online M.S. in Engineering Program

Funding
1990-93 Distributed Real-Time System, Naval Weapons Center, $131,239.
1994-95 Geographical Information Systems for Water Resource Planning, Santa Ana Watershed Project Authority, $9,978.
1994-95 Network Infrastructure Planning for Integrated Voice, Data, and Imaging Applications}, Los Angeles Metropolitan Transportation Authority, \$25,000.
2001-02 Optimizing System-On-A-Chip Memory Architectures for Video/Audio Processing Applications, Trimedia Inc., $44,199.
2000-01 Systems-Software Clinic,Spinway, Inc., $131,202.

Selected Publications
1. A linear-time algorithm for drawing planar graphs in a grid, Information Processing Letters, 54(1995), 241-246, with Marek Chrobak.
2. Case free programs: An Abstraction of Definite Horn Programs, Proceedings of the 10th International Conference on Automated Deduction, (Kaiserslautern, FRG, July 1990), 87-101.
3. A Hybrid Approach for Efficient Dataflow Computing, Proceedings of the Ninth Annual International Phoenix Conference on Computers and Communications, March 1990, 170-178. with Y. C. Hong.
4. New Results on Server Problems, The First ACM-SIAM Symposium on Discrete Algorithms, and SIAM Journal on Discrete Mathematics} 4(1991), 172-182, with Marek Chrobak, H. Karloff, and S. Vishwanathan.
5. Case inference in resolution-based languages, 9th International Conference on Automated Deduction}, 1988, with T. Wakayama.
6. Some properties of large filters, Journal of Symbolic Logic} 53(1988), 1027-1035,with Chris Freiling.

7. Parallel sorting in a ring network of processors, IEEE Transactions on Computers} 38(March 1989), 458-464, with Y. C. Hong.
8. A diamond structured dataflow machine with distributed memory, Proceedings of Int'l Computer Symposium, December 1986, 1011-1020, with Y. C. Hong.
9. Efficient computation of dataflow graphs in a hypercube architecture, Journal of Computer Systems Science and Engineering, Vol. 2, No. 1, January 1987, 29-41, with Y. C. Hong.
10. Graph allocation in static dataflow systems, Proc. of 1986 Int'l Symp. on Computer Architecture, 1986, 55-64, with Y. C. Hong and L.B.O. Ferguson.
11. An architecture for a dataflow multiprocessor, Proc. of Int'l Conf on Parallel Processing, August 1985, 349-355, with Y. C. Hong and L.B.O. Ferguson.
12. General computability, Notre Dame Journal of Formal Logic, XXI(1980), 272-292.
13. Sorting X+Y, Comm. of the Assoc. for Comp. Mach., 18(1975), 347-349, with L. H. Harper, J. E. Savage, and Ernst Strauss.
14. Computability on finite linear configurations, Notre Dame Journal of Formal Logic, XVI 1975), 354-356.
15. Concrete computability, Notre Dame Journal of Formal Logic, XVI(1975), 238-244.
16. Effective extendability and fixed points, Notre Dame Journal of Formal Logic, XIV(1973), 123-124.
17. On the existence of fixed points in a totally ordered set, Proc. Amer. Math. Soc., 31(1972), 441-444, with F. T. Metcalf.
18. Sequences having an effective fixed-point property, Trans. Amer. Math. Soc., 165(1972), 227-237.
19. Effectively minimizing effective fixed-points, Proc. Amer. Math. Soc., 30(1971), 561-562.
20. An elementary submodel never preserved by Skolem expansions, Zeitschrift fur Mathematische Logik und Grundlagen der Mathematik, 15(1969), 435-436.

C. V. Ravishankar
Department of Computer Science & Engineering
University of California, Riverside, Riverside, CA 92521

EDUCATION

- Ph.D., Computer Sciences, University of Wisconsin–Madison, 1987.
- M.S., Computer Sciences, University of Wisconsin–Madison, 1986.
- B.Tech., Chemical Engineering, Indian Institute of Technology, Bombay, 1975.

ACADEMIC EXPERIENCE

- Associate Dean (7/04 to present), The Bourns College of Engineering, University of California— Riverside.
- Professor (6/99 to present), Computer Science & Engineering Department, University of California— Riverside.
- Research Scientist (1996–1999), EECS Department and the Information Technology Division, University of Michigan—Ann Arbor.
- Associate Research Scientist (1991–1996), EECS Department and the Information Technology Division, the University of Michigan–Ann Arbor.
- Assistant Professor (1986–1991), Electrical Engineering and Computer Sciences Department, University of Michigan-Ann Arbor.

SAMPLE SERVICE ACTIVITIES

- Associate Editor, IEEE Transactions on Knowledge and Data Engineering, IEEE Press, 1999-2003.
- Program Committee, MSN'07, International Conference on Mobile Ad-hoc and Sensor Networks, 2007.
- Program Committee, CIKM'07, ACM Conference on Information and Knowledge Management, 2007.
- Program Committee, IEEE INFOCOM'04, the 23rd Annual IEEE Conference on Computer Communications, 2004.
- Program Committee, VLDB2002, the 28th International Conference on Very Large Databases, Hong Kong, Aug. 2002.
- Program Committee, ACM SIGMOD'99, International Conference on Management of Data, Philadelphia, PA, May 1999.
- Program Committee, ACM First International Conference on Data Warehousing and On-Line Analytical Processing, Washington D.C., November 7, 1998.
- Program Committee, 9th Int. Conference on Scientific and Statistical Databases, 1997.
- Program Committee, Fifth International Symposium on Large Spatial Databases, 1997.

- Reviewer for IEEE Transactions on Software Engineering, IEEE Transactions on Parallel & Distributed Systems, IEEE Transactions on Computers, IEEE Transactions on KDE, and numerous other journals and conferences. Reviewer for National Science Foundation, and the National Sciences and Engineering Research Council of Canada.

SAMPLE PUBLICATIONS:

- Peng Wang and Chinya V. Ravishankar, "Foisting and Stealing of Keys in Sensor Networks", Proc. 9th European Conference on Wireless Sensor Networks, Trento, Italy, February 2012.
- Md. Reaz Uddin, Chinya V. Ravishankar, Vassilis J. Tsotras, "Finding Regions of Interest from Trajectory Data", Proc. 12th IEEE International Conference on Mobile Data Management, Lulea, Sweden, June 2011.
- Jinfeng Ni and C. V. Ravishankar, "Indexing Spatiotemporal Trajectories with Efficient Polynomial Approximations", IEEE Transactions on Knowledge and Data Engineering, 19(5): 663-678(2007)
- Shanzhong Zhu, Wei Wang, and C. V. Ravishankar, "PERT: A New Power-Efficient Real-Time Packet-Delivery Scheme for Sensor Networks", International Journal of Sensor Networks, Vol3, no. 3(2008), to appear.
- Jinfeng Ni and Chinya V. Ravishankar, "Point-wise Dense Region Queries in Spatiotemporal Databases", Proc. 23rd International Conference on Data Engineering, Istanbul, Turkey, 2007, pp. 1066–1075.
- Li Zhou, Jinfeng Ni, and Chinya V. Ravishankar, "Supporting Secure Communication and Data Collection in Sensor Mobile Networks", Proc. INFOCOM'06, The 25th Annual IEEE Conference on Computer Communications, Barcelona, Spain, April 2006.
- Sandeep Gupta, Swastik Kopparty, and C.V. Ravishankar, "Roads, Codes, and Spatiotempora lQueries", Proc. SIGMOD-SIGACT Symposium on Principles of Database Systems, June 2004, Paris, France.
- Ming-Ling Lo and C. V. Ravishankar, "Spatial Hash-Joins", Proc. 1996 ACM SIGMOD International Conference on Management of Data, June 3–6, Montreal, Canada, pp. 247–258.
- Mingling Lo and C. V. Ravishankar, "Towards Eliminating Random I/O in Hash Joins", Proc. 12th IEEE International Conference on Data Engineering, February26–March1, 1996, New Orleans, LA, pp. 422–429.

Tamar T. Shinar

Education

Stanford University — Sept 2003 – Jun 2008
PhD, Scientific Computing and Computational Mathematics

University of Illinois at Urbana-Champaign — Sept 1995 – May 1998
BS, Mathematics, minor Computer Science

Iowa State University — Sept 1994 – May 1995
coursework in Physics, Chemistry, and Mathematics, concurrent with high school

Academic Experience

Jul 2011 - present	Amrik Singh Poonian Assistant Professor, Computer Science & Engineering, University of California, Riverside
Sept 2008 - Jun 2011	Postdoctoral Fellow, Courant Institute of Mathematical Sciences, New York University
Jun 2008 - Aug 2008	Research Assistant for Prof. Joseph Teran, Department of Mathematics, University of California, Los Angeles
Jan 2005 - Jun 2008	Research Assistant for Prof. Ronald Fedkiw, Department of Computer Science, Stanford University
Sept 2004 - Dec 2004	Research Assistant for Prof. Gene Golub, Department of Computer Science, Stanford University
Spring 2005/2006	Teaching Assistant, Numerical Solutions of PDE, Stanford University
Apr 1997 - Jul 1998	Research Assistant for Prof. David Wilkins, Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign

Non-Academic Experience

Apr 2008 - Jun 2008	Consultant, SimQuest, http://www.simquest.com
Nov 1999 - Aug 2003	Derivatives Technology Team Member, KBC Financial Products
Aug 1998 - Nov 1999	Derivatives Technology Team Member, D. E. Shaw & Co.

Professional Affiliation

2009 - present	American Physical Society
2009 - present	Genetics Society of America
2006 - present	ACM SIGGRAPH

Service Activities

Fall 2011 – present	Celebration of Women in Computing Liaison, Riverside, CA
Fall 2011 – present	Capstone Senior Engineering Project Mentor, Martin Luther King High School, Riverside, CA
Spring 2011	Team Mentor, Technovation Challenge, Iridescent Learning, New York, NY http://iridescentlearning.org/programs/technovation-challenge

Summer 2008 Academic Mentor, Research in Industrial Projects for Students, Institute for Pure and Applied Mathematics (IPAM), UCLA
http://www.ipam.ucla.edu/programs/rips2009/facultymentor.aspx

Referee Journal of Computational Physics, Journal of Scientific Computing, Computer Methods in Applied Mechanics and Engineering, ACM SIGGRAPH, Eurographics, Pacific Graphics

Publications

Shinar, T., Mana, M., Piano, F. and Shelley, M., A model of cytoplasmically-driven microtubule-based motion in the single-celled C. elegans embryo, Proceedings of the National Academy of Science, vol. 108 no. 26 pp. 10508-10513 (2011).

Robinson-Mosher, A., Shinar, T. and Fedkiw, R., Two-way coupling of fluids to rigid and deformable solids and shells, SIGGRAPH 2008, ACM TOG 27, pp. 46.1-46.9 (2008).

Shinar, T., Schroeder, C. and Fedkiw, R., Two-way coupling of rigid and deformable bodies, Proceedings of the 2008 ACM SIGGRAPH/Eurographics Symposium on Computer Animation, edited by D. James and M. Gross, pp. 95-103 (2008).

Hong, J.-M., Shinar, T. and Fedkiw, R., Wrinkled flames and cellular patterns, SIGGRAPH 2007, ACM TOG 26, 47.1-47.6 (2007).

Recent Invited Talks

Nov 2011 Aerospace and Mechanical Engineering Seminar, University of Southern California

Nov 2011 Computer Science & Engineering Colloquium, University of California, Riverside

Oct 2011 Mechanical Engineering Colloquium, UC Riverside

Mar 2011 Applied Mechanics Colloquium, SEAS, Harvard University

Feb 2011 Fluid Mechanics Seminar, New Jersey Institute of Technology

Feb 2011 Mechanical Engineering seminar, University of California, Merced

Feb 2011 Computer Science & Engineering Colloquium, University of California, Riverside

Professional Development Activities

Feb 2012 The dynamics of elastic biostructures in complex fluids, 2012 NSF-FRG Workshop, New York University, New York, NY

Jan 2012 Grant Writers Seminar Workshop, University of California, Riverside, CA

Jul 2011 Hydrodynamics, Boulder School for Condensed Matter and Materials Physics, University of Colorado, Boulder, CO

Nov 2010 The dynamics of elastic biostructures in complex fluids, 2010 NSF-FRG Workshop, Tulane University, New Orleans, LA

Mar 2010 Evolutionary perspectives on mechanisms of cellular organization, Kavli Institute for Theoretical Physics (KITP), UC Santa Barbara, CA

Christian R. Shelton

Education

Massachusetts Institute of Technology 1998–2001
PhD, Computer Science
Massachusetts Institute of Technology 1996–1998
SM, Computer Science
Stanford University 1993–1996
BS, Computer Science (with honors)

Research Positions

University of California, Riverside, Associate Professor 2010–present
Department of Computer Science and Engineering
University of California, Riverside, Assistant Professor 2003–2010
Department of Computer Science and Engineering
Intel, Visiting Faculty 2003–2004
Applications of machine learning to microprocessor fabrication
Stanford University, Research Associate 2001–2003
Reinforcement learning, game theory, stochastic processes
AT&T Research, Internship 1999–2000
Reinforcement learning in multi-agent systems

Professional Associations

Honors Societies
Tau Beta Pi
Phi Beta Kappa

Honors and Awards

Airforce Young Investigator Award (2006)
DARPA Computer Science Study Group (2009)

External Service Activities

Editorial Board 2009 – present
Journal of Artificial Intelligence Research (JAIR)
Managing Editor 2003 – 2008
Journal of Machine Learning Research (JMLR)
Conference Senior PC Member:
• Uncertainty in Artificial Intelligence (UAI): 2011, 2012
Conference PC Member:
• International Joint Conferences on Artificial Intelligence (IJCAI): 2007, 2009
• International Conference on Machine Learning (ICML): 2006, 2007, 2008, 2010
• Conference on Artificial Intelligence (AAAI): 2008
• Uncertainty in Artificial Intelligence (UAI): 2003, 2005, 2006, 2007
• International Conference on Knowledge Discovery and Data Mining (KDD): 2006, 2007

Internal Service Activities

Department Graduate Admissions	2009 – present
College Executive Council	2009 – 2011
Campus Preparatory Education Committee	2009 – present
Campus Non-Senate Faculty Review Committee	2011 – present

Recent Publications

Journals

Jing Xu and Christian R. Shelton. Intrusion detection using continuous time Bayesian networks. Journal of Artificial Intelligence Research, 39, 745–774, 2010.

Yu Fan, Jing Xu, and Christian R. Shelton. Importance sampling for continuous time Bayesian networks. Journal of Machine Learning Research, 11(Aug), 2077–2102, 2010.

Christian R. Shelton, Yu Fan, William Lam, Joon Lee, and Jing Xu. Continuous time Bayesian network reasoning and learning engine. Journal of Machine Learning Research, 11(Mar), 1137–1140, 2010.

Adriano Macchietto, Victor Zordan, and Christian R. Shelton. Momentum control for balance. ACM Transactions on Graphics / SIGGRAPH, 28(3), 2009.

Refereed Conferences

Zhen Qin and Christian R. Shelton. Socially-Aware Multi-target Tracking. In IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2012.

E. Busra Celikkaya, Christian R. Shelton, andWilliam Lam. Factored Filtering of Continuous-Time Systems. In Proceedings of the Twenty-Seventh International Conference on Uncertainty in Artificial Intelligence (UAI), 2011.

Antony Lam, Amit K. Roy-Chowdury, and Christian R. Shelton. Interactive event search through transfer learning. In Proceedings of the Tenth Asian Conference on Computer Vision (ACCV), 2010.

Yu Fan and Christian R. Shelton. Learning continuous-time social network dynamics. In Proceedings of the Twenty-Fifth International Conference on Uncertainty in Artificial Intelligence
(UAI), 2009.

Kin Fai Kan and Christian R. Shelton. Catenary support vector machines. In Knowledge Discovery in Databases (ECML/PKDD) (LNAI, vol 5211), pages 597–610, 2008.

Jing Xu and Christian R. Shelton. Continuous time Bayesian networks for host level network intrusion detection. In Knowledge Discovery in Databases (ECML/PKDD) (LNAI, vol 5212), pages 613–627, 2008.

Sheldon Tan

Education
Ph.D., Electrical Engineering, University of Iowa, 1999
M.S., Electronic Engineering, Fudan University, China, 1995
B.S., Electronic Engineering, Fudan University, China, 1992

Academic Experience
Assistant Professor, III, 7/1/2002
Assistant Professor, IV, 7/1/2004
Associate Professor, I, 7/1/2006
Associate Professor, III, 71/2008
Full Professor, II, 7/1/2010

Non-Academic Experience
Member of Technical Staffs, Altera Corporation, San Jose, CA. 01/01 – 007/02.
Member of Technical Staffs, Monterey Design Systems, Sunnyvale, CA. 08/99 --01/01.
Visiting Research Assistant, University of Washington, Seattle, WA. 09/98 – 05/99.
Summer Intern, Avant! Corp. (now Synposys), Fremont, CA. 05/98 – 09/99.
Summer Intern, Rockwell Semiconductor Systems, Newport Beach, CA. 07/97 – 09/97.
Research Assistant, University of Iowa, IA. 09/96 – 09/98.
Member of Faculty, Fudan University, Shanghai, China. 07/95 – 08/96.

Current Memberships in Professional Organizations
Senior member of IEEE

Honors and Awards
Best Paper Award Nomination, 46th IEEE/ACM Design Automation Conference, Anaheim, CA, 2009.
Outstanding Oversea Investigator Collaboration Award, National Natural Science Foundation of China (NSFC), 2008.
COR (committee on research) Research Fellowship, UC Riverside, 2008.
Best Paper Award, IEEE Int. Conf. on Computer Design (ICCD), Lake Tahoe, CA, 2007
Best Paper Award Nomination, 42th IEEE/ACM Design Automation Conference, Anaheim, CA, 2005.
NSF CAREER Award, 2005.
UC Regent's Faculty Fellowship, 04-05, 06-07.
Best Paper Award, 36th IEEE/ACM Design Automation Conference, New Orleans, LA, 1999.
First Place Poster Award (Ph.D. Dissertation), The Annual Conference of the Center for Design of Analog-Digital Integrated Circuits (CDADIC), Seattle, WA, 1999.

Service Activities
Ad Hoc Committees (July, 2006 to present)
UCR EE Undergraduate Committee, Member (July 2007 to present)

BCOE, Computer Engineering Program Committee, **Co-Chair**, (Jan. 2008 – June, 2009).
UCR Campus-level Senate Committee on Committee, **member**, (July 2009 to June 2012)
UCR EE, Committee on External Relations and Development, member (July 2009 – present)
BCOE, Computer Engineering Program, **Associate Director** and **Undergraduate Advisor** (July, 2009 – present)
UCR EE, Faculty Search Committee, **Chair**, (July 2010 to June 2011)
UCR EE, Colloquium Organizer and Host, (Jan, 2011 to June 2011)

Editorial Board

- ACM Transaction on Design Automation of Electronic Systems (TODAE), Associate Editor, 2009 - 2012
- Integration, the VLSI Journal, Associate Editor, 2008 –
- Journal of VLSI Design, Associate Editor, 2006 – 2011

Technical Program Committee Members

- IEEE/ACM Design Automation Conference, (DAC), 2011
- IEEE International Conference on Computer-Aided Design (ICCAD), 2006-2007
- IEEE/ACM Asia and South Pacific-Design Automation Conference (ASPDAC), 2005-2009, 2012
- IEEE International Behavioral Modeling and Simulation Conference (BMAS), 2005-2006
- IEEE International Symposium on Quality Electronic Design, (ISQED), 2006-2010.
- IEEE International Conference on Computer Design (ICCD), 2010.

Selected Publications, Past 5 Years

Ruijing Shi, Sheldon X.-D. Tan and Hao Yu, Statistical Performance Analysis and Modeling Techniques for Nanometer VLSI Designs, Springer Publishing 2012。
D. Li, S. X.-D. Tan, E. H. Pacheco, M. Tirumala, "Parameterized architecture-level thermal modeling for multi-core microprocessors", ACM Transaction on Design Automation of Electronic Systems (TODAES), vol. 15, no. 2, pp.1-22, February 2010 (one of top 10 downloaded ACM TODAES Articles published in 2010).
B. Yan, S. X.-D. Tan, L. Zhou, J. Chen, R. Shen, "Decentralized and passive model order reduction of linear networks with massive ports", IEEE Transactions on Very Large Scale Integrated Systems (TVLSI), 10.1109/TVLSI.2011.2126612.
See http://www.ee.ucr.edu/~stan/publication_list.html for complete publication list.

Selected Professional Development Activities

UC Export Control training in 2011.

Vassilis J. Tsotras

Education

Ph.D. (1991), M.Phil. (1988), M.Sc. (1986), Columbia University, NY.
Diploma (1985), National Technical University of Athens, Greece.

Academic Experience

[7/2001 - present]: Professor, Dept. of Computer Science and Engineering, University of California, Riverside, CA.

[10/1997 - 6/2001]: Associate Professor, Dept. of Computer Science and Engineering, University of California, Riverside, CA.

[9/ 1996 - 5/1997]: Associate Professor, Dept. of Computer and Information Science, Polytechnic University, Brooklyn, NY.

[9/1990 - 8/1996]: Assistant Professor, Dept. of Computer and Information Science, Polytechnic University, Brooklyn, NY.

Awards and Honors

Research Initiation Award: National Science Foundation, 1991.
Teaching Excellence Award: College of Engineering, UC-Riverside, 1999-00.
Keynote Speaker: 10^{th} Int'l Symposium on Spatial and Temporal Databases (SSTD),Boston, MA, 2007
7^{th} Int'l ACM Workshop on Data Engineering for Wireless and Mobile Access (MobiDE), Vancouver, Canada, 2008
2010 GIS Week, ESRI, Redlands, February 2010.

Service Activities

Co-Editor in Chief: International Journal of Cooperative Information Systems, since 2008.
Associate Editor: The VLDB Journal, 2003 - 2009.
IEEE Transactions on Knowledge and Data Engineering, 2002 -2007.
IEEE Data Engineering Bulletin, 2008 – 2010.

General Co-Chair: 26th IEEE International Conference on Data Engineering (ICDE 2010).
PC-Co-Chair (DB Track): 15th Conference on Information and Knowledge Management (CIKM), Arlington, VA, 2006.
PC-Co-Chair: 5^{th} Workshop on Multimedia Information Systems (MIS), Indian Wells, CA 1999.
General Chair: 7^{th} Symp. Spatial and Temporal Databases (SSTD), Redondo Beach, CA, 2001.

Recent Publications

M. Rice, V.J. Tsotras: "Graph Indexing of Road Networks for Shortest Path Queries with Label Restrictions", Proceedings of VLDB Endowment, Vol. 4, No. 2, pp. 69-80, 2010.

M. Vieira, P. Bakalov, V.J. Tsotras: "Querying Trajectories Using Flexible Patterns", Proc. EDBT Conference, March 2010, Lausanne, Switzerland.

P. Bakalov, E. Hoel, W-L. Heng, S. Menon, V.J. Tsotras: "Editing and versioning for high performance network models in a multiuser environment", GeoInformatica Journal, Vol 15, No. 4, pp 769-803, 2011.

P. Bakalov, V.J. Tsotras: "A Generic Framework for Continuous Motion Pattern Query Evaluation", Proc. of the 24th ICDE Conference, April 2008, Cancun, Mexico.

P. Bakalov, E. Hoel, W.L. Heng, V.J. Tsotras: "Maintaining Connectivity in Dynamic Multimodal Network Models", Proc. of the 24th ICDE Conference, April 2008, Cancun, Mexico.
M. Vieira, H. Razente, M. Nardini Barioni, M. Hadjieleftheriou, D. Srivastava, C. Traina Jr., V.J. Tsotras: "On query result diversification", Proc. of the 27th ICDE Conference, April 2011, Hannover, Germany.
R. Moussalli, M. Salloum, W. Najjar, V.J. Tsotras: "Massively Parallel XML Twig Filtering Using Dynamic Programming on FPGAs", Proc. of the 27th ICDE Conference, April 2011, Hannover, Germany.
A. Mitra, M. Vieira, P. Bakalov, W. Najjar, V.J. Tsotras: "Boosting XML filtering through a scalable FPGA-based architecture", Proc. of the 4th biennial Conference on Innovative Data Systems Research (CIDR), January 2009, Asilomar, CA.
M. Moro, P. Bakalov, V.J. Tsotras: "Early Profile Pruning on XML-aware Publish/Subscribe Systems". Proc. of the 33rd VLDB Conference, Sept. 2007, Vienna, Austria.
D. Zhang, A. Markowetz, V.J. Tsotras, D. Gunopulos, B. Seeger: "On computing temporal aggregates with range predicates", ACM Transactions on Database Systems, Vol.33, No. 2, 2008.

BOOK

Advanced Database Indexing, by Y. Manolopoulos, Y. Theodoridis and V.J. Tsotras. Kluwer International Series on Advances in Database Systems, Kluwer Academic Publishers, Boston, ISBN 0-7923-7716-8, November 1999, 312 pp.

Frank N. Vahid

Education

Ph.D. 1994, Information and Computer Science, University of California, Irvine
M.S. 1990, Information and Computer Science, University of California, Irvine
B.S. 1988, Electrical and Computer Engineering, University of Illinois, Urbana

Academic experience

Assistant Professor 1994-1999, Associate Professor 1999-2003, Professor 2003-present, Department of Computer Science and Engineering, University of California, Riverside.
Research Assistant / Lecturer, 1988-1994 (Lecturer 1993), University of California, Irvine.

Non-academic experience

Consultant: Altera (2011-present), Allflex (2009-2010), Atmel (2008-2009), Pulmonetics/Cardinal Health (2002-2004), NEC (1998-2002), Motorola (1998), San Bernardino County Superintendent (1997).
Engineer, Research and Development, June 1989-Sept. 1989, Hewlett Packard, Santa Clara, CA.
Engineer, Research and Development, May 1987-Sept. 1987, AMCC, San Diego, CA.

Certifications / professional registrations

None

Current membership in professional organizations

Senior member IEEE, member ACM.

Honors and awards

Outstanding Teacher of the UCR College of Engineering award in 1997 and the College's Teaching Excellence Award in 2003. SRC Fellow 1990-1994. Best paper award from IEEE Transactions on VLSI in 2000, DATE conference best paper award.

Service activities

Chair of the Faculty of Engineering at UCR (2008-2010). Program/General chair of Int. Symp. on System Synthesis (1996/1997) and Int. Symp. on Hardware/Software Codesign (1999/2000). Member of numerous technical program committees annually for over 15 years, including DAC, ICCAD, DATE, MICRO, FPGA, ISSS/CODES, CASES, FPL, and more.

Recent Publications

- B. Miller, F. Vahid, T. Givargis. Digital Mockups for the Testing of a Medical Ventilator, ACM SIGHIT Symposium on International Health Informatics (IHI), 2012, pp. 859-862. pdf
- Edgcomb, F. Vahid. MNFL: The Monitoring and Notification Flow Language for Assistive Monitoring, ACM SIGHIT International Health Informatics Symposium (IHI), 2012, pp. 191-200.
- G. Stitt and F. Vahid. Thread Warping: Dynamic and Transparent Synthesis of Thread Accelerators ACM Trans. on Design Automation of Electronic Systems (TODAES), Vol 16, Issue 3, June 2011, 21 pages.

- S. Sirowy, C. Huang, and F. Vahid. Online SystemC Emulation Acceleration. IEEE/ACM Design Automation Conference, June 2010.
- F. Vahid, G. Stitt, and R. Lysecky. Warp Processing: Dynamic Translation of Binaries to FPGA Circuits . IEEE Computer, Vol. 41, No. 7, July 2008, pp. 40-46.
- G. Stitt and F. Vahid. Binary Synthesis. ACM Transactions on Design Automation of Electronic Systems (TODAES), Vol. 12 No. 3, Aug 2007.
- Textbook: "Digital Design," F. Vahid, John Wiley and Sons, 1st ed 2005, 2nd ed 2011.
- Textbook: "Programming Embedded Systems: An Introduction to Time-Oriented Programming", F. Vahid and T. Givargis, UniWorld Publishing, 2011.

Professional development activities
Part of UC's online education pilot project.

Neal E. Young

Education

Ph.D. Computer Science, Princeton	1991
B.A. Computer Science and Mathematics, Cornell	1986

Academic Experience

Professor, Computer Science, University of California Riverside	4/2010-present
Associate Professor, Computer Science, University of California Riverside	1/2004-3/2010
Senior Research Scientist/Network Architect, Consultant, Akamai Technologies	9/1999-12/2004
Assistant Professor, Computer Science, Dartmouth	9/1995-3/2001
Postdoc, AT&T Bell Labs	9/1994-9/1995
Postdoc, Operations Research and Industrial Engineering, Cornell	1/1994-8/1994
Consultant, Astrophysics Department, Princeton and Fermilabs, Chicago	9/1993-1/1997
Instructor, Computer Science, Princeton	9/1993-1/1994
Postdoc, UMIACS, University of Maryland	9/1991-8/1993
Visitor, Indian Institute of Technology, New Delhi, India	12/1991-1/1992
Research Intern, DEC (now HP) Systems Research Center, Palo Alto, California	summer 1988
Instructor, Center for Talented Youth, Johns Hopkins	summers 1985-1987
Programmer, Robotics Project, Computer Science, Cornell University	summers 1984-1985
Programmer, Cornell Programming Environment Project, Computer Science	1/1983-8/1983
Programmer, Wintek Corporation, Lafayette, Indiana	9/1981-9/1982

Program Committees

2010 Scandinavian Symposium and Workshops on Algorithm Theory (SWAT)
2010 Integer Programming and Combinatorial Optimization (IPCO)
2009 Workshop on Approximation and Online Algorithms (WAOA)
2006 Foundations of Software Technology and Theoretical Computer Science (FSTTCS)
2006 ACM-SIAM Symposium on Discrete Algorithms (SODA)
2004 Approximation Algorithms for Combinatorial Optimization Problems (APPROX)
2004 Randomization and Computation (RANDOM)

Refereeing

ACM J. Experimental Algorithmics, ACM Transactions on Networking, Algorithmica, J. Algorithms, Artificial Intelligence,Cambridge Univ. Press, J. Computer System Sciences, Discrete Applied Mathematics, Distributed Computing, J. Graph Algorithms and Applications, Information and Computation, Information Sciences, Information Processing Letters, INFORMS J. Computing, Mathematical Programming, Mathematica Slovaca, Mathematics of Operations Research, National Science Foundation (CISE), Networks, Operations Research, SIAM J. Optimization, SIAM J. Computing, SIAM J. Discrete Mathematics, SIAM J. Optimization, Theoretical Computer Science, Theory of Computing,Transactions on Algorithms
ACM Symp. on Theory of Computing (STOC), ACM-SIAM Symp. on Discrete Algorithms (SODA), ACM Symposium on Parallel Algorithms and Architectures (SPAA), ACM Symposium on Principles of Distributed Computing (PODC),European Symposium on Algorithms (ESA), International Colloq. on Automata, Languages, and Programming (ICALP), International Symposium on Algorithms and Computation (ISAAC), IEEE Symp. on

Foundations of Computer Science (FOCS), The International Computing and Combinatorics Conference (COCOON), International Symposium on Parallel Architectures

Selected Publications

- On a linear program for minimum-weight triangulation, ACM-SIAM Symposium on Discrete Algorithms with Arman Yousefi 2012

- Greedy Δ-approximation algorithm for covering with arbitrary constraints and submodular cost Algorithmica:(2012); ICALP'09 with Christos Koufogiannakis Journal version of [2009]. 2012

- Distributed algorithms for covering, packing and maximum weighted matching Distributed Computing 24(1):45-63(2011); PODC'09, DISC'09 with Christos Koufogiannakis 2011

- Beating simplex for fractional packing and covering linear programs IEEE Symposium on Foundations of Computer Science with Christos Koufogiannakis 2007

- Rounding algorithms for a geometric embedding of minimum multiway cut Mathematics of Operations Research 29(3):0436-0461(2004); STOC'99 with David Karger, Philip Klein, Cliff Stein and Mikkel Thorup Journal version of [1999]. 2004

- On-line, end-to-end congestion control IEEE Symposium on Foundations of Computer Science with Naveen Garg 2002

- Sequential and parallel algorithms for mixed packing and covering IEEE Symposium on Foundations of Computer Science 2001

- On the number of iterations for Dantzig-Wolfe optimization and packing-covering approximation algorithms Integer Programming and Combinatorial Optimization (IPCO'99) (LNCS 1610:320-327) with Philip Klein 1999

- Data collection for the Sloan Digital Sky Survey: a network-flow heuristic Journal of Algorithms 27(2):339-356(1998); SODA'96 with Robert Lupton and Miller Maley Journal version of [1996]. 1998

- Randomized rounding without solving the linear program ACM-SIAM Symposium on Discrete Algorithms 1995

- The k-server dual and loose competitiveness for paging Algorithmica 11(6):525-541(1994); SODA'91 Journal version of [1991]. 1994

Qi Zhu

Education

Ph.D., Electrical Engineering and Computer Sciences, University of California, Berkeley, 2008
M.S., Electrical Engineering and Computer Sciences, University of California, Berkeley, 2006
B.E., Computer Science and Technology, Tsinghua University, 2003

Academic Experience

2011 – Present, Assistant Professor III, Department of Electrical Engineering, University of California, Riverside

Non-Academic Experience

2008 – 2011, Research Scientist, Strategic CAD Laboratories, Intel Corporation

Current Memberships in Professional Organizations

Member, Institute of Electrical and Electronics Engineers (IEEE)
Member, Association for Computing Machinery (ACM)

Honors and Awards

Design Automation Conference Best Paper Award, 2007, 2006
Pao Family Fellowship from University of California, Berkeley, 2003

Service Activities

Graduate Committee, Department of Electrical Engineering, UCR, 2011 – 2012
Technical Program Committee, IEEE/ACM Design Automation Conference (DAC), 2012
Technical Program Committee, IEEE International Conference on Parallel and Distributed System (ICPADS), 2012
Technical Program Committee, IEEE Real-time and Embedded Technology and Applications Symposium (RTAS), 2012
Technical Program Committee, IEEE/ACM International Conference on Formal Methods and Models for Codesign (MemoCODE), 2012
Technical Program Committee, IEEE International Symposium on VLSI Design, Automation and Test (VLSI-DAT), 2010 – 2012
Technical Program Committee, IEEE International Conference on Embedded Software and Systems (ICESS), 2011

Selected Publications, Past 5 Years

1. Qi Zhu, Yang Yang, Marco Di Natale, Eelco Scholte and Alberto Sangiovanni-Vincentelli, "Optimizing the Software Architecture for Extensibility in Hard Real-Time Distributed Systems", *IEEE Transactions on Industrial Informatics (TII)*, Vol. 6, No. 4, pp. 621-636, November, 2010.

2. Qi Zhu, Nathan Kitchen, Andreas Kuehlmann and Alberto Sangiovanni-Vincentelli, "SAT Sweeping with Local Observability Don't-Cares", in *Advanced Techniques in Logic Synthesis, Optimizations and Applications*, Sunil P. Khatri and Kanupriya Gulati, Editors, Springer, 2010.
3. Yang Yang, Alessandro Pinto, Alberto Sangiovanni-Vincentelli and Qi Zhu, "A Design Flow for Building Automation and Control Systems", *31st IEEE Real-Time Systems Symposium (RTSS'10)*, San Diego, CA, December, 2010.
4. Qi Zhu, Yang Yang, Eelco Scholte, Marco Di Natale and Alberto Sangiovanni-Vincentelli, "Optimizing Extensibility in Hard Real-time Distributed Systems", *15th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS'09*), San Francisco, CA, April, 2009.
5. Qi Zhu, Abhijit Davare and Alberto Sangiovanni-Vincentelli, "A Formal Approach for Optimizing Mapping in System Level Design", *TECHCON 2008*, Austin, TX, November, 2008.
6. Wei Zheng, Qi Zhu, Marco Di Natale and Alberto Sangiovanni-Vincentelli, "Definition of Task Allocation and Priority Assignment in Hard Real-Time Distributed Systems", *28th IEEE Real-Time Systems Symposium (RTSS'07)*, Tucson, Arizona, December, 2007.
7. Abhijit Davare, Qi Zhu, Marco Di Natale, Claudio Pinello, Sri Kanajan and Alberto Sangiovanni-Vincentelli, "Period Optimization for Hard Real-time Distributed Automotive Systems", *44th IEEE/ACM Design Automation Conference (DAC'07)*, San Diego, California, June, 2007. (Best Paper Award)

Thomas F. Stahovich
Professor

Education

- Ph.D., Mechanical Engineering, Massachusetts Institute of Technology, 1995
- S.M., Mechanical Engineering, Massachusetts Institute of Technology, 1990
- B.S., Mechanical Engineering, University of California, Berkeley, 1988

Academic Experience

- 2010-present. Professor, Department of Mechanical Engineering, UCR
- 2003-2010 Associate Professor, Department of Mechanical Engineering, UCR
- 2001-2003 Associate Professor, Department of Mechanical Engineering, Carnegie Mellon University.
- 1996-2001 Assistant Professor, Department of Mechanical Engineering, Carnegie Mellon University.

Non-Academic Experience

- 1986 – 1988 (summers), North American Rockwell, Mechanical Engineer.
- 1997 (June – September). Boeing North American, helped plan and implement the Pathfinder 6 project to incorporate knowledge-based software tools into the design, analysis, and manufacturing processes.
- 2009 – 2010 ***Decision Modeling, Inc. v. Timevalue Software,*** Inc. Expert witness for defendant.

Current Memberships in Professional Organizations

ASME, ASEE, AAAI

Recent Honors and Awards

- "Design and Evaluation of a Pen-Based Tutoring System for Statics Instruction," National Science Foundation, $394,000, PI, May 2008.
- "Enhancing Learning in Engineering with Pen-Based Tutoring Systems," HP, $75,000, PI, 2008.
- "Transforming Statics Instruction through the Creation and Evaluation of Efficient and Effective Practice Experiences," National Science Foundation, $399,695, PI 2009.

Service Activities

Internal (at UCR)

- Chair, Mechanical Engineering Department 2010 – present.
- Subcommittee on Excellence in Undergraduate Education (UCR Path to Preeminence Plan) 2009 – 2010.
- Chair, ME Undergraduate Committee, 2008 – 2010.
- ME Undergraduate Advisor, 2008 – 2010.

- Bourns College of Engineering Executive Committee 2006 – 2009
- Vice-Chair, Bourns College of Eng. Executive Committee 2006 – 2008
- ME Undergraduate Committee, 2007 – 2008.
- ME Faculty Search Committee, 2007 – 2008.
- Faculty Search Committee, Anderson Graduate School of Management, 2007 – 2008

External

- Chair, "Sketch Understanding," AAAI Spring Symposium Series, March 2002, Stanford, CA.
- Co-Chair, "Making Pen-Based Interaction Natural and Intelligent," AAAI Fall Symposium Series, 2004.
- Program Co-chair, Eurographics Workshop on Sketch-Based Interfaces & Modeling, Vienna, Austria, 2006.
- General Chair, Eurographics Workshop on Sketch-Based Interfaces & Modeling, Riverside, CA, 2007.
- NSF site visit team for Network for Earthquake Engineering Simulation (NEES) 2010 – present.
- Member Board of Advisors, NSF Spatial Intelligence and Learning Center (SILC) 2011 – present.

Selected Publications, Past 5 Years

Journal Publications

1. Lee, W., de Silva, R., Peterson, E., Calfee, R., and Stahovich, T., "Newton's Pen: A pen-based tutoring system for statics. *Computers & Graphics* 32(5): 511-524, 2008.
2. Kara, L., Gennari, L., and Stahovich, T., "A Sketch-Based Tool for Analyzing Vibratory Mechanical Systems," *J. Mechanical Design* 130(10), 2008.
3. Calfee, R. and Stahovich T., "Galloway's 21st Century Engineer: An Essay Review," *Education Review*, 12(14), 2009.
4. Herold, J. and Stahovich, T. F., "SpeedSeg: A Technique for Segmenting Pen Strokes Using Pen Speed," *Computers & Graphics,*35(2):250-264, 2009.
5. Herold, J. and Stahovich, T.F., "The use of speech to identify gestures in multi-modal collaborative design," *AI EDAM, 2011.*

Conference Presentations & Proceedings

1. de Silva, R., Bischel, D., Lee, W., Peterson, E., Calfee, R. and Stahovich, T., "Kirchhoff's Pen: A Pen-based Circuit Analysis Tutor," In proceedings Fourth Eurographics Workshop on Sketch-Based Interfaces and Modeling, pp. 75-82, 2007.
2. Bischel, D., Stahovich, T., Peterson, E., Davis, R., and Adler, A., "Combining Speech and Sketch to Interpret Unconstrained Descriptions of Mechanical Devices," In Proceedings of the 2009 International Joint Conference on Artificial Intelligence, 2009.
3. J. Reaver, T. F. Stahovich, and J. Herold: How to make a Quick$: Using hierarchical clustering to improve efficiency of the dollar recognizer. In Proceedings of the 8th Eurographics workshop on Sketch-based Interfaces and Modeling, 2011.

Selected Professional Development Activities

- UC Export Control training, 2011

Victor B. Zordan

Education

1988-1992: B.S. magna cum laude, Mechanical Engineering, Boston University
1994-2002: Ph.D. in Computer Science, Georgia Institute of Technology

Academic Experience

2002 – 2009: Assistant Professor, Computer Science, University of California, Riverside
2009 – : Associate Professor, Computer Science, University of California, Riverside

Non-Academic Experience

1992 - 1993: Mechanical Engineer, Torrington Company, Torrington CT
1993 - 1994: High School Teacher, Shady Side Academy, Pittsburgh PA

Memberships

ACM - Association of Computing Machinery
ACM Siggraph - Special Interest Group Graphics
Tau Beta Pi Engineering Honor Society, Golden Key International Honor Society

Honors/Awards

Academy of Distinguished Teachers 2011
Regents Faculty Fellow 2008-2009
UCR Teaching Innovation Award 2008
UC Discovery Grant Recipient 2007
Omnibus Senate Grant Recipient 2007-2008
Office of Research Collaborative Seed Grant 2006-2007
Omnibus Senate Grant Recipient 2003-2004

Service Activity

CONFERENCES/SYMPOSIUM

Conference co-Chair - ACM Siggraph/Eurographics Symposium on Computer Animation - 2005

Steering Committee - ACM Siggraph/Eurographics Symposium on Computer Animation 2005-present, "Gathering Animated Lifelike Agents" GALA 2005

Program Committee - ACM Siggraph/Eurographics Symposium on Computer Animation 2006-2011

Reviewer - ACM Siggraph, Eurographics, Symposium Computer Animation, Graphics Interface, ACM Transactions on Graphics, IEEE Transactions on Visualization and Computer Graphics, ACM Symposium on Virtual Reality Software and Technology, ACM Siggraph Video Game Sandbox, Interactive 3D Graphics and Games, IEEE Transactions on Pattern Analysis and Machine Intelligence, Future Generation of Computer Systems, American Journal of Human Biology, Journal Artificial Intelligence Research

Retreat co-Organizer - Southern California Animation Retreat - organized and facilitated retreat for researchers, held at University of Southern California

GRANTING AGENCIES

Steering Committee - Industry-University of California Research in Digital Media

Proposal Reviewer - National Science Foundation, Industry-University of California Research Program, University of California Micro Grants

UNIVERSITY OUTREACH/EDUCATIONAL ACTIVITIES

Faculty Advisor - ACM, UCR Student Chapter 2004-2009,
Tau Beta Pi, Bourn's College of Engineering Student Chapter 2007-present
Mellon Workshop on Global Interface - co-Advisor 2005-2006
Mellon Workshop on Affect, Technics, and Ethics - co-Advisor 2006-2007
Mellon Workshop on Affect, Technics, and Ethics II - co-Advisor 2007-2008
Mellon Workshop on Affect, Technics, and Ethics III - co-Advisor 2008-2009

Steering Committee – Riverside Community College Video Game Program

Selected Publication

Zordan, V., Angular Momentum Control in Coordinated Behaviors, Third Annual International Conference on Motion in Games (MIG), 2010.

Wu, C.C., Zordan, V., Goal-Directed Stepping with Momentum Control, ACM SIGGRAPH/Eurographics Symposium on Computer Animation (SCA), 2010.

Nguyen, N., Wheatland, N., Brown, D., Parise, B., Liu, C. K., Zordan, V., Performance capture with physical interaction, ACM SIGGRAPH/Eurographics Symposium on Computer Animation (SCA), 2010.

Macchietto, A., Zordan, V., Shelton, C.R., Momentum Control for Balance, Transactions on Graphics/ACM SIGGRAPH 2009.

Ishigaki S., White T., Zordan V., Liu K.C., Performance-Based Control Interface for Character Animation, Transactions on Graphics/ACM SIGGRAPH 2009.

Wu, C.C., Medina, J. , Zordan, V., Simple Steps for Simply Stepping, International Symposium on Visual Computing (ISVC), 2008.

Zordan, V.B., Macchietto, A., Medina, J., Soriano, M., Wu C.C., Interactive Dynamic Response for Games, ACM SIGGRAPH Sandbox Symposium 2007.

Zordan, V. B., Majkowska, A., Chiu, B., Fast, M., Dynamic Response for Motion Capture Animation, Transactions on Graphics/ACM SIGGRAPH 2005.

Metoyer, R. A., Zordan, V. B., Hermens, B., Wu, C. C., Soriano, M., Psychologically inspired anticipation and dynamic response for impacts to the head and upper body, Transactions on Visual Computing and Graphics (TVCG) 2007.

Other Activities

Design and implement related curriculum for a games concentration, including work with digital artists and music composers – four lecture/lab courses, one senior design project, lead to teaching innovation award.

Created and coordinated a summer academy which is a professional certificate program for an eager and interested population in the local region. This academy had its first successful offering in 2011.

Note to ABET evaluators: Sharon Burton is not full time staff at UCR. But for the last 5 years she has co-taught ENGR 180: Technical Communications.

Sharon Burton

3055 Priscilla Street, Riverside CA 92506
951-202-0813 or 951-369-8590 *sharon@sharonburton.com*

Skills

Strong skills in: content strategy, content management, social media; technical communication, user-centered content development, social marketing campaigns, social media ROI, market research; project management and scheduling; classroom, virtual, and onsite training and training material development; content creation, technical writing, management, publishing, and workflow; product evangelism, public speaking
Computer skills: GoToWebinar/GoToMeeting, Microsoft Office, FrameMaker, MadCap Flare, RoboHelp, Author-it, Acrobat, Visio, HTML, CSS, Twitter, HootSuite, Google Analytics, online document and traditional book publishing
Education: PhD candidate in Cultural Anthropology, University of California, Riverside, ABD with emphasis on communities and economics; Bachelors of Science, Cultural Anthropology, University of California, Riverside, emphasis on communities and economics

Career Highlights

- Wrote *8 Steps to Amazing Webinars*, available on Amazon and bn.com
- Advised clients and customers on creating and implementing content development strategies
- Increased product leads and sales by creating successful free webinar series
- Leveraged social media to increase buzz for products and company
- Reduced support costs for consumer products by up to $500,000 a year
- Created products that improve life for the customer

Awards and Honors

- Identified as 18th most influential person about technical communication and content strategy by Mindtouch. Full list at http://www.mindtouch.com/blog/2012/01/06/techcomm-contentstrategy-400-knowledgebase/
- Inducted as an Associate Fellow of the Society for Technical Communication
- Awarded honors for manuals, websites, e-books, and online help

Experience

2011-present — **Content Strategist** Independent Consultant

- Support clients to select the right tools for unique workflows, including advising best practices to import/convert/use legacy content
- Identify and solve workflow issues
- Product training, including Flare, Author-it, and others
- Writing user documents for clients

2010 – 2011 — **Product Evangelist** Author-it, Auckland NZ

Created a series of highly successful educational webinars in a variety of content development topics, resulting in 1500 new leads, with a qualification rate of 30%.
Innovated social media to support branding and generate product buzz. For example, increased Twitter following from 60 to over 600. Created a product-specific LinkedIn group with over 300 users in 10 months. Wrote and directed marketing content, including website, blog, show collateral, and articles. Increased blog traffic by 400%.
Developed marketing campaigns, analyzed market trends, and directed the marketing message.
Ran product trainings, rewrote the training materials, and increased trainee satisfaction with the materials.

2009 – 2010 — **Technical Communication Consultant** Independent Contractor/Self-Employed

Consulting expert, including:

- Writing user documents for clients

- Product training
- Recommend cost-effective and custom workflows

Provide writing and content conversion support

2007-2009 **Product Manager/Product Evangelist** MadCap Software, La Jolla CA

Represented the company at industry events, including demonstrating products and soliciting customer response.

Supported the sales staff with presales activities, including online demos, travel to customer sites, and responding to RFPs.

Created a series of highly successful educational webinars in a variety of technical communication topics.

Analyzed industry trends, predicted product adoption rates, managed press relations, developed marketing campaigns, and drove products to meet market needs.

Innovated social media uses to support branding and generate product buzz.

2005-2007 **Manager, Technical Publications** Wonderware, Lake Forest CA

- Hired to improve quality of product documentation for industrial automation products, with the goal of supporting the user experience.
- Introduced and implemented writing standards and content strategy that reduced localization costs for product documents. Resulting documents eased simultaneous international product release bottleneck.
- Trained and managed 13 salaried and contract international writers for the 400+ product documents in the library.
- Established project planning, designed and administered user surveys, created and implemented documentation planning and process, and educated departments in the importance of product documentation. Increased user satisfaction by ~20%.

2003-2004 **Technical Writer** Safetran Systems, Rancho Cucamonga CA

- Wrote user and reference manuals for train signaling equipment.
- Developed online help for signals software and script-based standup training manuals.
- Designed customer surveys and, using the research data, led the Tech Pubs group in rewriting existing user documentation to be more task-based and less feature-based, while supporting the customer's needs and regulatory requirements.
- Helped the writers meet deadlines, supporting them in developing graphics, and generating solid PDF files for CD and web distribution.
- Moved Tech Pubs from Word to FrameMaker and WebWorks Publisher to more efficiently develop user documentation.

Additional Professional Activities

- Teach Technical Communication and Scientific Writing to undergraduate and graduate Engineering students at the University of California, Riverside (10 years)
- Teach Business Writing for the University of Redlands (one year)
- Teach working professionals advanced topics for the Society for Technical Communication (180 months)

Bonni Graham

Note to ABET evaluators: Bonni Graham is not full time staff at UCR. But for the last 5 years she has co-taught ENGR 180: Technical Communications.

Summary of qualifications

I am the Senior Manager, Marketing Communication - Commercial for Scantron Corporation, where I plan and develop marketing and social media strategy and tactics. Previously, I led a team that planned, developed, and maintained a complete suite of end-user documentation (user guides, help systems, job aids, training materials, etc.)

I owned and operated a technical documentation business from 1994 to 2009. Our core offerings included technical manual preparation for a variety of industries, policy and procedure documents, and online help and curriculum development deliverables.

I have lectured for two University of California campuses (Riverside and San Diego) since 2003. My instructor ratings are always high, and I receive emails from students regularly expressing how much they appreciate what they've learned from my classes.

As a speaker, I have always garnered the highest ratings from conference attendees; I was in the 90th percentile of speaker scores at LavaCon 2003-2009, WinWriters 2002 & 2008, InfoProducer 2001, InfoStrategies 2001, and each of the STC Annual Conferences where I have presented. STC chapters throughout California, and in Washington, Hawaii, Arizona, Texas, and India have rated me highly.

Professional experience

2012 - Present GlobalScholar/Scantron Corporation Bellevue, WA

Senior Manager, Marketing Communication - Commercial

Create market strategy and tactics for Scantron Commercial Group data capture and analysis products covering markets like employee safety, surveys, and government. Design and produce marketing collateral and sales support materials. Drive market thought leadership through our social media presence.

2005 – 2012 Scantron Corporation Irvine, CA

Senior Manager, User Experience & Documentation

Prepare end-user documents & training materials for Scantron products ranging from K-12 assessment & diagnostic tools to survey applications to OMR scanners; coach and train staff on proper documentation procedures and quality standards; determine working group strategy and planning.

2003 - Present University of California Riverside & San Diego, CA

Lecturer

Present curriculum material for both online and in-person classes on technical communication. Subjects covered: Intro to Technical Communication/Technical Communication I, Policies and Procedures, Critical Thinking for Technical Communicators, Webinar Skills for Technical Communicators, project Management for Technical Communicators, ENG180W: Technical Communication.

1994 - Present Manual Labour, Inc San Diego, CA

President/CEO

Determine business strategy, tactics, and direction for technical publications outsourcing; coach and train staff writers at all levels (from entry-level to senior, experienced staff); develop and deliver training in proprietary standard document development process and methodology for internal staff; prepare compelling sales and marketing materials; present service solutions to prospects and clients.

1993 - 1994 ENFIN Technology Labs San Diego, CA

Technical Writer

Prepare technical manuals, including: writing, editing, indexing, graphic development, audience analysis, usability testing of product and manuals.

1990 - 1993 Data Trek, Inc San Diego, CA

Technical Writer

Prepare technical manuals, including: writing, editing, indexing, graphic development, audience analysis, usability testing of product and manuals.

Additional professional activities: Articles & Presentations

Selected Articles published and presented

- *How to Build a Business Case*, co-authored with Jack Molisani, published in STC's Intercom, July/August 2008 issue
- *Building a Business Case: Demonstrating Added Value to Clients and Employers; How to Speak CEO: and Other Corporate Language Skills; Using Historical Data To Estimate, Bid, and Manage Documentation Projects*
  Presentation slides published 2003-2009 LavaCon, The International Conference on Technical Project Management, currently hosted on Manual Labour Inc's web site (http://www.manuallabour.com/symposia)
- *Corporate 101: Understanding the Role Technical Communicators Play in Business; Document to the Question: Understanding what users ask and where they look for the answers*
  Presentation slides published in the *Proceedings* for the 2003 STC India Chapter 5th Annual Conference
- *Identity Crisis; The Persona as a Tool for Creating and Evaluating Information Design*
  Presentation slides published 2002 WinWriter's Annual Conference, currently hosted on Manual Labour Inc.'s web site (http://www.manuallabour.com/symposia)
  Presented at approximately 7 STC chapter meetings and at the 2000 STC Annual Conference
- *Management by Leveraging Your Personality Flaws (presented as The Beast With Two Brains)*
  Presentation slides published 2001 InfoStrategies Conference Proceedings
  Presented under original title at approximate 5 STC chapter meetings

Additional professional activities: Awards

Professional and Honor Society Awards

- Harland Clarke Holding Company Pillar Award: Customer Focus
- Southern California STC Spotlight Competitions Award of Excellence for *Scantron Leadership Academy Handbook-*
- Southern California STC Spotlight Competitions Award of Excellence for *Scantron Achievement Series and Performance Series API Guide*
- Southern California STC Spotlight Competitions Award of Merit for *Class Climate CD case set*
- Harland Clarke Holding Company Idea Challenge, 2nd place in Scantron for *iForms: Electronic Scantron Test Forms for Mobile Devices*
- **Associate Fellow**, Society for Technical Communication
- Communications Concepts Award of Excellence in Training Manuals for *Item Development Training Manual*
- Communications Concepts Award of Excellence in Hardware & Software Manuals for *Achievement Series Job Aid set*
- Southern California STC Spotlight Competitions Award of Excellence for *Proctoring Performance Series Tests Documentation Set*

Professional memberships

- Associate Fellow, Society for Technical Communication (STC); served on Board of Directors as Director-Sponsor for Region 8 (representing CA, HI, NV, Australia, and New Zealand)
- Member, International Executive's Guild
- Senior Member, National Association for Female Executives

Education

University of California at San Diego

Bachelor of Arts Literature/Writing

University of California at Los Angeles (Extension)

Online Instructor Development Training (certificate of completion)

Victor Hill

Education
University of California, Riverside
BS, Computer Science, 1999

University of California, San Diego
BS, Chemical Engineering, 1996

Academic Experience
Lecturer
Department of Computer Science and Engineering (2000-present), part time

CS 183: UNIX System Administration: Topics include the technical aspects of system administration on UNIX systems, including managing system devices, operating systems, installation, configuration, management, communications, and networking.

CS 100: Software Construction (2007) Topics include design, coding layout and style, implementation strategies; quality attributes; prototyping, reuse, and components; debugging, testing, and performance; integration and maintenance; documentation; standards, analysis, and selection of tools and environment; and personal software processes.

Related Experience
Manager of Technical Operations
Department of Computer Science and Engineering(2000-present), full time

Designed, developed, and optimized the infrastructure for a wide range of UNIX and Windows systems and Cisco network equipment for the Department of Computer Science and Engineering. Improved the reliability and efficiency of these systems and related services at the same time the Department roughly tripled in number of faculty and students, at the same time staff and budgets were decreasing.

Application of advanced system administration and programming techniques including virtualization, automation, configuration management, and version control, leading to a full continuous integration and deployment architecture for Departmental business processes. Commodity hardware and open source software were used wherever possible to maximize performance while minimizing costs.

Completed system administration and software development projects for networking and systems research groups. Programming in Bash, Python, Ruby, and Perl; some projects in Java and PHP.

Professional Organizations
ACM
IEEE
LOPSA

SAGE
USENIX

Honors and awards

Staff of the year, Department of Computer Science and Engineering (2011).

Service Activities:

- Technical Advisory Group (TAG), Campus wide group for discussing broad reaching technical issues. UC Riverside
- Committee on Instruction: Department of Computer Science and Engineering, UC Riverside. Ex Officio Member.
- Facilities Committee. Department of Computer Science and Engineering, UC Riverside. Ex Officio Member.
- CS 193: Design project. Provided volunteer assistance to instructors for design project courses with elements of UNIX system administration and programming.
- CS 198-I: Internships in Computer Science: Provided internships to students with a career interest in Computer Science, focused on UNIX system administration and software development.
- ENGR 101-G, ENGR 101-I: Invited speaker on the topic of careers in system administration.

Professional Development

- Conferences: LISA, O'Reilly Emerging Technologies (2009), SCALE(2010), UC Cloud Summit (2011)

Co-hosted informal seminar at UCR on system administration and software development.

Kristen T. Miller

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Moreno Valley, CA 92551
Home: (951) 488-0532
Work: (951) 827-2604
kmiller@cs.ucr.edu

Education

B.S. (Cum Laude), 2001, Computer Science, University of California, Riverside.

Teaching and Research Experience

April 2003 – present: Lecturer, Computer Science & Engineering Department, University of California, Riverside. Classes taught include Embedded System Design, Intro to Computer Science for Science, Math, and Engineering majors, and Intro to Data Structures and Algorithms.

Jul 2004 – Sep 2004: Staff Research Associate, Computer Science & Engineering Department, University of California, Riverside. Developed and studied firm-core virtual fpgas for just-in-time fpga compilation.

2002 – 2003: Seminar Instructor, Computer Science & Engineering Department, University of California, Riverside. Taught C++ and VHDL programming for graduate students.

2001 – 2002: Teaching Assistant, Computer Science & Engineering Department, University of California, Riverside. Designed and supervised Embedded System Design and Computer Architecture labs.

2000 - 2001: Undergraduate Student Researcher, Embedded Systems Lab, Dr. Frank Vahid, University of California, Riverside.

2000: Reader/Lab Assistant, Computer Science & Engineering Department, University of California, Riverside.

Awards

Outstanding Lecturer Award, 2004-05, Bourns College of Engineering, University of California, Riverside

Relevant Coursework Completed

Machine Organization and Assembly Language Programming, Introduction to Data Structures and Algorithms, Logic Design, Introduction to Embedded Systems Design, Intermediate Embedded and Real-Time Systems, Advanced Embedded and Real-Time Systems, Intermediate Data Structures and Algorithms, The Theory of Automata and Formal Languages, Programming Language Concepts, Compiler Design, Design of Operating Systems, Design and Architecture of Computer Systems, Advanced Computer Architecture, Design and Analysis of Algorithms, Synthesis of Digital Systems.

University Activity and Public Service

- CSE Committee on Instruction – 2008 to present
- RUSD Science and Engineering Fair – Feb 2009/10/11/12 - Judge
- Scholarship of Teaching, Flex Classrooms – Apr 2007 – Panel Member
- Scholarship of Teaching, Academic Integrity – Apr 2006 – Panel Member
- Non-Senate Faculty Council on Professional Development – 2007/8 to 2010

Professional Memberships

- Associated for Computing Machinery

Appendix C – Equipment

Major pieces of equipment used by the program in support of instruction.

Equipment Managed by the Computer Science and Engineering Department

INSTRUMENT/MANUFACTURER	LABS		Quantity
AS-2042G-6RF/TRF SUPERMICRO SERVER	BOURNS	B260	1
6026T-NTR+/3RF SUPERMICRO SERVER	BOURNS	B260	5
MSDNAA – AVAILABLE TO ALL STUDENTS ENROLLED IN CSE COURSES by MICROSOFT - ALL TITLES EXCEPT OFFICE	CHUNG	106	N/A
SHI SOFTWARE; MICROSOFT TITLES - MS OFFICE, VISUAL STUDIO	CHUNG	106	N/A
6026T-NTR+/3RF SUPERMICRO SERVER	CHUNG	106	2
SuperServer 6013A-T SUPERMICRO SERVER	CHUNG	106	2
AS-2042G-6RF/TRF SUPERMICRO SERVER	CHUNG	106	1
TRANSPORT GX28 B2881 TYAN SERVER	CHUNG	106	6
PowerEdge1750 DELL SERVER	CHUNG	106	1
FAS250 NETWORK APPLIANCES SERVER	CHUNG	106	2
ASUS SERVER	CHUNG	106	3
OPTIPLEX GX620 DELL DESKTOP COMPUTERS	CHUNG	110	12
4250DTNSL HP PRINTER	CHUNG	110	1
fi-5120C FUJITSU SCANNER	CHUNG	110	1
i320 KODAK SCANNER	CHUNG	110	1
CanoScan LiDE 70 CANON SCANNER	CHUNG	110	1
OPTIPLEX GX620 DELL DESKTOP COMPUTERS	CHUNG	118	2
2012 AUTODESK ENTERTAINMENT CREATION SUITE (30 seat license)	CHUNG	127	N/A
PRECISION T3500 DELL DESKTOP COMPUTERS	CHUNG	127	33
4250DTNSL HP PRINTER	CHUNG	127	1
PRECISION T3500 DELL DESKTOP COMPUTERS	CHUNG	129	33
4250DTNSL HP PRINTER	CHUNG	129	1
PRECISION T3500 DELL DESKTOP COMPUTERS	CHUNG	132	32
4250DTNSL HP PRINTER	CHUNG	132	1
PRECISION T3500 DELL DESKTOP COMPUTERS	CHUNG	133	32
4250DTNSL HP PRINTER	CHUNG	133	1
PRECISION T3400 DELL DESKTOP COMPUTERS	CHUNG	135	33
4250DTNSL HP PRINTER	CHUNG	135	1
PRECISION T3500 DELL DESKTOP COMPUTERS	CHUNG	136	20
4250DTNSL HP PRINTER	CHUNG	136	1
PRECISION T3400 DELL DESKTOP COMPUTERS	CHUNG	226	32
4250DTNSL HP PRINTER	CHUNG	226	1
REMARK OFFICE OMR by GRAVIC SOFTWARE - MODEL 8	CHUNG	311	N/A
REMARK OFFICE OMR by GRAVIC SOFTWARE - MODEL 8	CHUNG	312	N/A
REMARK OFFICE OMR by GRAVIC SOFTWARE - MODEL 8	CHUNG	mobile	N/A

Equipment Managed by the Electrical Engineering Department

LOCATIONS: WINSTON CHUNG HALL 121, 125, 126, 128, 221

All EE lab computers (except WCH 126) run Windows 7 with the following software installed: Atmel AVR Studio, Cadence SPB, Codewarrior IDE, Digilent Adept, Hapsim, Matlab, Microchip MPLAB C32, Microchip MPLAB IDE, Microchip PICkit 2, MS Office, MS Visual Studio, Realterm, and Xilinx ISE Design Studio.

Additionally computing resources that support students are three *NIX computational servers that are available anytime for students. These computational servers have the following programs installed for instructional support: Mathematica 8, Matlab, Cadence IC 5141, Cadence IC 610, Sentaurus TCAD, Agilent ADS, Agilent EMPRO, Agilent ICCAP, and Synopsys HSPICE.

The EE Shop provides hands on support for tool use and equipment. The students receive further guidance on equipment use with equipment orientation documents and help from the TA. The students receive guidance on computing resources from the lab manuals.

EE maintains a schedule of approximate dates for lab equipment upgrades. Upgraded hardware must meet the minimum specifications for the courses/labs taught, software requirements, and hardware interaction. Software upgrades must work with the current labs being taught. Additionally, computers must meet the minimum hardware requirements as required by the software. Both hardware & software upgrades are done in a non-disruptive process. This usually occurs during summer before the beginning of the fall quarter.

WCH 121 (Instruction Lab: Available to students only during lab.)		
INSTRUMENT/MANUFACTURER - WCH 121	**LABS**	**QUANTITY**
19inch LCD monitors	WCH 121	16
Intel Core2 Duo E7200 @ 2.53 GHz w/ 4 GB RAM & 80 GB HD computers	WCH 121	16
HP 54600B Oscilloscope	WCH 121	16
HP 33120A Waveform Generator	WCH 121	16
HP E3630A Power Supply	WCH 121	16
HP 34401A Meter	WCH 121	16
WCH 125 (Instruction Lab. Available to students from 8am to 10 pm daily) Computers and Monitors upgraded in 2011		
Wch 125 also has 5 computers installed with an Nvidia Quadro 2000 graphics card. This card is used for an upper division EE Course in parallel computing. These computers include the following additonal software: Nvidia 3D Vision, Nvidia CUDA Toolkit & SDK, NVidia GPU Computing SDK, and NVidia Parallel Nsight.		
INSTRUMENT/MANUFACTURER - WCH 125	**LABS**	**QUANTITY**
21-23 inch LCD wide-screen monitors	WCH 125	30
Intel Core i5-2400 @ 3.10 GHz w/ 3 GB RAM and 250 GB HD	WCH 125	16
Intel Core i3-2100 @ 3.10 GHz w/ 3 GB RAM and 250 GB HD	WCH 125	14
NVidia Quadro 2000 PCI-X graphics cards (installed in 5 lab computers).	WCH 125	5

WCH 126 (Instruction Lab: Available to students only during lab and 24/7 for senior design.)		
Due to older hardware restrictions to support the ECP Model 205 Torsional Plants, WCH 126 computers run Windows XP with a smaller subset of the software mentioned above.		
INSTRUMENT/MANUFACTURER - WCH 126	**LABS**	**QUANTITY**
17inch LCD monitors, Pentium 4 3.0GHz CPU, 512MB RAM, 40 GB HD computers	WCH 126	16
Tektronix TDS420A Oscilloscope	WCH 126	16
A15:E27HP 33120A Waveform Generator	WCH 126	16
INSTRUMENT/MANUFACTURER - WCH 126 (con't…)	**LABS**	**QUANTITY**
Power Supply	WCH 126	16
Fluke 45 Meter	WCH 126	16
ECP Model 205 Torsional Plants	WCH 126	12
ECP Model 205 ISA computer control cards	WCH 126	9
ECP Model 205 PCI computer control card	WCH 126	1
WCH 128 (Instruction Lab: Available to students only during lab.) Computers and Monitors upgraded in 2011		
INSTRUMENT/MANUFACTURER - WCH 128	**LABS**	**QUANTITY**
21inch LCD monitors	WCH 128	16
Intel Core 2 Duo E6750 @ 2.66 GHz w/ 2 GB RAM & 80 GB HD computers	WCH 128	16
Agilent DSO3102A Oscilloscope	WCH 128	16
Agilent 33210A Waveform Generator	WCH 128	16
HP E3630A Power Supply	WCH 128	16
HP 34401A Meter	WCH 128	16
WCH 221 (Computational Lab. Available to students 24/7.) Computers and Monitors upgraded in 2011		
INSTRUMENT/MANUFACTURER - WCH 221	**LABS**	**QUANTITY**
16 of Dell E2011H 20-inch Widescreen LCD monitors	WCH 221	16
16 of Pentium D 2.80GHz CPU, 1GB RAM, 80GB Hard drive	WCH 221	16

Appendix D – Institutional Summary

1. The Institution

a. University of California, Riverside
(Legal name: The Regents of the University of California)
900 University Avenue
Riverside, CA 92521

b. Chief executive officer of the institution.

Timothy P. White, Chancellor

c. The individual submitting the self-study report.

Reza Abbaschian, Dean, Bourns College of Engineering

1.d The organizations by which the institution is now accredited and the dates of the initial and most recent accreditation evaluations.

The University of California, Riverside, is accredited by the Western Association of Schools and Colleges (WASC). UCR was most recently accredited on March 3, 2010. WASC reaccreditation occurs approximately every 10 years, and UCR's next proposal for reaccreditation is due to be submitted to WASC in fall 2016.

Other accreditations at UCR include:

- Graduate School of Education, accredited by the California Commission on Teacher Credentialing. Reaccreditation is under way now; a report is due in fall 2012, and the next

site visit is expected to be in 2014. Further, the GSOE School Psychology program is being reaccredited in 2012. A site visit was in March 2012, and a decision is due in August 2012.

- The Chemistry Department is reviewed by the American Chemical Society. The Chemistry department provides annual reports and 5-year reports on curriculum and student performance. The most recent 5-year report was in June 2010.
- The School of Business Administration (SoBA) will begin its AACSB Maintenance of Accreditation in 2012-13, with a site visit expected in January 2013.
- The UCR School of Medicine was denied initial accreditation by the Liaison Committee on Medical Education (LCME) in June 2011 because of budget uncertainties. The University expects to reapply this year with a new funding model that is less reliant on state funds.

2. Type of Control

The University is a state-controlled institution of higher education and an accredited Hispanic Serving Institution (HSI).

3. Educational Unit

Figure 22 describes the program organizational structure for the Bourns College of Engineering. Each program chair reports to the Dean of the College, who reports to the Vice Chancellor and Provost, who reports to the Chancellor of the UC Riverside Campus. The program chairs shown on the top line of the college section are also Department Chairs. The Computer Engineering Program is supported by faculty from both the Electrical Engineering and Computer Science Programs. The Material Science and Engineering Program includes faculty from the Bioengineering, Mechanical Engineering, Chemical Engineering, Environmental Engineering, Electrical Engineering, and Computer Science Programs.

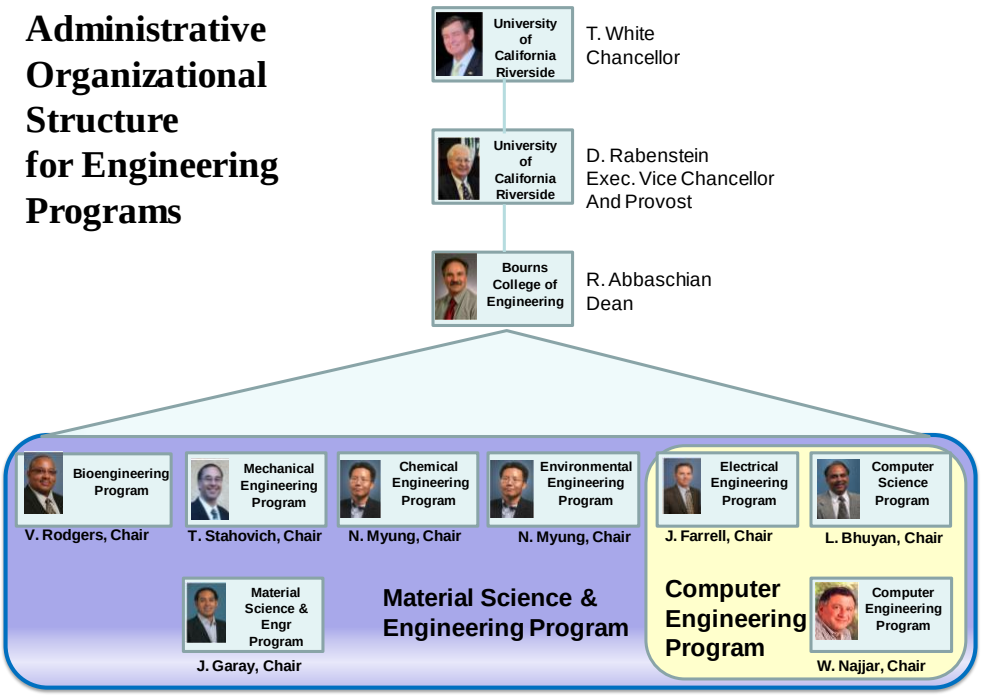
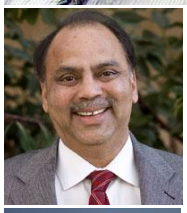
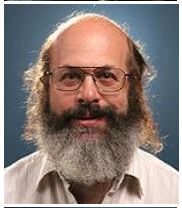


Figure 22: Administrative Organization Chart

4. Academic Support Units

Table 38 lists the names and titles of the individuals responsible for each of the units that teach courses required by the program being evaluated.

Table 38: Academic Support Units

	**Chemistry** *eric.chronister@ucr.edu* 951-827-3288	Eric Chronister	*Chair*
	**Computer Science** *bhuyan@cs.ucr.edu* 951-827-2244	Laxmi Bhuyan	*Chair*
	**Electrical Engineering** *farrell@ee.ucr.edu* 951-827-2159	Jay Farrell	*Chair*
	**English** *deborah.willis@ucr.edu* 951-827-1458	Deborah Willis	*Chair*
	**Math** *chari@math.ucr.edu* 951-827 6463	Vyjayanthi Chari	*Chair*
	**Physics** *jory.yarmoff@ucr.edu* 951-827-5336	Jory Yarmoff	*Acting Chair*
	**Statistics** *daniel.jeske@ucr.edu* 951-827-3014	Daniel Jeske	*Chair*

5. Non-academic Support Units

UCR Libraries: Dr. Ruth Jackson, University Librarian
ruth.jackson@ucr.edu

Computing & Communications: Charles J. Rowley, Associate Vice Chancellor & Chief *Information Officer*
rowley@ucr.edu

Learning Center: Michael P. Wong, Director
michaelpaul.wong@ucr.edu

Career Center: Randy Williams, Director
randy.williams@ucr.edu

6. Credit Unit

One quarter credit represents one class hour or three laboratory hours per week. One academic year normally represents 30 weeks of classes, exclusive of final examinations.

7. Tables

See below.

Table D-1. Program Enrollment and Degree Data

Computer Engineering

	Academic Year		Enrollment Year					Total Undergrad	Total Grad	Degrees Awarded			
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
Current Year	2011-12	FT	79	77	32	33	9	230	N/A	N/A			
		PT	0	1	1	0	2	4	N/A				
2010-11		FT	110	50	43	16	12	231	N/A	N/A	16	N/A	N/A
		PT	0	2	0	1	0	3	N/A				
2009-10		FT	78	66	25	22	13	204	N/A	N/A	19	N/A	N/A
		PT	0	3	1	0	2	6	N/A				
2008-09		FT	105	32	29	11	14	191	N/A	N/A	14	N/A	N/A
		PT	0	0	2	0	2	4	N/A				
2007-08		FT	59	52	20	30	9	170	N/A	N/A	28	N/A	N/A
		PT	1	1	0	0	3	5	N/A				

Give official fall term enrollment figures (head count) for the current and preceding four academic years and undergraduate and graduate degrees conferred during each of those years. The "current" year means the academic year preceding the fall visit.

FT--full time
PT--part time

Table D-2. Personnel

As Computer Engineering is supported by both the Computer Science and Engineering Department and the Electrical Engineering Department, we provide data for both below.

Year: Fall 2011: Computer Science and Engineering Department

	HEAD COUNT		FTE
	FT	PT	
Administrative	0	0	-
Faculty (tenure-track)	21	2	22.33
Other Faculty (excluding student Assistants)	9	4	10.46
Student Teaching Assistants	15	26	28.00
Student Research Assistants	40	26	53.00
Technicians/Specialists	2	1	2.02
Office/Clerical Employees	3	34	10.48
Others	2	0	2.00

Year: Fall 2011: Electrical Engineering Department

	HEAD COUNT		FTE
	FT	PT	
Administrative[4]			
Faculty (tenure-track)	22	1	22.10
Other Faculty (excluding student Assistants)	6	7	7.32
Student Teaching Assistants[2]	4	20	14.00
Student Research Assistants[3]	38	30	53.00
Technicians/Specialists	2	2	3.00
Office/Clerical Employees	2	11	3.68
Others[5]	2	0	2.00

Signature Attesting to Compliance

By signing below, I attest to the following:

That the Computer Engineering Program has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET's *Criteria for Accrediting Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the ABET *Accreditation Policy and Procedure Manual.*

Dean's Name (As indicated on the RFE)

June 21, 2012

Signature **Date**