ABET
Self-Study Report

for the

Materials Science and Engineering Program

at

University of California, Riverside

July 1, 2012

CONFIDENTIAL

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BACKGROUND INFORMATION

A. Contact Information

Materials Science and Engineering is one of eight degree programs undergoing ABET accreditation or reaccreditation at the University of California, Riverside, in 2012. The primary point of contact for all ABET matters is Reza Abbaschian, Dean of the Bourns College of Engineering. Contact information for Dean Abbaschian is given below:

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The Chair of the Materials Science and Engineering Program is Javier Garay. He will serve as the main point of contact for the MSE site visit. Alexander Balandin is former Chair and a member of the program ABET Accreditation and Assessment Committee. Contact information for these individuals is given below:

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B. Program History

The Materials Science and Engineering (MSE) program at the University of California, Riverside, began accepting undergraduate students in the fall of 2007. The program was conceived as a new approach to educating materials scientists and engineers in a multidisciplinary setting: All departments of the Bourns College of Engineering (BCOE), plus the departments of Chemistry and Biology in the College of Natural and Agricultural Sciences, contribute. There is no MSE Department; although it has dedicated administrative staff and educational resources, MSE draws on the courses and capabilities of its participating departments. An undergraduate student enrolls in one of the BCOE departments but ultimately receives a degree in Materials Science and Engineering.

The interdisciplinary nature of the MSE program at UCR is intended to prepare graduates to work with the great variety of materials responses at the electrical, optical, magnetic, mechanical, and chemical levels. The program builds on the strength of BCOE faculty in experimental, theoretical, and computational research in materials science and engineering; it also complements significant investments that UCR has made in establishing a strong research and educational base in nanoscale science, engineering, and technology.

Most significantly, the MSE program represents a novel approach to educating the next generation of engineers. The National Science Board's report *The Engineer of 2020* calls on the engineering community to (1) agree on an exciting vision for the future, (2) transform engineering education to help achieve the vision, (3) build a clear image of the new roles for engineers, including as broad-based technology leaders, in the mind of the public and an aging engineering workforce, (4) accommodate innovative developments from non-engineering fields, and (5) find ways to focus the energies of the different disciplines of engineering toward common goals. The UCR MSE program embodies these priorities. Without a major investment in a new department (and without the constraints that a department structure imposes on the range of what it can offer), we have created a program that draws from a wide range of disciplines and will feed graduates into a wide range of engineering fields, from biomedical technology to aerospace to energy and the environment.

We recognized from the start that course and program assessment for purposes of accreditation would be challenging, because MSE must rely on its constituent departments to offer the required courses. The constituent programs also provide assessment of the courses, which we as MSE Faculty in turn assess. Thus, if changes to courses are required they need to fit both the needs of the constituent department and MSE. As this Self-Study demonstrates, the required cooperation is in place, and the protocols for management and assessment are working. We are confident that we have built an innovative, effective, and top-quality MSE program at UCR, and it will continue to improve as it matures.

Key dates in the history of the MSE program are as follows:

Summer 2005: Professor Reza Abbaschian becomes Dean of the Bourns College of Engineering at the University of California, Riverside.

Spring 2006: Dean Abbaschian holds consultations with the BCOE department chairs and faculty active in materials research on prospects of creating MSE program at UCR.

September 2006: Dean Abbaschian appoints Professor Alexander Balandin to chair the MSE Program Committee, and tasks him with creation of the undergraduate MSE program.

September 2006: MSE Program Committee is formed with representatives from each BCOE department: Bioengineering, Chemical and Environmental Engineering, Computer Science and

Engineering, Electrical Engineering, and Mechanical Engineering. The committee's charge is to prepare the proposal to the University for a college-wide undergraduate MSE program.

December 2006: MSE Undergraduate Program proposal receives the letters of support and participation from each BCOE department. The proposal is submitted for approval to each of the departments, BCOE Executive committee, and for the BCOE faculty-at-large vote.

January 2007: Professor Alexander Balandin submits the MSE undergraduate proposal to the campus Committee on Educational Policy (CEP) for approval. The first MSE faculty search committee is formed to hire MSE Core Faculty members (whose appointments will be in existing BCOE departments). The committee is chaired by Professor Alexander Balandin and includes representatives from each BCOE department. The committee considers and recommends faculty pre-selected by the participating departments.

May 2007: Dean Abbaschian tasks MSE Founding Chair Professor Alexander Balandin to initiate work for creating the campus-wide MSE Graduate Research and Educational program.

June 2007: UCR Academic Senate meeting approves the MSE undergraduate program leading to the B.S. degree in MSE. The program starts to recruit students.

July 2007: The first MSE Core Faculty members join the program.

July 2007: Professor Balandin is formally appointed a Chair of the MSE Program and charged with running the undergraduate program and developing the MSE Graduate Program.

September 2007: Professor David Kisailus starts serving as the first MSE Undergraduate Advisor chairing the undergraduate committee, which consists of representatives of each department.

September 2007: Professor Javier Garay becomes the first MSE ABET coordinator. The MSE Program Educational Objectives are posted on the BCOE web-site.

September 2007: MSE Program welcomes its inaugural class of 20 undergraduate students (freshmen and transfers).

December 25, 2007: The proposal for MSE Graduate Program is submitted for consideration to the BCOE faculty. The proposal is supported by 40 Founding Faculty Members and chairs of the participating departments, including all BCOE departments and two CNAS departments.

January 17, 2008: Dean Abbaschian and MSE Chair Alexander Balandin submit proposal for the campus-wide MSE Graduate Program to Executive Vice Chancellor and Provost Ellen Wartella and pertinent CNAS and campus committees.

July 2008: The MSE Core Faculty members Assistant Professors Elaine Haberer (Electrical Engineering) and Masaru Rao (Mechanical Engineering) join the program. Professor Haberer becomes the first MSE colloquium series coordinator.

April 22, 2009: Professor Balandin submits a response to the CCGA committee with outside reviewers' reports of the MSE graduate program proposal.

August 24, 2009: University of California system President Mark G. Yudof approves the campus-wide UCR Graduate Program leading to M.S. and Ph.D. degrees in MSE.

September 2009: Professor Ludwig Bartels (Chemistry) and Professor Cengiz Ozkan (Mechanical Engineering) are appointed as the first MSE Graduate Advisors for Curriculum and Recruitment, correspondingly. Ms. Julia Nemeth is appointed as the first MSE Graduate Program Assistant.

June 2010: The first three students with B.S. degree in MSE are graduated.

Figure 0-1. Occupancy of the Materials Science and Engineering Building, which offers more than 75,000 assignable square feet of office, laboratory, and classroom space, began in 2011.

September 2010: The first cohort of 10 Ph.D. graduate students is welcomed by the MSE Program.

September 2011: MSE program has 25 graduate students (6 M.S. and 19 Ph.D.). It graduated 3 M.S. students.

November 2011: The first US News & World Report ranking is submitted by the MSE Program.

January 2012: Professor Balandin, Founding Chair of MSE, steps down as a chair considering his mission accomplished and planning to focus on his family and research.

January 2012: Professor Javier Garay (Mechanical Engineering) becomes the Chair of MSE Program.

February 2012: Professor Garay coordinates MSE lab organization in the new MSE building (Figure 0-1).

February 2012: Jennifer Morgan, MSE Graduate Program Assistant moves the MSE office to the new MSE Building.

Table 0-1 summarizes the enrollment history of the MSE program.

Table 0-1. Enrollment and graduation statistics since the inception of MSE.

	New Students		Total Enrollment			Degrees Granted		
	Freshmen	Transfer	UG	Grad	Total	UG	Grad	Total
2008-09	15	0	17	0	17			0
2009-10	14	1	31	0	31	1		1
2010-11	20	1	53	11	64	6	2	8
2011-12	4	2	39	23	62			

C. Options

There are currently no track options for the B.S. degree in MSE.

D. Organizational Structure

Figure 0-2 presents a schematic of UCR/BCOE/ME organizational structure.

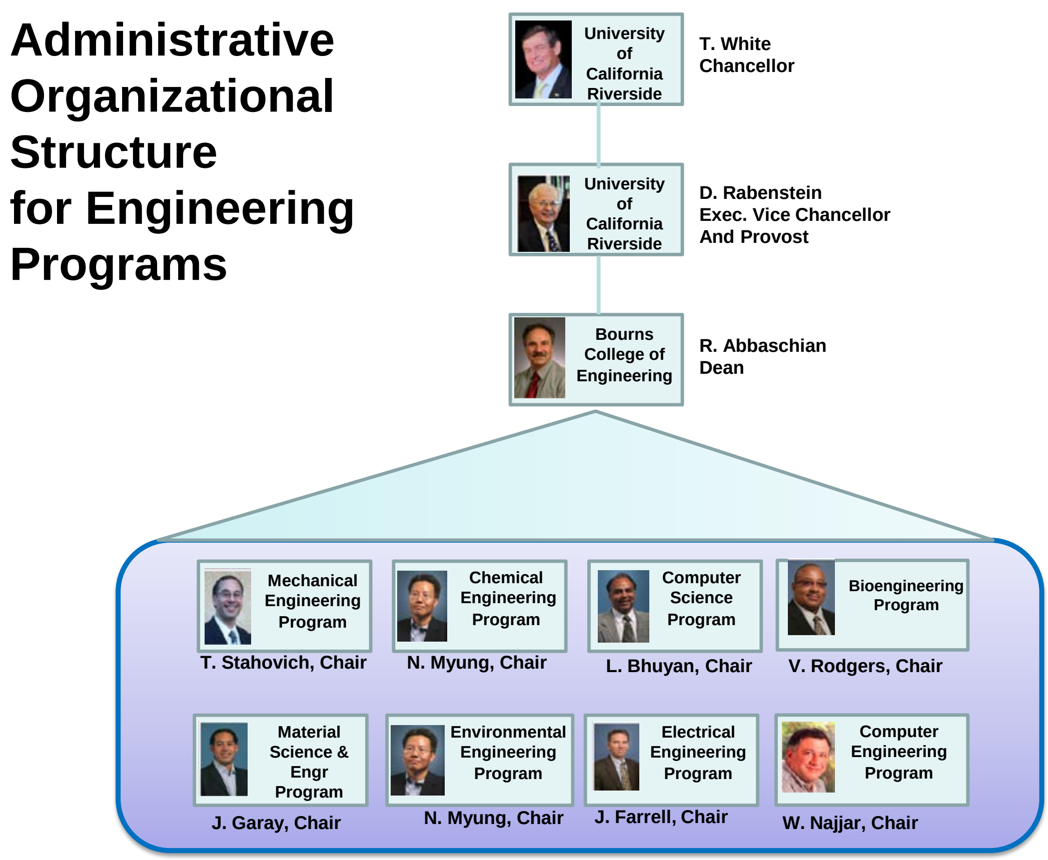

Figure 0-2. The MSE as it fits into the institutional organizational structure. All programs in the lower box are participants in MSE.

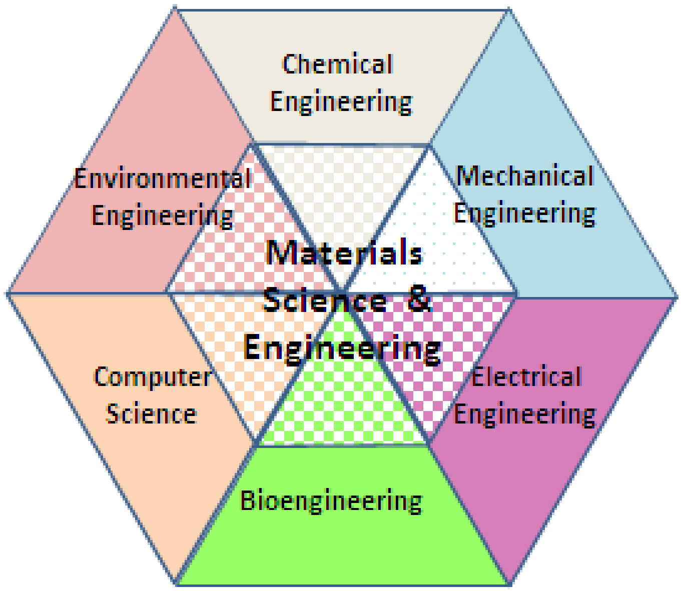

Figure 0-3. The MSE program is not a free-standing department. Rather, it relies on the participation of every department in the Bourns College of Engineering for providing curriculum, facilities, and assessment.

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, and no 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

Not applicable. This is the first accreditation review for MSE.

H. Joint Accreditation

This program is seeking EAC accreditation only.

GENERAL CRITERIA

CRITERION 1. STUDENTS

A. Student Admissions

The admissions processes for all 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 1-1 summarizes the freshman admissions process to the Bourns College of Engineering. 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 the 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. 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 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.

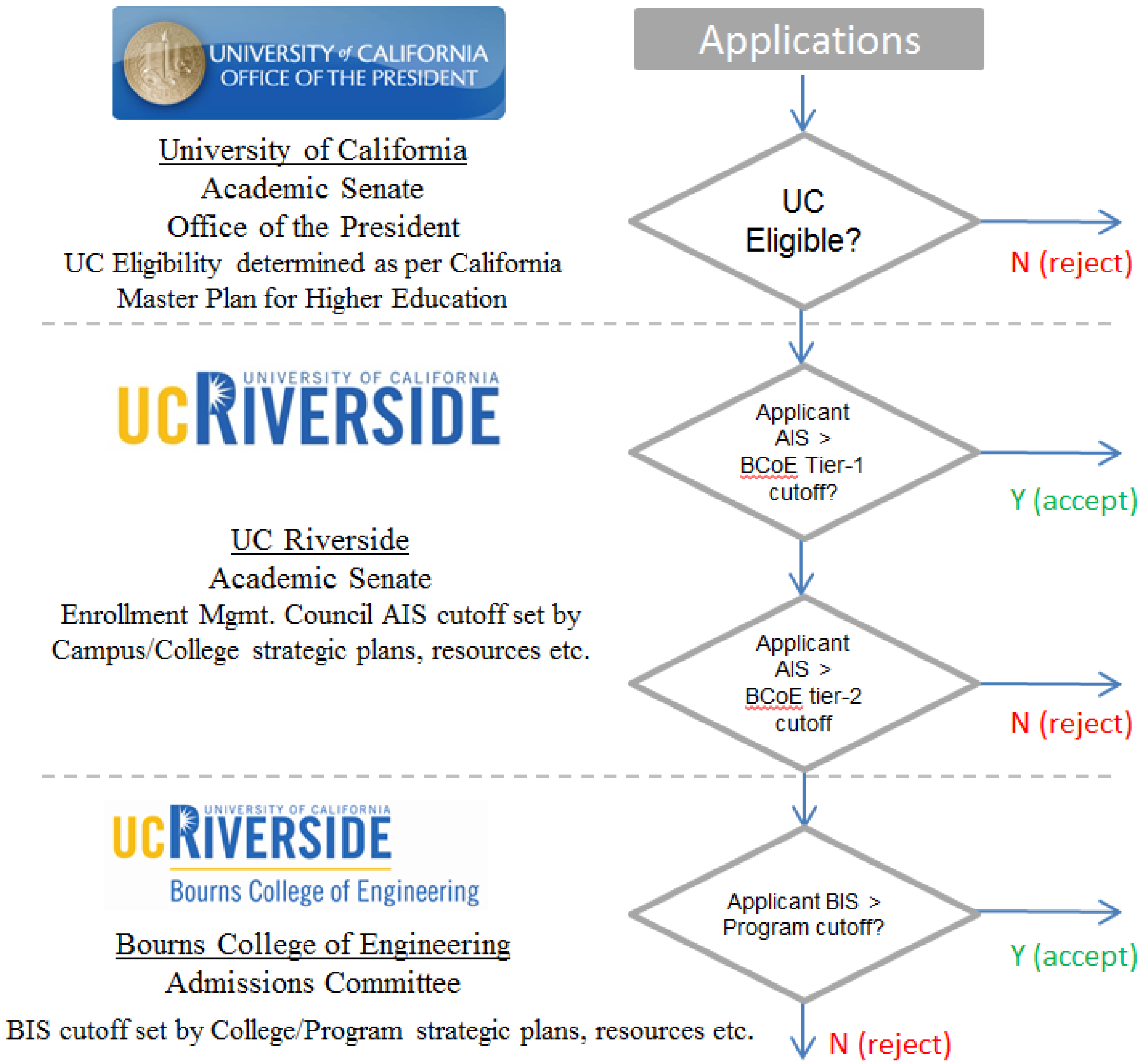

Figure 1-1. The admissions process begins with an application to the UC system, which is forwarded to the campus and then to the college for consideration.

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.

Subsection C addresses the transfer admission process.

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 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 1-2 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 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). SIS, which is maintained by the campus Computing and Communications office, records all student registrations and grades. 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 the degree may be awarded.

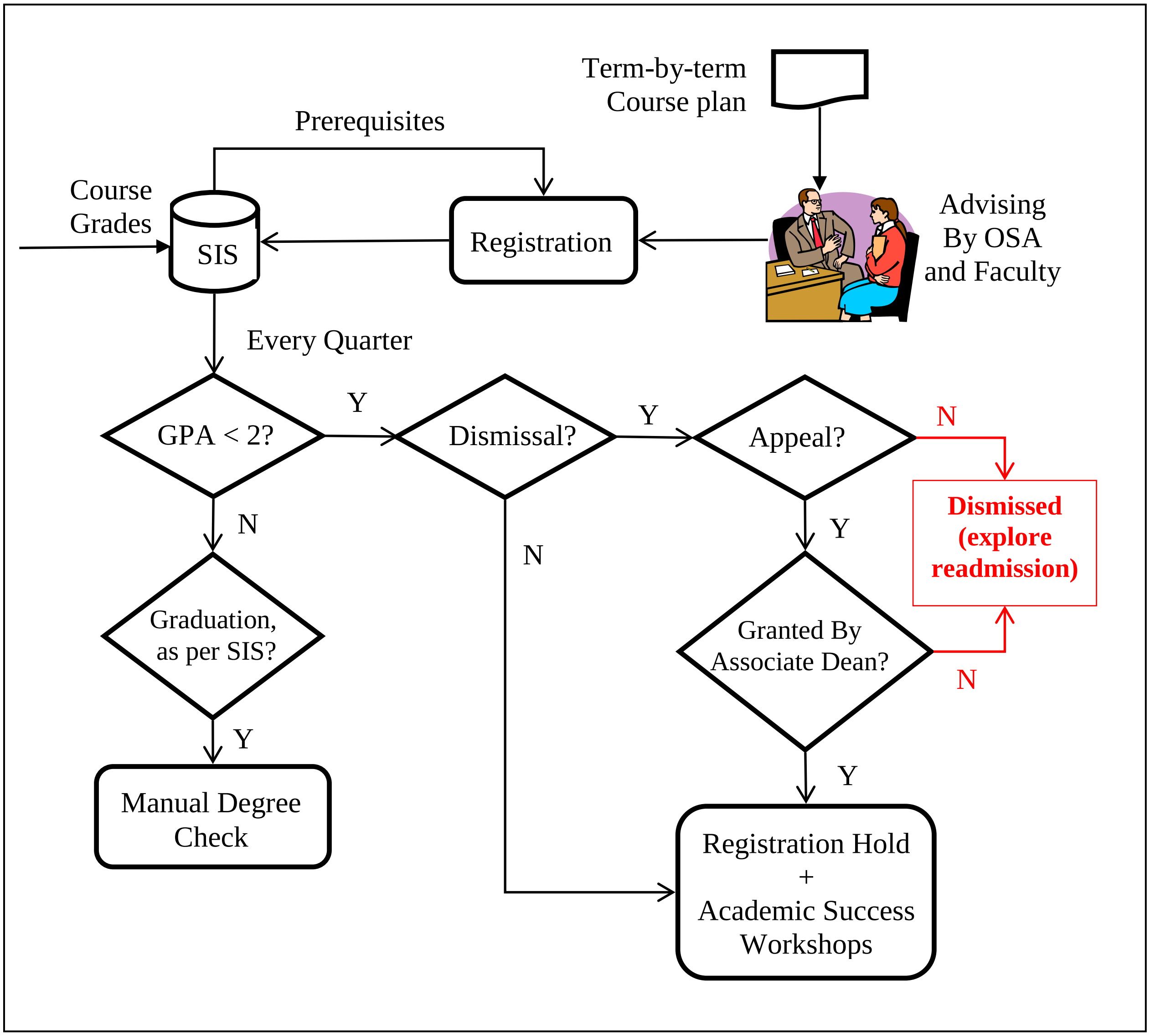

Figure 1-2. Students meet at least quarterly with staff advisers to establish a course plan, monitor progress, and take corrective action if necessary.

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. Table 1-1 shows the basic course plan for the Materials Science and Engineering program.

Table 1-1. The generic course plan for the MSE bachelor's degree program.

First year		
First quarter	**Second quarter**	**Third quarter**
• English 1A, English Composition • Math 9A, Calculus • Chemistry 1A/1LA, General Chemistry • MSE 1, Fundamentals of Materials Science	• English 1B, English Composition • Math 9B, Calculus • Chemistry 1B, General Chemistry	• Math 9C, Calculus • Chemistry 1C, General Chemistry • BREADTH: Humanities/ Social Sciences
Second year		
First quarter	**Second quarter**	**Third quarter**
• Math 46, Differential Equations • Physics 40A, Physics (Mechanics) • BREADTH: Humanities/ Social Sciences • Chemistry 112A, Organic Chemistry	• Math 10A, Multivariable Calculus • Mechanical Engineering 10, Statics • Physics 40B, Physics (Heat/Waves/Sound) • BREADTH: Humanities/ Social Sciences	• Math 10B, Multivariable Calculus • Physics 40C, Physics (Electricity/Magnetism) • Electrical Engineering 1A/1LA, Engineering Circuits Analysis • Computer Science 30, Intro to Computational Science and Engineering
Third year		
First quarter	**Second quarter**	**Third quarter**
• Chemical Engineering 135, Chemistry of Materials • Mechanical Engineering 114, Introduction to Materials Science and Engineering • Electrical Engineering 138, Electrical Properties of Materials • Engineering 180W, Technical Communication	• Mechanical Engineering 110, Mechanics of Materials • Chemical Engineering 100, Engineering Thermodynamics • BREADTH: Humanities/ Social Sciences • TECHNICAL ELECTIVE	• Mechanical Engineering 156, Mechanical Behavior of Materials • Materials Science and Engineering 160, Nanostructure Characterization Lab • TECHNICAL ELECTIVE • FREE ELECTIVE
Fourth year		
First quarter	**Second quarter**	**Third quarter**
• Statistics 155, Probability & Statistics for Engineers • Materials Science and Engineering 161, Analytical Materials Characterization • BREADTH	• Materials Science and Engineering 175A, Senior Design • TECHNICAL ELECTIVE • BREADTH: Humanities/ Social Sciences	• Materials Science and Engineering 175B, Senior Design • TECHNICAL ELECTIVE • BREADTH

Whether or not students follow this course plan, prerequisites are enforced by the registration system. Students register for courses through the GROWL system that interfaces with SIS, and is able to enforce prerequisites. (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 bills, 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.) A student prevented from taking a course due to lack of prerequisites can petition the undergraduate committee, which 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 very special situations.

In one instance (Spring 2010) a student who was graduating in the MSE program needed to take the MSE 160 course (Nanostructure Characterization Lab), but had not taken the prerequisite ME 114 course (Introduction to Materials Science and Engineering). In order to make sure he would be on schedule to graduate, David Kisailus (MSE UG advisor) waived his requirement to take ME 114 course, since he had taken CEE 135, Chemistry of Materials, which is also taught by Professor Kisailus. The rationale was that there is some overlap in the two courses (please see course descriptions below), the student had done well in CEE 135 and was thus deemed properly prepared for the MSE 160 course. The student took ME 114 next time it was offered.

- ME 114 description: Covers materials classification, atomic structure and interatomic bonding, crystal structure of metals, imperfections in solids, diffusion, mechanical properties of engineering materials, strengthening mechanisms, basic concepts of fracture and fatigue, phase diagrams, ceramics, polymers and composites.

- CEE 135 description: Introduction to the synthesis, structure, properties and performance of modern materials. Topics include the science of materials, bonding and structure, the strength of materials, electrons in materials, semiconductors, superconductors, and optical properties of materials.

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 http://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, 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 http://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 http://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.

Transfer applicant to the College of Engineering must meet both UCR Admission criteria and BCOE major-selection 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

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 (ENGL 1A, 1B, 1C).

Major-Specific Transfer Requirements:

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

- Three courses in general chemistry with labs (CHEM 1A/LA, CHEM 1B/LB, CHEM 1C/LC)
- A minimum of THREE (3) 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.

- one course in introduction to ordinary differential equations (MATH 46)
- one course in organic chemistry with lab (CHEM 112A)
- three courses in calculus based physics with labs (PHYS 40A, 40B, 40C)
- two courses in calculus of several variables I (MATH 10A, 10B)

Potential Course Sequences for Materials Science and Engineering: CHEM 1A/LA, CHEM 1B/LB, CHEM 1C/LC; or PHYS 40A, 40B, and 40C; or MATH 10A, MATH 10B, and MATH 46.

In addition to the general and major-specific requirements, applicants are strongly encouraged to complete all the recommended courses below prior to enrollment. The recommended courses are not required for transfer admission. Completing this coursework prior to enrollment at UCR is critical to maintaining satisfactory progress in the upper-division engineering curriculum and to finishing all degree requirements within two years of enrollment at UC Riverside, provided a full-time course load is maintained at UCR.

- CHEM 112A, Organic Chemistry
- ME 10, Statics
- MATH 10A, Multivariable Calculus
- MATH 10B, Multivariable Calculus
- MATH 46, Differential Equations
- CS 10, Introduction to Computer Science
- EE 1A/LA, Circuits
- PHYS 40A, Physics (Mechanics)
- PHYS 40B, Physics (Heat/Wave/Sound)
- PHYS 40C, Physics (Electricity/Magnetism)
- BIOL 2, Cellular Basis of Life, BIOL 3, Organisms in their Environment, or BIOL 5A/LA, Introduction to Cell and Molecular Biology
- 1 Humanities/Social Sciences courses to satisfy BCOE Breadth

Advising and Career Guidance

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

Table 1-2 lists 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 for OSAA staff.

Table 1-2. OSAA staff and qualifications.

	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

Professional guidance and mentoring is provided by staff (particularly the Director of Student Professional Development), the faculty, and the Career Center. The overall philosophy of BCOE 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 and schools.

As is typical for undergraduate programs in engineering, our students spend most of 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.

To help our student feel connected to their chosen field of MSE, engaged in BCOE and properly prepared professionally ours students are involve in a variety of Professional Development activities organized by BCOE. Activities to be performed are program-specific, and 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, organizations, and societies.
- 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 complements 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 1-3 summarizes these milestones.

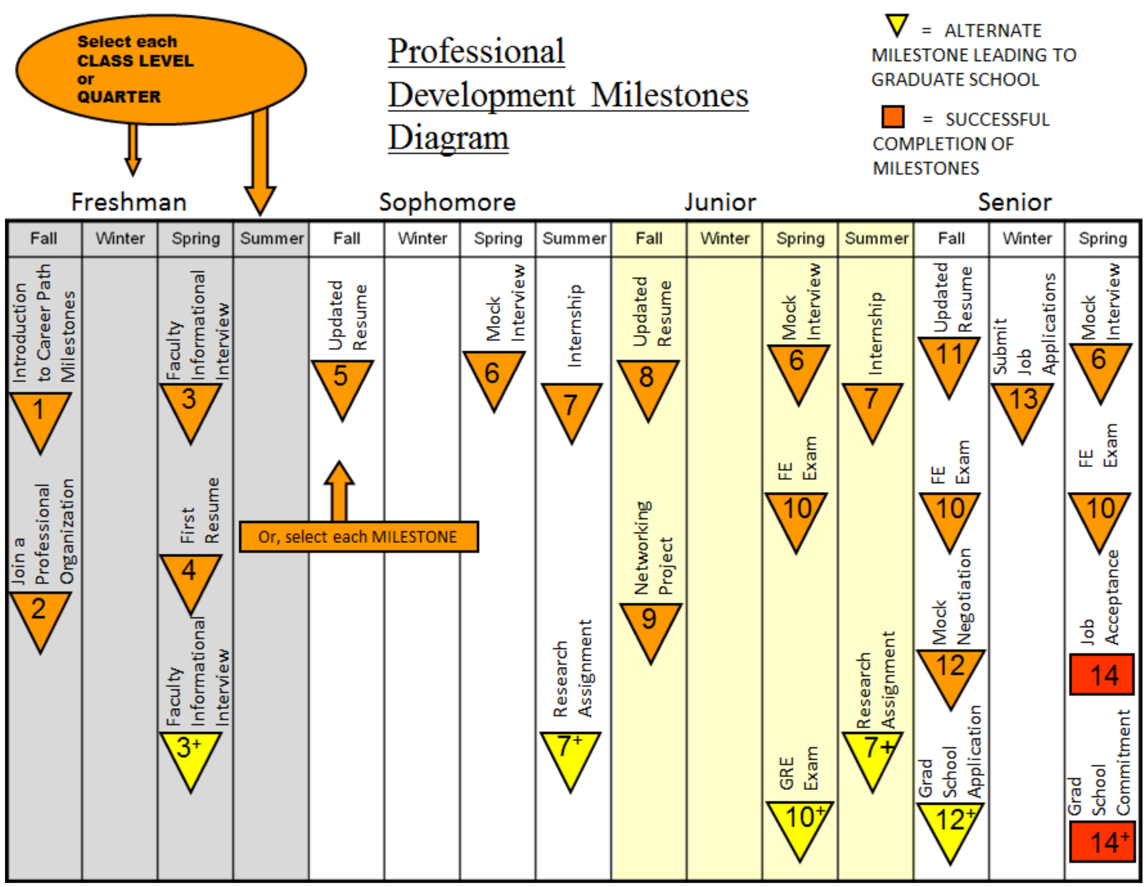

Figure 1-3. The Professional Development Milestones program guides students on key activities they should be undertaking during their undergraduate years to assure that they are ready for careers or graduate school.

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, Mr. Jun Wang, participate in a broad range of activities during the year. A summary for the 2010-11 and 2011-12 academic years appears below.

2010-11

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 Connection 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 Oil well 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	Engineering 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
1/12/2011	FE/EIT Exam Preparation Workshop with California Water Board	52	5/5/2011	Interview Skills, Featuring INROADS	37
1/18/2011	Interview Skills Workshop with Abbott Vascular	64	5/5/2011	Advanced Resume Writing, Featuring: Sherwin Williams	30

2011-12

Event	Date	Time	Location	Attendees
Student Leadership Workshop	9/25/2011	2PM - 4PM	WCH 205/6	120
Information Session: Peace Corps	9/26/2011	10AM - 2PM	HUB Mall	56
Information Session: HACU National Internship Program	9/27/2011	2PM - 3PM	HUB 260	32
Information Session: U.S. Department of State	9/27/2011	4PM - 5PM	HUB 367	45
Information Session: U.S. Marine Corps	9/28/2011	10AM - 12PM	HUB Mall	27
Beginning Resume Writing Workshop	10/3/2011	10:15AM - 10:45AM	HUB 268	30
Job Search 101 Workshop	10/3/2011	12PM - 12:45PM	HUB 268	42
Career Presentation by Synapse	10/5/2011	5PM - 6:30PM	WCH 205/6	65
Internships: What, Why & How?	10/6/2011	11AM - 12PM	HUB 268	37
Now Hiring Interns!	10/11/2011	1PM - 2:30PM	HUB 355	40
Beginning Resume Writing Workshop	10/11/2011	4PM - 4:30PM	HUB 355	35
Preparing for the Job Fair	10/12/2011	2PM - 4PM	HUB 260	54
Interview Skills	10/13/2011	1PM - 1:45PM	HUB 355	36
The New GRE: What does it mean for grad school applicants	10/13/2011	2PM - 3:30PM	HUB 355	68

Advanced Resume Writing, featuring Cal Steel Industries, Inc.	10/13/2011	4PM - 5PM	HUB 355	70
Careers in BioTech	10/14/2011	12PM - 1:30PM	HUB 355	98
Yikes! I'm Graduating!	10/14/2011	2PM - 3:30PM	HUB 355	26
Resumania, Feating Target	10/17/2011	1PM - 4PM	Career Center	30
Law School Forum	10/17/2011	2PM - 4PM	HUB 268	35
Why Can't I Find a Job?	10/17/2011	2:15PM - 3PM	HUB 260	42
Google Day at BCOE	10/17/2011	5PM - 7:30PM	WCH 205/6	135
Resumania, Featuring Sherwin Williams	10/18/2011	1PM - 4PM	Career Center	25
Careers at EPA Info Session	10/18/2011	6PM - 7PM	WCH 205/6	67
Career Expo	10/19/2011	10AM - 2PM	Rivera Library	
Visit at NAVSEA NSWC Corona	10/20/2011	10AM - 2PM	NSWC Corona	25
Guest Speakers from NASA/ Carnegie Mellon Silicon Valley	10/20/2011	5PM - 6:30PM	WCH 205/6	59
Part-Time Job Search/Beginning Resume Writing Workshop	10/20/2011	11AM - 12:15PM	HUB 268	23
Information Session: USMC Aviation	10/20/2011	12PM - 1PM	HUB 367	25
Making Professional Connections, Featuring: Target	10/24/2011	11AM - 11:45AM	HUB 355	28
LinkedIn 101: Networking Professionally Online	10/26/2011	12PM - 1:30PM	HUB 260	30
Graduate & Professional School Information Day	10/27/2011	10AM - 2PM	Rivera Library	
Guest Speakers from Northrop Grumman Aerospace Systems	10/27/2011	6PM - 7PM	WCH 205/6	78
Interview Skills, Featuring: Aerotek	10/31/2011	10:15AM - 11AM	HUB 260	35
Law School Information Day	11/1/2011	10AM - 2PM	Rivera Library	
Advanced Resume Writing, featuring Kohl's	11/2/2011	2:15PM - 2:45PM	HUB 260	21
Interview Skills, Featuring: Best Buy	11/7/2011	11AM - 11:45AM	HUB 260	27
Part-Time Job Search/Beginning Resume Writing Workshop	11/7/2011	1:15PM - 2:30PM	HUB 260	32
Jump Start to Grad School, Featuring: Kaplan	11/7/2011	1:30PM - 2:30PM	HUB 367	36
Careers in Internet Retail	11/7/2011	2:30PM - 4PM	HUB 268	25
SWE Female Engineers Guest Speaker Panel	11/7/2011	5PM - 6PM	Bourns A265	67
ASQ Biomedical Industrial Panel	11/7/2011	6PM - 7PM	WCH 205/6	75
Information Table: Peace Corps	11/8/2011	10AM - 2PM	HUB Mall	29
Engineer Your Future: Careers in Mechanical Eng (Northrop Grumman)	11/8/2011	1:30PM - 3PM	HUB 260	56
INROADS Meeting with BCOE students	11/8/2011	7PM - 9PM	Bourns A265	102
Internships: What, Why & How?	11/9/2011	3PM - 4PM	HUB 268	23
Information Session: CIA	11/9/2011	3PM - 4PM	HUB 355	46
Undergraduate Research Opportunities Workshop	11/14/2011	11AM - 12:30PM	HUB 260	45
Yikes! I'm Graduating!	11/14/2011	2PM - 3:30PM	HUB 260	19
Now Hiring Interns!	11/15/2011	2PM - 3:30PM	HUB 260	23
Information Session: 50th Anniversary of Peace Corp	11/15/2011	12PM - 1:30PM	HUB 268	34

Career Marathon (resume reviewing)	11/16/2011	1:30PM - 5:30PM	HUB 355	60
AICHE Presentation/Guest Speakers from Energy Industry	11/18/2011	1PM - 2:30PM	Bourns A265	76
Visit at K&N Engineering	11/19/2011	10AM - 2PM	K&N	25
INROADS Workshop & Interview with students	12/10/2011	10AM - 12PM	WCH 205/6	32
Visit at Luxfer Cylinder Company	12/14/2011	4PM - 6PM	Luxfer	15
Information Table: Graduate School Prep, featuring: Princeton Review	1/4/2012	10AM - 2PM	HUB Mall	36
Internships: What, Why & How?	1/17/2012	12PM - 1PM	Transfer Center	27
Part-Time Job Search Webinar	1/17/2012	3PM - 4PM	Careers.ucr.edu	33
College to Careers: BCOE Alumni Panel	1/17/2012	5PM - 6:30PM	Bourns A265	65
Career Station	1/18/2012	11AM - 1PM	HUB Mall	21
Beginning Resume Writing FYSS	1/18/2012	12PM - 12:45PM	Transfer Center	22
Prepare For Engineering & Technical Career Fair	1/19/2012	5PM - 6:30PM	Bourns A265	97
Interview Skills Workshop	1/24/2012	10AM - 11AM	HUB 268	36
Career Station	1/24/2012	11AM - 1PM	HUB Mall	12
LinkedIn: Your Professional Version of Facebook	1/24/2012	1PM - 2:30PM	HUB 268	47
Now Hiring Interns: WINternships Edition	1/24/2012	2:30PM - 4PM	HUB 335	25
SHPE & NSBE Meeting with EPA	1/24/2012	4PM - 6:30PM	Bourns A265	66
Information Table: The Princeton Review	1/25/2012	10AM - 2PM	HUB Mall	23
ENGINEERING & TECHNICAL CAREER FAIR	1/25/2012	10AM - 2PM	HUB 302	
Career Station	1/25/2012	11AM - 1PM	HUB Mall	14
Why Can't I Find a Job?	1/25/2012	11AM - 11:45PM	HUB 268	29
Advanced Resume Writing	1/26/2012	10AM - 10:45AM	HUB 268	38
Career Station	1/26/2012	11AM - 1PM	HUB Mall	24
How to Perfect Your 30-Second Elevator Speech	1/26/2012	5PM - 6:30PM	HUB 355	50
Making Professional Connections	1/27/2012	11AM - 12PM	HUB 255	31
Career Station	2/1/2012	11AM - 1PM	HUB Mall	12
Career Marathon (resume reviewing)	2/1/2012	1:30PM -5:30PM	HUB 268	36
ASQ Mock Interviews for Engineering Students	2/2/2012	5PM - 8:30PM	HUB 302	87
Trip to Life Technology	2/3/2012	9AM - 2PM	Life Technology	34
Yikes! I'm Graduating!	2/7/2012	1PM - 2:30PM	HUB 268	21
Visit to Meggitt	2/8/2012	9AM - 1PM	Meggitt	15
Information Table: The Princeton Review	2/8/2012	10AM - 2PM	HUB Mall	20
Career Station	2/8/2012	11AM - 1PM	HUB Mall	10
Undergraduate Research Opportunities Workshop	2/9/2012	2PM - 3PM	Bourns A265	42
Non-Clinical Health Profession Panel	2/9/2012	2PM - 3:30PM	HUB 268	48
Google Day at BCOE	2/9/2012	5PM - 6PM	WCH 205/6	111
Jump Start to Medical School, Featuring: Kaplan	2/9/2012	5PM - 7PM	HUB 268	21

iStartStrong: Connection You to Satisfying Careers	2/13/2012	1:30PM - 3PM	HUB 268	16
AICHE Guest Speakers from Fluor Corp	2/13/2012	4:30PM - 6:30PM	Bourns A265	79
Conversation Skills	2/14/2012	2PM - 3PM	HUB 268	14
Beginning Resume Writing	2/15/2012	10AM - 10:45AM	HUB 268	28
Career Station	2/15/2012	11AM - 1PM	HUB Mall	13
Visit to Circor	2/15/2012	2PM - 3PM	Circor	10
Agricultural Careers Dinner & Industry Professionals Networking Event	2/15/2012	6PM - 8PM	HUB 355	85
Internships: What, Why & How?	2/16/2012	11AM - 12PM	HUB 268	20
GOVERNMENT AND NON-PROFIT JOB FAIR	2/16/2012	11AM - 3PM	HUB 203	
SWE Resume Workshop	2/21/2012	5PM - 6PM	WCH 205/6	45
Career Station	2/22/2012	11AM - 1PM	HUB Mall	15
Presentation Skills	2/22/2012	11AM - 11:30AM	HUB 268	32
Now Hiring Part-Time Jobs	2/23/2012	11:30AM - 1PM	HUB 268	22
Making Professional Connections	2/23/2012	2PM - 3PM	HUB 268	26
Beginning Resume Writing	2/27/2012	1PM - 1:45PM	HUB 268	20
Former Interns Tell All	2/28/2012	12PM - 1PM	HUB 268	54
Interview Skills	2/28/2012	2PM - 3PM	HUB 268	16
BCOE IMPACT Mentoring Meeting	2/28/2012	6PM - 8PM	Bourns A265	82
Information Table: The Princeton Review	2/29/2012	10AM - 2PM	HUB Mall	19
Career Station	2/29/2012	11AM - 1PM	HUB Mall	18
Advanced Resume Writing	2/29/2012	11AM - 11:45AM	HUB 268	28
Are You Really Ready to Work? Workplace Etiquette	3/1/2012	10AM - 11:30AM	HUB 379	46
Careers at Air Force	3/1/2012	4PM - 5PM	Bourns A265	24
BCOE IMPACT Mentoring Meeting	3/1/2012	6PM - 8PM	Bourns A265	78
ACM Guest Speaker from Western Digital	3/5/2012	6PM - 7PM	WCH 205/6	56
GRADUATE VIRTUAL FAIR	3/7/2012	10AM - 7PM	Careers.ucr.edu	
Making Professional Connections	3/7/2012	11AM - 12PM	HUB 268	26
Yikes! I'm Graduating!	3/7/2012	2PM - 3:30PM	HUB 268	24
Visit at JPL	3/8/2012	8AM - 3PM	JPL	18
Part-Time Job Search/Beginning Resume Writing	3/8/2012	11AM - 12:15PM	HUB 268	31
Interview Skills	3/13/2012	3PM -4PM	HUB 268	22
Why Can't I Find a Job?	3/14/2012	11AM - 11:45AM	HUB 268	25
Non-Academic Job Search (Grad Students Only)	3/15/2012	3PM -4PM	HUB 268	60
Information Table: Kaplan Test Prep	4/4/2012	10AM - 2PM	HUB Mall	21
Information Session: Target Distribution	4/5/2012	12PM - 1PM	HUB 367	32
Yikes! I'm Graduating!	4/9/2012	1PM - 2:30 PM	HUB 260	17
Part Time Job Search/Beginning Resume Writing Webinar	4/9/2012	2PM - 3:15PM	http://bit.ly/ jobresumewebinar	20
Prepare For Spring Job Fair and Dress for Success	4/9/2012	5PM - 6:30PM	HUB 302N	67

Careers in Public Service Webinar	4/10/2012	11AM - 2PM	http://bit.ly/ publicservicewebinar	52
Internships: What, Why & How Webinar	4/10/2012	1PM - 2PM	http://bit.ly/nar internshipwebi	21
Beginning Resume Writing	4/10/2012	1:30PM - 2:15PM	HUB 268	19
Career Station	4/11/2012	11AM - 1PM	HUB Mall	26
SPRING JOB FAIR: CAREER NIGHT	4/11/2012	4PM - 7:30PM	HUB 302	
What Can You Do Besides Becoming a Doctor?	4/12/2012	10AM - 11:30AM	HUB 355	30
Choosing a Health Professions School	4/12/2012	11:30AM - 1PM	HUB 355	32
Hands-On Healthcare: Volunteer Opportunities	4/12/2012	1PM - 2:30 PM	HUB 355	41
HEALTH PROFESSIONS SCHOOL FAIR	4/12/2012	4PM - 7PM	HUB 302	
Advanced Resume Writing Webinar	4/16/2012	11:15AM - 12PM	Careers.ucr.edu	15
Conversation Skills	4/16/2012	1PM - 2PM	HUB 260	17
Interview Skills	4/17/2012	11AM - 12PM	HUB 260	13
Making Professional Connections	4/17/2012	12PM - 1PM	HUB 260	20
Job Search Skills	4/17/2012	1Pm - 1:45PM	HUB 260	22
Information Table: Peace Corps	4/18/2012	10AM - 2PM	HUB Mall	23
Information Table: Kaplan Test Prep	4/18/2012	10AM - 2PM	HUB Mall	14
Career Station	4/18/2012	11AM - 1PM	HUB Mall	12
Careers at NAVY Info Session	4/19/2012	5PM - 6:30PM	WCH 202	17
Entrepreneur Career Panel: Starting Your Own Business	4/19/2012	5PM - 6:30PM	Bourns A265	115
Work Green, Earn Green: Careers that Save the Planet	4/20/2012	11AM - 12:30PPM	HUB 260	46
Information Session: City Year Los Angeles	4/20/2012	12PM - 1PM	HUB 265	48
LinkedIn: Network & Get Recruited, Featuring: Fresh & Easy	4/23/2012	2PM - 3:15PM	HUB 260	68
Now Hiring Part-Time Jobs	4/24/2012	2:30PM - 4PM	HUB 355	40
Career Station	4/25/2012	11AM - 1PM	HUB Mall	25
Job Search (Grad Students Only)	4/25/2012	11AM - 12PM	HUB 260	22
Now Hiring Interns	4/25/2012	1PM - 2:30PM	HUB 268	24
Information Table: Across the Pond	4/26/2012	10AM - 2PM	HUB Mall	23
Visit at Chevron	4/27/2012	9AM - 5PM	Chevron	36
Internships: What, Why & How	4/30/2012	1PM - 2PM	HUB 260	20
LinkedIn Webinar: Your Professional Version of Facebook	4/30/2012	2:30PM - 3:30PM	http://bit.ly.webinarlinkedin	14
Interview Skills, Featuring: Consolidated Electrical Distributors	5/1/2012	12:30PM - 1:30 PM	HUB 260	42
Yikes! I'm Graduating!	5/1/2012	2PM - 3:30PM	HUB 260	35
Jump Start to Law School, Featuring: Kaplan	5/1/2012	5PM - 7PM	HUB 355	22
Advanced Resume Writing, Feat: California Steel Industries	5/2/2012	10AM - 10:45AM	HUB 260	29
Career Station	5/2/2012	11AM - 1PM	HUB Mall	15
Job Search Skills	5/3/2012	10AM - 10:45AM	HUB 268	12
Interview Skills	5/3/2012	12PM - 1PM	HUB 268	16
Resume & CV Writing (Grad Students Only)	5/8/2012	1PM - 1:45PM	HUB 268	

Career Station	5/9/2012	11AM - 1PM	HUB Mall	
Beginning Resume Writing	5/9/2012	1PM - 1:45PM	HUB 268	
Interview Skills	5/10/2012	11AM - 12PM	HUB 268	
Job Search Skills Webinar	5/10/2012	1PM - 1:45PM	http://bit.ly/GEtPPa	
Yikes! I'm Graduating!	5/14/2012	10AM - 11:30AM	HUB 260	
Career Marathon	5/16/2012	12:30PM - 4:30PM	HUB 355	
Information Session: Peace Corps	5/16/2012	12PM - 1:30PM	HUB 367	
Former Interns Tell All	5/16/2012	1PM - 2:30PM	HUB 268	
Careers in Defense Industries	5/16/2012	5PM - 6PM	WCH 205/6	
LAST CHANCE JOB FAIR	5/17/2012	10:00AM - 2:00PM	Rivera Library	
Seasonal Job Search/Beginning Resume Writing	5/21/2012	1PM - 2:15PM	HUB 260	
Advanced Resume Writing	5/22/2012	12PM - 12:45PM	HUB 260	
Conversation Skills	5/22/2012	2PM - 3PM	HUB 260	
Job Search Skills	5/23/2012	11AM - 11:45AM	HUB 268	
			TOTAL	**5774**

In addition, the College has a very active undergraduate research program. 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. This included one MSE student, Brian J. Weden, who was mentored by Dr. David Kisailus, and presented the topic on “A Microstructural Analysis of Fully Mineralized Ultra-Hard Radular Teeth”. For the second year in a row, BCOE students made more presentations at SCCUR than students from any other engineering college in Southern California.

A summary of the range of Professional Development, Mentoring, and Success program in BCOE appears in Figure 1-4.

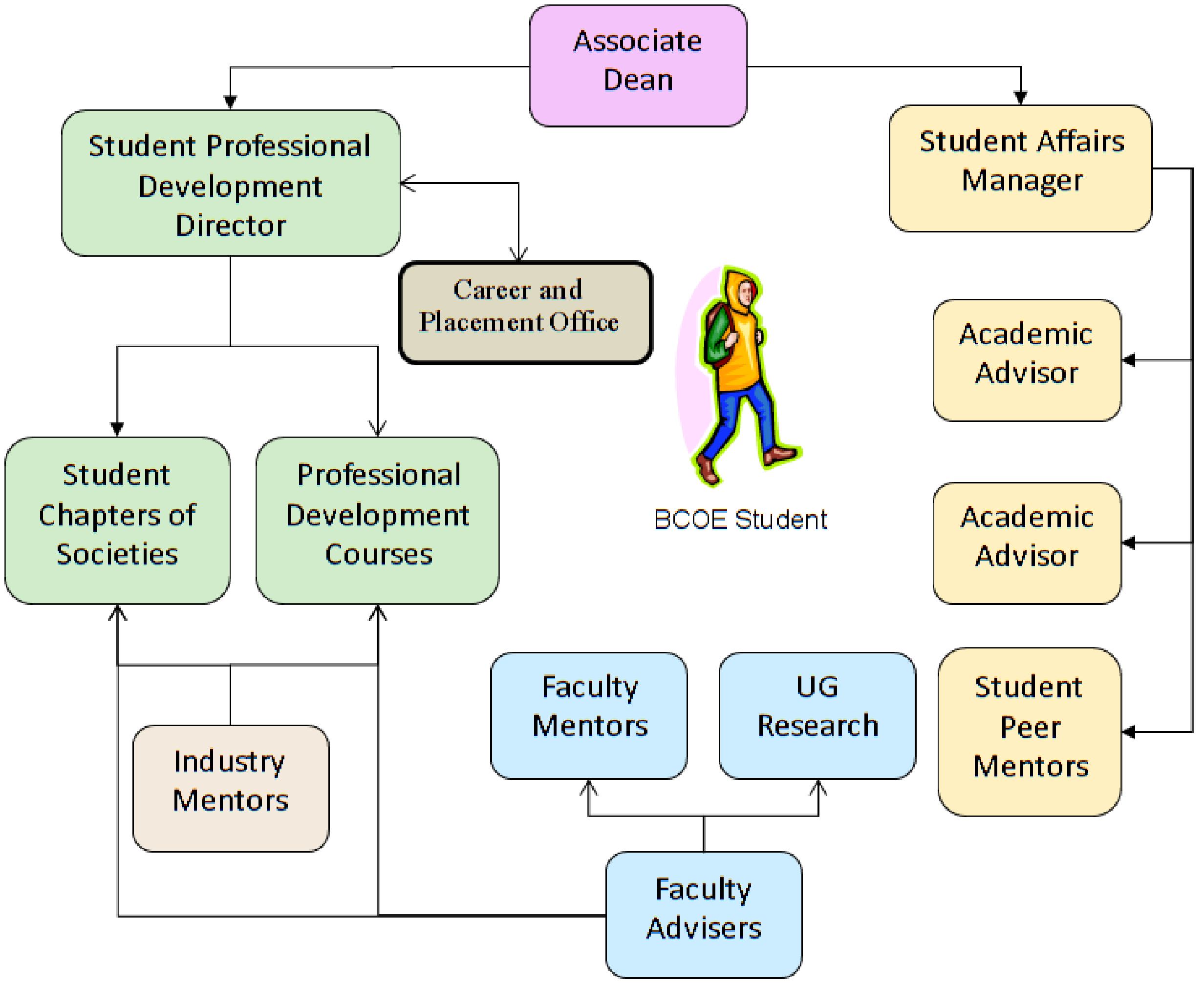

Figure 1-4. Professional development, placement, and success programs offered to BCOE undergraduate students.

As shown in Figure 1-5, student feedback on advising and career development support is strongly positive.

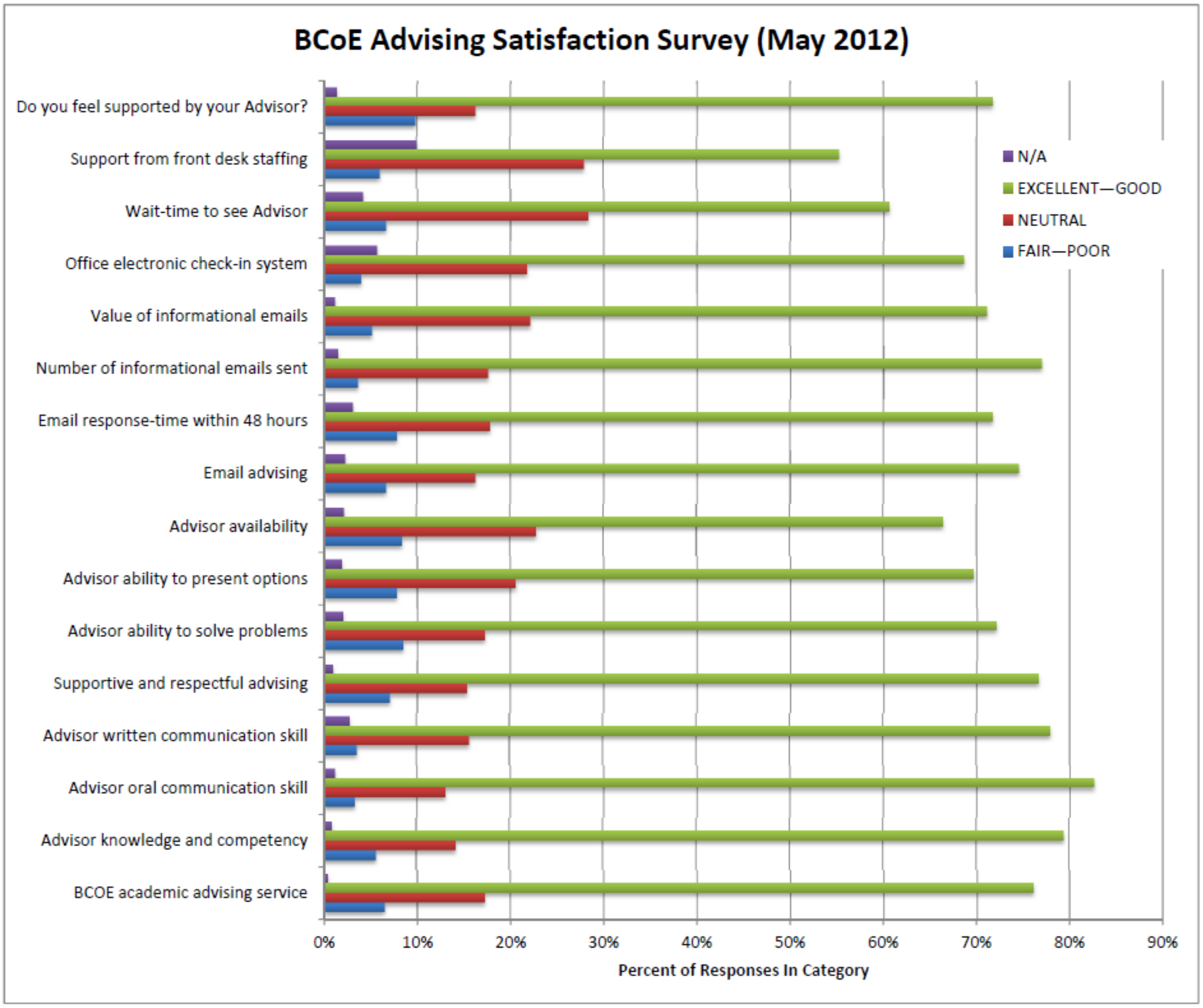

Figure 1-5. Student satisfaction survey results on advising.

D. 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, is 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.

E. **Graduation Requirements**

The Materials Science and Engineering major uses the following major requirements to satisfy the **College's** Natural Sciences and Mathematics breadth requirement.

1. One course in the biological sciences chosen from an approved list.
2. CHEM 001A, CHEM 001LA, General Chemistry.
3. MATH 008B, Introduction to College Mathematics for the Sciences, or MATH 009A, First-Year Calculus.
4. PHYS 040A, PHYS 040B, General Physics.

MS&E Major Requirements

1. Lower-division requirements (68 units)
a) CHEM 001A, CHEM 01LA, CHEM 001B, CHEM 01LB, CHEM 001C, CHEM 01LC, General Chemistry lecture and lab, 3 quarters.
b) CS 030, Introduction to Computer Science.
c) EE 001A, EE001LA, Circuit Analysis
d) ME 010, Statics.
e) MATH 009A, MATH 009B, MATH 009C, Calculus (three quarters); MATH 010A, MATH 010B, Multivariable Calculus (two quarters); MATH 010B, MATH 046, Differential Equations.
f) MSE 001, Fundamentals of Materials Science.
g) PHYS 040A, PHYS 040B, PHYS 040C, General Physics (Newton's laws, waves and heat, elasticity, fluids, and electricity/magnetism).

2. Upper-division requirements (53 units)
a) CHEM 112A, Organic Chemistry
b) CEE 135, Chemistry of Materials.
c) CHE 100, Engineering Thermodynamics.
d) EE 138, Electrical Properties of Materials.
e) ENGR 180W, Technical Communications.
f) ME 110, Mechanics of Materials; ME 114, Introduction to Materials Science & Engineering; ME 156, Mechanical Behavior of Materials
g) MSE 160, Nanostructure Characterization Laboratory; MSE 161, Analytical Materials Characterization; MSE 175A, MSE 175B, Senior Design.
h) STAT 155, Probability and Statistics for Science and Engineering.
i) Technical Electives (20 units): chosen from BIEN 140A/CEE 140A, BIEN 140B/CEE 140B, Biomaterials; CEE 147, Bio-Microelectromechanical Systems; EE 133, Solid State Electronics; EE 136, Semiconductor Device Processing; EE 137, Introduction to Semiconductor

Optoelectronic Devices; EE 139, Magnetic Materials; ME 113, Fluid Mechanics; ME 116, Heat Transfer; ME 138, Transport Phenomena in Living Systems; ME 153, Finite Element Methods; ME 180, Optics and Lasers in Engineering.

To provide depth in satisfying breadth in the humanities and social sciences, at least two of the courses must be upper division. Further, at least two courses, one of them upper division, must be from the same subject area. The list of approved courses is available in the Office of Student Academic Affairs.

F. Transcripts of Recent Graduates

The 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. These transcripts will be requested separately by the team chair.

G. Diversity in the Bourns College of Engineering

Figure 1-6. Associate Dean C.V. Ravishankar, left, accepts the 2009 Claire Felbinger Award from ABET President-Elect David Holger.

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) (Table 1-3). 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 (Figure 1-6). 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.

Table 1-3. 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.

In agreement with the College vision, the vision of the Materials Science and Engineering program is to provide fundamental knowledge for the understanding of materials with the objective of predicting, modifying, and tailoring the properties of materials to achieve enhanced performance of devices based on these materials. The MSE program at UCR is designed with the premise that materials scientists and engineers should not work in isolation but rather work closely with engineers in other disciplines since we realize that other engineers are often the end-users of materials. The interdisciplinary nature of the MSE program at UCR is ideally suited to address this requirement.

In addition to the four fundamental elements of materials science and engineering — properties, structure and composition syntheses and processing and performance (discussed below) — the MSE program at UCR emphasizes other related core strengths of BCOE such as nanotechnology, materials for energy generation and storage and sustainability. It is synergetic with the campus efforts in nanotechnology and the only program that involves all five departments of the College of Engineering.

The MSE program at UCR provides training in the four aspects of materials science and engineering, properties, structure and composition syntheses and processing and the strong interrelationship among them that define the discipline of MSE. These elements known as the MSE tetrahedron are shown schematically in Figure 2-1. The emphasis on these fundamentals ensures that graduates receive an education that is not solely driven by current market pressures but rather have the knowledge to perfume effectively in industry and have the fundamental underpinnings that permit them to pursue graduate work.

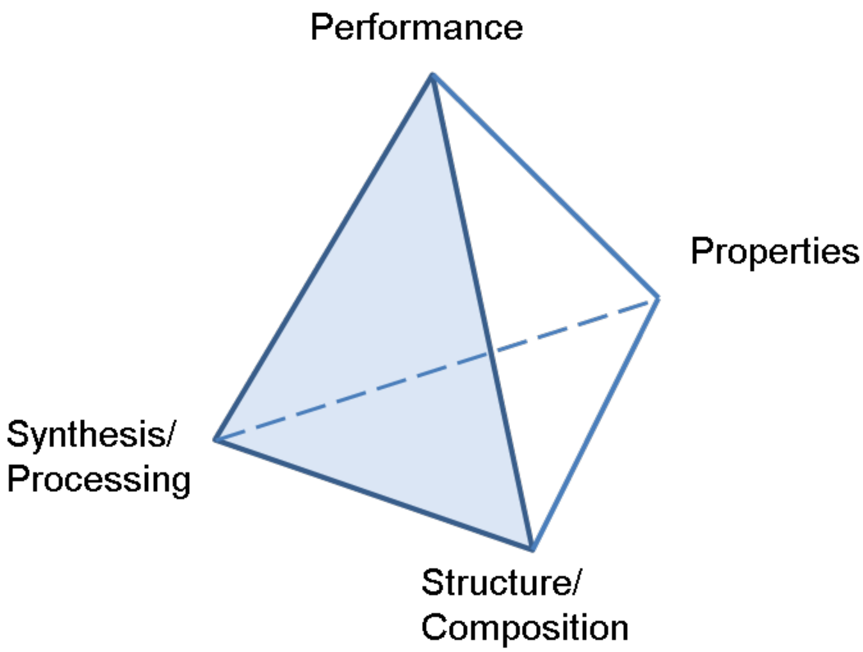

Figure 2-1. A schematic representation of the four fundamental elements of MSE

B. Program Educational Objectives

The MSE Program Educational Objectives are to produce materials scientists and engineers who:

1) Have the knowledge and skills to adapt to the dynamic engineering environment in industry.
2) Are able to pursue and succeed in graduate studies.
3) Exercise professional responsibilities and are sensitive to a broad range of societal concerns, such as ethical, environmental, economic, regulatory, and global issues.
4) Have an ability to work in multi-disciplinary teams.
5) Engage in a lifetime of learning.

These Program Educational Objectives are published on the MSE web site and submitted for publication in the next version of the UCR course catalog.

These Program Educational Objectives are met through:

1) Strong training in the areas of mathematics, science, and the fundamentals of materials science and engineering that constitute the foundation of the discipline.
2) Extensive laboratory and hands-on experience to strengthen understanding of fundamental principles.
3) Exposure to contemporary computer/numerical methods.
4) Application of knowledge to design problems common to modern engineering practice.
5) Emphasis on both oral and written communication throughout the curriculum.
6) A well-rounded and balanced education achieved through required studies in selected areas of the Humanities and Social Sciences.

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

The mission of the Bourns College off Engineering is inherently broader than the goals of the Materials Science and Engineering program since the College's mission includes its graduate programs and several centers. Table 2-1 maps the Educational Objectives of the Materials Science and Engineering Program to the objectives of the University and the College.

Table 2-1. Alignment of the objectives of the University and, the College with the Materials Science and Engineering Program Educational Objectives.

	MSE PEOs				
	1. Adaptable to dynamic engineering environment	2. Graduate studies	3. Professional responsibility	4. Multi-disciplinary teams	5. Lifetime learning
Chancellor's Strategic Goals					
1. Enhance UCR's ranking		X	X	X	
2. Invest in areas of strength		X		X	X
3. Expand opportunity; be a "first choice" campus	X	X	X	X	X
4. Reshape the curriculum		X	X	X	X
5. Diversify faculty, staff, student ranks			X	X	
6. Build professional schools	X	X			
7. Forge closer ties with the community	X			X	X
BCOE strategic goals					
1. Serve rapidly evolving industries	X	X	X	X	
2. Research		X			X
3. Contribute to knowledge		X			X
4. Provide diverse curricula				X	X
5. Enable our graduates to serve in a wide variety of fields	X	X	X	X	X
6. Be a catalyst for industrial growth	X	X	X	X	X

D. Program Constituencies

The stakeholders of the Materials Science and Engineering program are MSE undergraduate and graduate students, program faculty and lecturers, program alumni, employers in industry, and representatives from graduate schools. The MSE program obtained informal feedback from industry and graduate schools through the advisory boards of the constituent departments and through informal contacts with colleagues. Inputs from faculty/lecturers and students have been obtained at a few formal faculty meetings and in informal meetings and consultations. No formal consultation of alumni has been undertaken yet because of the small number of graduates the program has produced since inception.

In 2012, the MSE program established its own Board of Advisors (BOA) with the appointment of three members from industry (Table 2-2). The primary purpose of the BOA is to provide insight and counsel to the Chair and members of the faculty in evaluating the effectiveness of the program and defining the future direction of the department, its curricul.um and degree programs (BS, MS, and PhD), and research directions.

We plan to increase the BOA to 10 members by June 2013.

We anticipate that the BOA will convene once each year for a day to discuss current issues. As needed, the Chair may also call upon Board members for individual advice and input. Areas for which the Chair seeks such counsel include, but are not limited to the following.

- Industry trends and needs, and how those should translate into curriculum
- Industry collaboration opportunities
- Centers of excellence
- Program expansion
- Industry recruitment process, internship and employment opportunities for UCR MSE students
- Consultation as stakeholder in ABET accreditation process

Given the significant industrial experience of our BOA, it serves as a vital link to the employer constituency.

Table 2-1. Materials Science and Engineering Program Board of Advisors.

Name	**Title**	**Affiliation**
Dr. Mike Clinch	Vice President of Technology & Innovation	Luxfer Inc
Dr. Joseph Wilde	Engineering Fellow	Raytheon
Dr. Leslie Momoda	Director, Sensors and Materials Laboratory	HRL Laboratories, LLC

E. Process for Revision of the Program Educational Objectives

A summary of the procedures adopted to review and refine the Program Educational Objectives and our assessment methodology is presented below:

- Program Educational Objectives are reviewed by the program faculty annually at a department planning retreat for faculty and lecturers (September of each year).
- An update of our assessment procedure and a review of our overall objectives are addressed as part of the agenda of Board of Advisors and stakeholders meetings.
- Program Educational Objectives guide our assessment process review at faculty meetings (monthly during the nine-month academic year).

CRITERION 3. STUDENT OUTCOMES

This section describes Student Outcomes and their relation to the Program Educational Objectives. Our process for evaluating Student Outcomes as well as the process by which the assessment results are applied to further develop and improve the program is described in the next section – Continuous Improvement.

A. Student Outcomes

To prepare students to attain the Program Educational Objectives we adopted the ABET Student Outcomes (a) through (k):

(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.

These Student Outcomes are posted on our website http://www.mse.ucr.edu/.

B. **Relationship of Student Outcomes to Program Educational Objectives**

Figure 3-1 indicates the relationship of the Student Outcomes to the Program Educational Objectives. To qualitatively delineate the most significant specific impacts of SOs to PEOs we developed the "influence" matrix shown in Figure 3-1.

PEOs /SOs	1 Adaptable to dynamic engineering environment	2. Graduate studies	3. Professional responsibility	4. Multi-disciplinary teams	5. Lifelong learning
(a) Apply STEM knowledge					
(b) Experiments, data					
(c) Design ability					
(d) Multidisciplinary teams					
(e) Solve problems					
(f) Professional and ethical responsibility					
(g) Communicate effectively					
(h) Context					
(i) Life-long learning					
(j) Contemporary issues					
(k) Techniques, skills, tools					

Figure 3-1. The connection between the Student Outcomes and the Program Educational Objectives for the Materials Science and Engineering program.

By way of an example, let us consider how SO(a), an ability to apply knowledge of mathematics, science, and engineering, relates to four of the five PEOs for the program. As a review of the curriculum and course files will show, MSE graduates are well-grounded in the mathematics, science, and engineering concepts that they will need to begin their careers or pursue higher studies. Because MSE students learn in a highly interdisciplinary environment, and because materials science and engineering touches on so many fields, they are exposed to examples of engineering challenges from many domains, ranging from biomedical technology to energy and environment. Because faculty members are encouraged to draw on examples from their own research in their teaching, undergraduates understand the pace of technological change and the many domains in which the concepts they are learning can apply PEOs 1, 2, and 5. They also learn about the constraints around engineering solutions – physical, economic, and, often, sociopolitical. This training speaks to PEO 3.

CRITERION 4. CONTINUOUS IMPROVEMENT

As we noted in the Program History in the Background Information section of the self-study, assessment of the Materials Science and Engineering Program's educational effectiveness requires a heavy reliance on departmental efforts and coordination among the departments. This section describes the processes and tools used for evaluating the success of our courses and curriculum, and how we use those tools to (a) assure that Student Outcomes are being attained and (b) identify the need for any changes.

A. Program Educational Objectives

Table 4-1 summarizes the processes and instruments that every program in the Bourns College of Engineering uses to evaluate its Program Educational Objectives. A discussion of the mechanisms follows the table. Because the MSE is so new, the full cycle of assessments has not yet been completed. The MSE graduates have not been in the workplace long enough to obtain sufficient information for proper assessment of the PEOs.

Table 4-1. Mechanisms for evaluating attainment of the Materials Science and Engineering Program Educational Objectives.

Mechanism	***Frequency***
Alumni survey	At least every two years
Employer surveys	At least every two years
Board of Advisors meetings	Every year
Informal feedback	Intermittent

- Alumni surveys: The Bourns College of Engineering maintains an account with a web-based surveying service (SurveyMonkey) so it can conduct surveys of alumni and employers. We also occasionally review surveys that other engineering programs conduct. Since it is understood that Program Educational Objectives speak to the performance and abilities of alumni three to five years after completion of the bachelor's degree, most departments conduct their surveys every two years. This enables us to obtain two to three data points per alumnus.

- Employer surveys: We use the same survey system to ask employers about the qualities of our alumni. When we send the survey to our alumni, we ask them to forward a message to their supervisors with a link to a second survey for them to complete. Our experience, however, has been that the return on this survey is generally poor. We hypothesize that some of our alumni do not feel comfortable asking their supervisors to complete the survey, and that some employers do not respond because they are fearful of legal consequences.

- Board of Advisors meetings: We strive to have companies that hire our alumni on our advisory boards. Thus, the Board of Advisors industry members stand in as surrogates for employers for our evaluation purposes.

- Informal feedback: We obtain additional information from the UCR Career Center about placement of our alumni and their career progress, and UCR's Alumni Affairs office makes efforts to track our alumni. Further, alumni often come back to visit, or contact faculty members for recommendations when they have applied to graduate school or jobs (or are seeking prestigious graduate fellowships). These contacts give us a sense for how the students are performing after graduation, although the information does not come in a consistent enough format for a data-driven analysis of our PEOs.

All graduating seniors are required to complete an extensive exit survey, administered by EBI. The MSE program has only two years of data from this survey so far, but the results show that students are satisfied that the curriculum is meeting the targeted Student Outcomes (Figure 4-1).

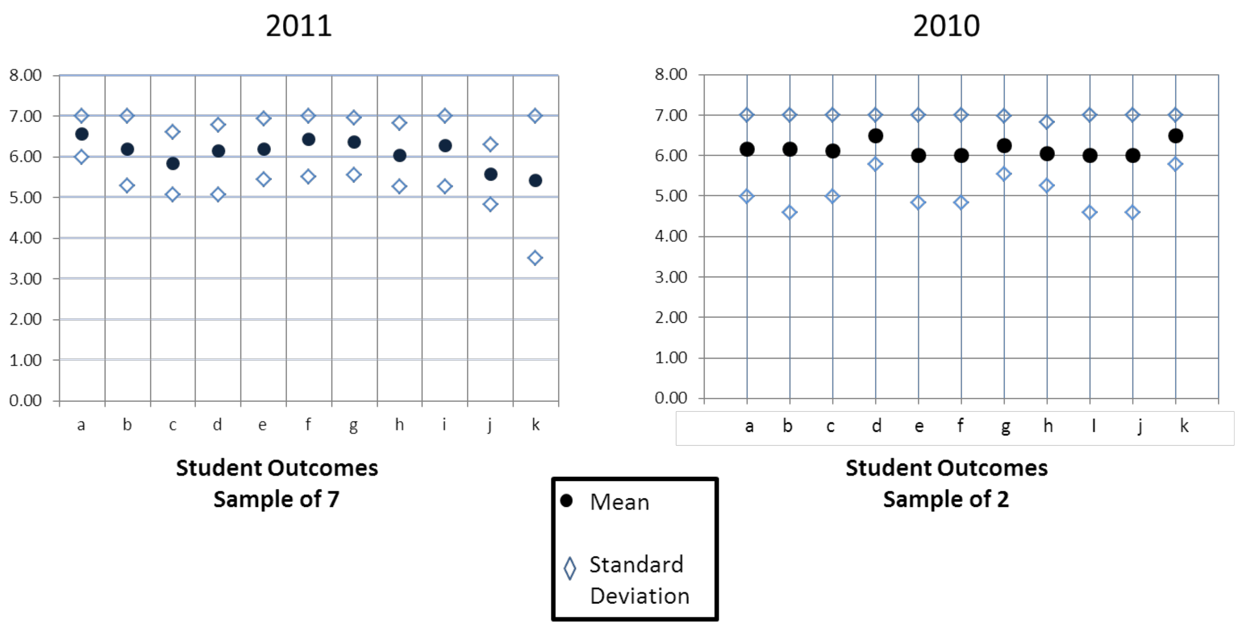

Figure 4-1. EBI student exit (for MSE students) survey results show high satisfaction with the Student Outcomes. Ratings are on a 7-point scale, 7 being highest.

B. Student Outcomes

To prepare students to attain the Program Educational Objectives we adopted the ABET Student Outcomes (a) through (k):

(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.

Achieving these Student Outcomes in the MSE program requires students to complete courses in a number of BCOE departments. Every program has fundamentally the same approach to establishing the *course objectives* (not to be mistaken with Program Educational Objectives), which relate directly to the Student Outcomes, and subsequently measure the extent to which students are achieving the course objectives. It is important to note that a course has only one set of objectives; it cannot serve one purpose for MSE and another for, say, Electrical Engineering. MSE achieves its unique set of Student Outcomes and Program Educational Objectives by assembling a curriculum from the departmental offerings and by offering its own dedicated courses.

The course objectives are established by the faculty such that the entire course of study leading to a bachelor's degree that fulfills the requirements of the University of California and of any professional societies and accrediting bodies – and, of courses, addresses the needs identified by the program's constituencies. The instructor of each course implements the course objectives through some combination of readings, lectures, homework assignments, labs, and quizzes and examinations. The relationship between the course objectives and the Student Outcomes is documented in a matrix; Table 4-2 provides an example from Electrical Engineering. The instructor selects particular exercises throughout the course to measure student performance on each course objective. The matrix is then used to compute the performance on the Student Outcomes. The exercises used for assessment may include exam questions, quiz questions, homework questions, and class projects. The analysis of this data results in a quantitative measure of the efficiency with which the students achieve both the course objectives and the Student Outcomes.

Table 4-2. The course matrices for Electrical Engineering courses that are included in the MSE curriculum, mapped to the Student Outcomes.

Course#:	**Course Name:**	**Student Outcomes**										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
EE-1A	Engineering Circuit Analysis I	X	X									
EE-1B	Engineering Circuit Analysis II	X	X									
EE-138	Electrical Properties of Materials	X										

The instructor monitors student progress during the quarter and can make adjustments to the teaching schedule or homework assignments if it is apparent that more work is necessary for students to grasp a needed concept. At the end of each course, students are also asked to complete surveys in which they report their perceived level of accomplishment of the both the course objectives and the Student Outcomes. (It is understood, however, that student opinions on what they believe they have learned cannot stand on their own as a measurement of student accomplishment.)

In general, Student Outcomes are considered to have been achieved if two-thirds of the class shows sufficient command of the concepts. This level of achievement is set in concert with the departments that control the course offerings. As noted earlier, MSE core courses are in several departments. The content, targeted Student Outcomes, and success metrics are developed by the departments in consultation with the MSE program leadership.

At the end of the quarter, the instructor inserts material into the ABET course binder and communicates recommendations on course changes to colleagues in the department. In the case of a course that is central to more than one degree program, the chair of the collaborating program also is consulted. Subsection C describes how changes are implemented for continuous improvement.

C. Continuous Improvement

At the end of each class, the instructor evaluates the assessment results including (a) quantitative performance on the course objectives and (b) Student Outcomes and qualitative performance on these measured with student surveys. The instructor uses this data to recommend changes to improve the course. In making these recommendations, the instructor may also consider a variety of other qualitative data. This may include particular types of errors students made on homework and exam problems, feedback from students during office hours, and faculty course evaluations administered by campus. The recommendations are recorded on a form included in the ABET course binder.

The recommendations provided by the instructors are reviewed quarterly by the MSE Course Assessment committee (please see below for description).

Minor tweaks to a course are handled by the instructor in consultation with the department chair (and, in the case of MSE, the program chair). More significant changes to a course are reviewed and approved formally by a departmental curriculum committee (which includes the department's MSE representative), and then by the BCOE Executive Committee, and ultimately by the Academic Senate (Figure 4-2). Approved changes appear in the next edition of the UCR General Catalog.

To assure continuous improvement and assess the effectiveness of courses, the MSE program has established a committee called the MSE Course Assessment committee. The charge of the MSE curriculum assessment committee is to assess how well the required MSE courses are meeting the needs of the MSE program. Many courses required by the MSE program are taught by other programs. The committee looks at the assessments (recommendations, changes etc.) provided by other programs on courses and evaluates assesses whether they are appropriate for MSE Program Educational Objectives. The information assessed comes from the Course binders. The committee meets at least once per quarter (at beginning of quarter). The committee then initiates any necessary changes in consultation with MSE program chair.
The committee members and chair are:

MSE curriculum assessment committee

Chair: David Kisailus

Members:
Lorenzo Mangolini, MSE, ME
Philip Christopher, MSE, CEE

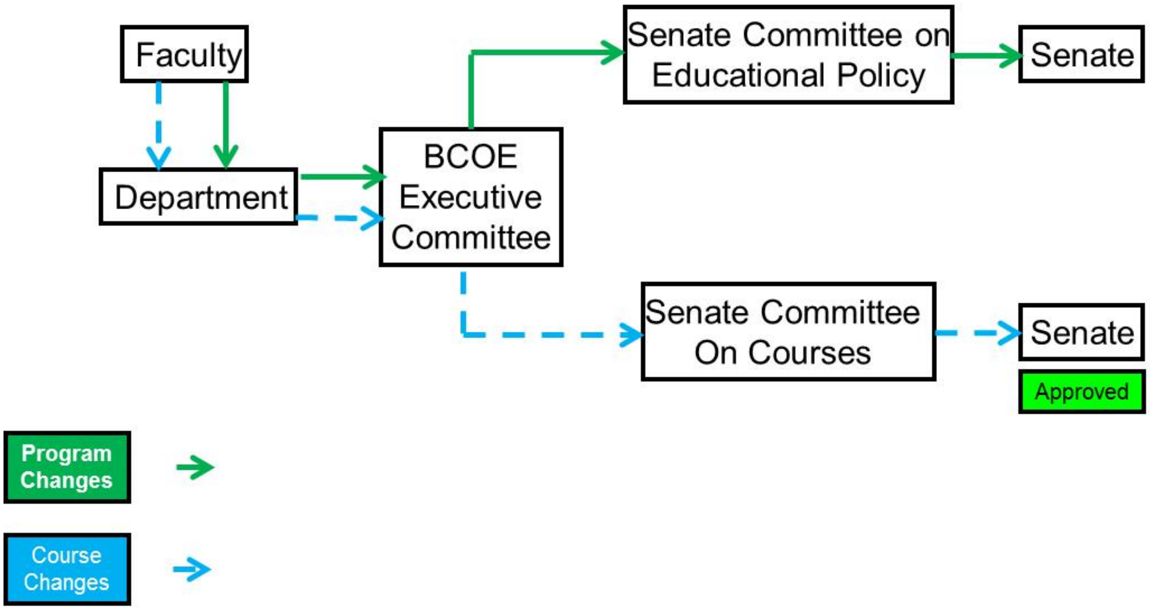

Figure 4-2. The process for changes to curriculum at UCR.

When a course is taught the next time, the instructor reviews the course changes recommended by the previous instructor and identifies suitable improvements. Often, the same instructor teaches the course, so there is solid "institutional knowledge" about the evolution of the course, the purpose of the course, and the performance of students in the course. Regardless of whether the instructor is new or continuing, the instructor summarizes any changes on a new recommendation form. At the end of the course, the instructor adds recommendations for the next instructor, and the process repeats. As mentioned above, the MSE Course Assessment Committee reviews these recommendations quarterly. Below are a few examples on MSE required courses.

Example: Chemical and Environmental Engineering 135, Chemistry of Materials

In CEE 135, there are 5 assigned Student Outcomes that are independently assessed within the course. The instructor is expected to directly link (whole or part) of a homework, quiz, midterm exam question(s), oral report, written report, design project, laboratory report, or final exam question(s) to the SOs assigned to the course.

Each element used must independently assess a single Student Outcome so as to ensure a unique result to the SO score from the class. The following are SOs addressed by CEE 135.

Student Outcomes b, c, f, i, and j are evaluated in this course:

- Outcome b: An ability to apply knowledge of science
- Outcome c: An ability to apply knowledge of engineering
- Outcome f: An ability to analyze and interpret data
- Outcome i: An ability to identify, formulate, and solve engineering problems
- Outcome j: A knowledge of contemporary issues

Each course instructor identifies the unique question(s) used to assess the SO and reports the average student score on that question.

A number of review loops are used in the Materials Science and Engineering degree program for continuous improvement. At the course level, each course instructor is required to, prior to the start of the class:

1. Perform a course pre-assessment, where the faculty member reviews the notes and post-assessment of the class from the year prior. Any changes to the course as a result of the prior year's pre-assessment or based on departmental needs are documented there (e.g., an increased emphasis on a course objective or an SO/PEO).
2. Evaluate and update course syllabus.
3. Evaluate and update course objectives—especially in light of student performances from the previous year or as a result of increased emphasis as cited by needs (SOs/PEOs).

At the end of the class, the students are surveyed to assess achievement of course objectives. These surveys are quickly returned to the instructor within two weeks of the end of the course to be used in a post-course evaluation form. In the post-evaluation course form, improvements/changes in the course are assessed for their effectiveness and suggested changes based on student grades and/or course surveys are suggested.

At the program level, the course outcome scores and exit surveys linked to Student Outcomes (a) – (k) are reviewed by the MSE course assessment committee and action items are suggested by the committee for the upcoming academic year to improve upon course outcomes as specified by the committee. These changes may include:

1. Recommendation to faculty of specific courses to incorporate changes to improve attainment of course outcomes.
2. Recommendation to all faculty to emphasize various Student Outcomes.
3. Recommendation for major changes (course addition/removal) to reflect constituent needs.

All recommendations are then discussed at the departmental level and implemented by entire faculty.

Figure 4-3 depicts the system used by the MSE Program to "foster the systematic improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and competitive environment.” The yellow boxes refer to the processes used in the system, while the blue boxes refer to the “objects” that these processes operate on.

Course objectives are formulated to yield course outcomes, which in turn produce program outcomes. The program outcomes are designed to foster attainment of Program Educational Objectives.

The outcomes are assessed to produce qualitative and quantitative measures of performance. These measures are then evaluated against metrics. We have not established absolute metrics to evaluate assessment results. We have evaluated these results by quantifying year to year changes in measures of their relative importance in the curriculum and student performance in achieving them.

Evaluation of results from outcomes assessment leads to the modification of a variety of components of the educational process to improve the effectiveness of attaining program outcomes and Program Educational Objectives. The processes illustrated in Figure 4-3 are used by a stakeholder group consisting of faculty members, graduate and undergraduate students, alumni, and industry representatives.

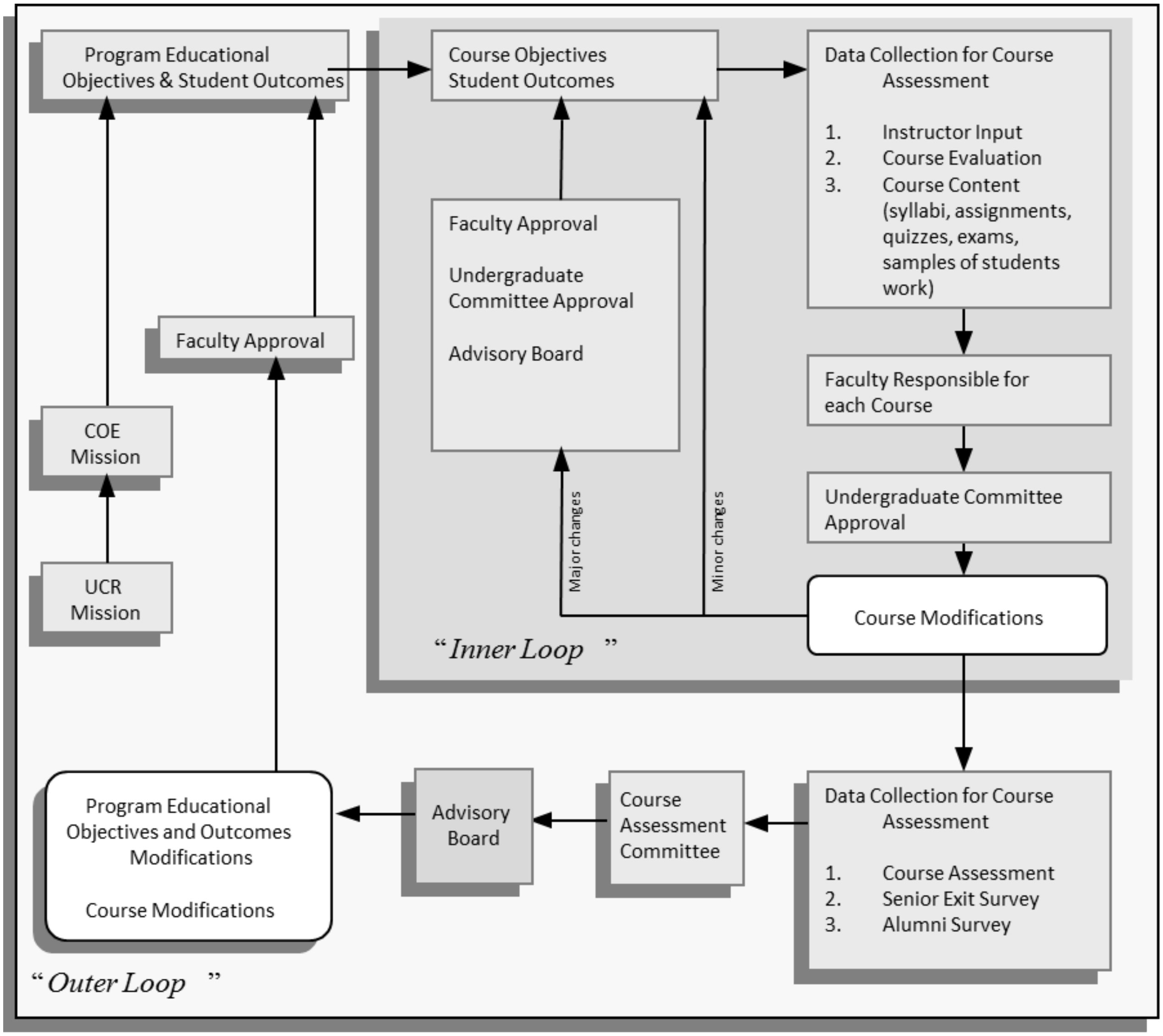

Figure 4-3. The process to make continuous improvements in the MSE program to achieve Student Objectives formulated by stakeholders.

In summary, the assessment process results in:

1. Relative weights assigned to Student Outcomes by each course in the program.
2. Grade-based measures of degree of achievement of course objectives and Student Outcomes.
3. Survey-based measures of degree of achievement of course objectives and Student Outcomes.
4. Comments from students on course shortcomings and possible improvements in course.

This information is used by faculty members to improve the course. Faculty members also rely on formal teaching evaluations conducted by the University.

Other Student Outcome Analysis Mechanisms

The College and the campus also perform assessments to evaluate student expectations and performance. At the campus level, the most significant assessment tool is the UC Undergraduate Experience Survey, or UCUES. This is a uniform questionnaire, which is administered at all UC campuses. Each campus also is able to add its own questions. The questionnaire is administered every two years, although there is some discussion of converting to an annual format. While UCUES does not enable us to compare our student responses directly with those of non-UC campuses, it does provide a basis for comparison with all of the other UCs with undergraduate programs (note that UC San Francisco has no undergraduate programs).

As noted earlier, UCR also conducts an annual senior exit survey (see Figure 4-1). This survey is not particularly valuable for assessing the Engineering Student Outcomes because of its breadth. The MSE program also conducts our own exit survey.

The campus has developed a single relational database (200 fields) to answer queries on student performance and trends, with longitudinal information. There is tiered access to different levels of detail; this protects the privacy of the students for whom data are gathered. As the database is populated with new information, it should be a valuable resource for providing information on the performance of engineering students in non-engineering courses and for evaluating their overall experiences.

Examples of Curriculum Changes Resulting from the Process

Since the MSE program began, the process described above has resulted in changes to specific courses and to BCOE's educational approach. Examples include:

- MSE 001. In Fall, 2009, a number of students did not pass the MSE 001 (Fundamentals of Materials) course. In the instructor's opinion (David Kissailus), he had given the students too much information to learn for a 2 unit course and had required too much in terms of reading and examinations. For example, in 2009, the syllabus required the students to read 30 chapters from the text book, all of which were covered in a total of 20 lecture hours. In addition, the instructor required the students to take 2 mid-term examinations and give a final 20-minute group presentation. After the course was finished the instructor evaluated his syllabus and felt it was too much to expect students taking a 2-unit course to be responsible for so much material and that that type of workload was more suited for a 4 unit course.

  To remedy this, in Fall 2010, the same instructor modified the syllabus such that the students were still exposed to the core material needed for this course, but removed the chapters on case studies as required reading, and instead, provided examples during the lectures that covered that material. In addition, he reduced the testing requirements to 2 short quizzes, 1 midterm (versus 2) and 1 final exam (versus a lengthy presentation). The result was a significant improvement in the passing rate in this course From Fall 2009 to

Fall 2010, the failure rate declined from 18.2% to 12.5%. (The figure was less than 10% in Fall 2011, but enrollment that year was very small.)

This change addressed the need to assure that MSE students are fulfilling Student Outcomes: (b) an ability to apply knowledge of science; (c) an ability to apply knowledge of engineering;(f) an ability to analyze and interpret data); (i) an ability to identify, formulate, and solve engineering problems.

- Course scheduling. In 2011 and 2012, the Chair of the MSE program began working closely with the department chairs to assure that MSE courses are available in the quarters that they are needed so MSE students can be assured of timely graduation. As described earlier, many courses that MSE students take are offered by other programs within BCOE. It is thus essential that courses required for MSE are offered in the same quarter every year. This is ensured meeting between the MSE chair and other chairs where teaching course plans are shared and discussed. This speaks to the need to achieve all Student Outcomes, which can happen only if students complete the entire course of study.

- Ensuring the involvement of all departments. To address Student Outcomes (d) and (h) (the ability to function on multidisciplinary teams and the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context), among others, the MSE program committee on 4/05/2012 voted to include Bioengineering 140A, Biomaterials, as a core course. Previously, no Bioengineering course was a required course for MSE. This will ensure more buy-in from all 5 departments.

D. Additional Information

Copies of assessment materials will be available for the site visit.

CRITERION 5. CURRICULUM

A. Program Curriculum

A.1. Table of MSE Curriculum

Table 5-1 appears at the end of this section. UCR operates on academic quarters.

A.2 How the Curriculum Aligns with the Program Educational Objectives

The Materials Science and Engineering Program Educational Objectives presented in Section 2 are broadly met through a curriculum that offers:

- A well-rounded and balanced education achieved through required studies in selected areas of the humanities and social sciences.
- Strong training in the areas of mathematics, science, and the fundamentals of engineering that constitute the foundation of the discipline.
- Laboratory and hands-on experience to strengthen understanding of fundamental principles, with opportunities for teamwork, written communication, and oral communication.
- Use of computer simulation and modeling in the solution of problems and in design.
- Application of knowledge to design problems common to modern materials science and engineering practice.
- Introduction of design for manufacturability, engineering economics, and engineering ethics into the curriculum to emphasize the relationship between design, fabrication, cost, and impact on society.
- Freedom for the student to mold his or her program of professional specialty studies by allowing each student to choose from a number of technical electives and offering a selection of senior design capstone projects sponsored by faculty and industrial sponsors.

The relationship between each Program Educational Objective and the curriculum is discussed in some detail below.

PEO 1: To produce materials scientists and engineers who have the knowledge and skills to adapt to the changing engineering environment in industry

PEO 2: To produce graduates who are able to pursue and succeed in graduate studies

The technical rigor required to pursue advanced graduate degrees in materials science and engineering and other allied fields is emphasized in our basic curriculum. Students are exposed to basic mathematical tools including applied linear algebra, solution of ordinary, and partial differential equations relevant to mechanical engineering science, thereby preparing them for advanced degrees in engineering and other technical disciplines. In addition, the curriculum allows students the explicit option to experience research under faculty supervision as a technical elective. Faculty are available to advise students about career options that include opportunities for advanced study through graduate education.

PEO 3: To produce graduates who have the educational breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law

Science and engineering courses discussed in the context of Program Educational Objective 1 provides students with disciplinary intellectual rigor required to succeed in industry or in their pursuit of advanced degrees. The ability to formulate problems, make and test assumptions, predict and solve problems enable students to branch out in to other professional areas such as business and law. In addition, the College has breadth requirements that include English composition, Humanities, Social Sciences, and Ethnicity. Thus the overall set of skills acquired, enable graduates to make contributions to society in a multitude of fields.

PEO 4: To produce graduates who have an ability to work in multi-disciplinary teams.

Materials Science and Engineering as a field of study is inherently multidisciplinary. The UCR MSE program exemplifies this multidisciplinary nature by having required courses from many engineering disciplines as well as physics, chemistry and mathematics. Thus the students are exposed to and work with students majoring in other engineering and science fields. This is likely to make graduates comfortable with cooperation and interaction in multidisciplinary teams.

PEO 5: To produce graduates who engage in a lifetime of learning

Most courses assign problems and design projects that require research and understanding of material not included in the syllabus. The program's emphasis on design provides a natural avenue that promotes intellectual curiosity. All technical elective classes expose students to state of the knowledge in those areas highlighting open questions, unsolved problems, etc. This is likely to promote the need to engage in lifelong learning.

A.3 How the Curriculum Supports the Attainment of Student Outcomes

The Student Outcomes (a)→(k) are listed below.

(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.

Table 5-2 show the relationships between MSE required courses and the (a)$\rightarrow$(k) Student Outcomes.

Table 5-2. Connection of MSE courses and Student Outcomes.

Course	a	b	c	d	e	f	g	h	i	j	k
CHEM 001A	X										
CHEM 01LA	X	X									
CHEM 001B	X										
CHEM 01LB	X						X				
CHEM 001C	X	X									
CHEM 01LC	X	X					X				
CS 030	X										
EE 001A	X										
EE001LA	X	X		X			X				X
ME 010	X										
PHYS 040A	X										
PHYS 040B	X										
PHYS 040C	X										
MATH 009A	X										
MATH 009B	X										
MATH 009C	X										
MATH 010A	X										
MATH 010B	X										
MATH 046	X										
CHEM 112A	X										
CEE 135	X										
CHE 100	X										
EE 138	X			X	X						X
ENGR 180W	X						X				
ME 110	X										
ME 114	X										X
ME156	X			X	X		X				X
MSE 160	X	X			X						X
MSE 161	X	X			X						X
MSE 175A	X	X	X	X	X	X			X	X	X
MSE 175B	X	X	X	X	X	X			X	X	X
STAT 155	X	X			X						X
Tech Electives										X	
Breadth courses								X			

A.4 Prerequisite Structure

Table 5-3 shows the progression through pre-requisites required of MSE students. The courses in the **(A. Course)** column represent all of the engineering courses required for an MSE degree. The courses in the (B. **Pre-requisite**) column are the prerequisite for those in the **(A. Course)** column and the course in the (C. **Required for)** column are the courses that may be taken after the course in the **(A. Course)** has been taken**.**

Table 5-3. Pre requisite structure.

A. Course	B. Pre-requisite	C. Required for
CS 030	MATH 009C	
EE 001A	MATH 046, PHYS 040C, CONCURRENT ENROLMENT IN EE 01LA	EE 105, EE 133, EE134
EE 001LA	EE001A	EE 105, EE 133, EE134
ME 010	MATH 009C, PHYS 040A	ME 110,
MSE 001		
CEE 135	CHEM 112A, MATH 009B	MSE 160
CHE 100	CHEM 001C, MATH 010A, PHYS 040B	CHE 116, CHE 161
EE 138	PHYS 040C OR EQUIVALENT	
ENGR 180W	A GRADE OF C OR BETTER IN ENGL 001B	
ME 110	MATH 046, ME 010, ME 018	ME 156
ME 114	CHEM 001B, PHYS 040C	ME 156, MSE 160
ME 156	ME 110, ME 114	
MSE 160	CEE 135 (F12), ME 114	MSE 161
MSE 161	MSE 160	
MSE 175A	CHE 116 OR ME 116A; EE 139	MSE 175B
MSE 175B	MSE 175A	

A.5 Meeting the Requirements for Hours, Depth, and Breadth

To provide depth in satisfying breadth in the humanities and social sciences, the MSE program requires at least two of the courses must be upper division. Further, at least two courses, one of them upper division, must be from the same subject area. The list of approved courses is available in the Office of Student Academic Affairs.

A.6 Design Experiences

The Senior Design Project (MSE175 A-B) is planned as rigorous two-quarter course that provides students the experience of designing a real-life project. At the initial stage of the MSE program development the Senior Design Projects to MSE students were offered via the existing Senior Design Projects of the participating departments, e.g. Electrical Engineering (EE175 A-B) or Mechanical Engineering (ME175 A-B). <u>To ensure the design project relevance to the MSE</u>

educational goals the projects were carried out in the laboratories of participating MSE faculty. As the number of students in the program grows MSE175 will be offered independently.

The following procedures are common for all Senior Design Projects at BCOE. 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 engineering courses. In fact, each project requires knowledge and skills from multiple engineering courses.

For MSE students in their design projects, we specifically require substantial materials component in addition to identification of the engineering standards and design constraints. 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. Please note these are in syllabus form.

Prerequisites

The students must have senior standing in Materials Science and Engineering.

Objectives

The Senior Design Project is the culmination of coursework in the bachelor's degree program in MSE. In this comprehensive two-quarter course, students are expected to apply the concepts and theories of materials science and 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 (Table 5-4):

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

Table 5-4. Course objectives and their relationship to Student Outcomes for the MSE capstone design course.

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 Senior Design Project class 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 are 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, materials selection or synthesis, hardware and software design, test plan and test, broad impact and ethical issues, among other things. Note 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, Materials Selection 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, materials properties, 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 (e.g. reusable materials), 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. **Materials Characterization and 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 meet 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 a convincing evidence that you 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 your 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 a 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 instructor. 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 5-5 shows a typical organization of the course (sample from 2011-12 academic year).

Table 5-5. Typical capstone design course organization.

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, and 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 project definition and feasibility study, and go through one or more iterations of specification, design review, prototyping, testing and revision. Students are also responsible to 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 to follow 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. Assembly of project subsystems requires a preparation of test plans and test reports; requires conducting relevant data analysis and a development of subsystems' specifications.

3. 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.

The selected topics for MSE Senior Design Projects should have a clear materials science component. Examples of recent projects with materials focus (in Professor A.A. Balandin's lab) include Design of Thermoelectric Element with High-ZT Material, Nanostructure-Based Photovoltaic Solar Cell; Design of the Thermal Interface Materials for Thermal Management of Electronics.

Engineering Standards and Multiple Design Constraints

Every design project involves industry standards, some more and some less, depending on what is being designed. The most widely involved standards are interfacing standards, e.g., I2C, SPI, RS232/UART, USB, etc. The based on modern system engineering practices adopted by both industry and government [1], and includes elements of

1. ISO 9000 standards on "*Quality Management*",
2. ISO/TC 207 "***Environmental management***" [2] and similar,
3. Standards specific to the electrical and computer engineering discipline [3] or,
4. Standards related to health and safety government regulation standards [4].

[1]Frank Hoban, Ed Hoffman, "NASA Systems Engineering Handbook", SP-610S, STD-8739-8, NASA Headquarters, 1995
[2] International Organization for Standardization, http://www.iso.org
[3] IEEE Standards Association, http://standards.ieee.org/

[4] ANSI Standards Education Database,
http://www.ansi.org/education_trainings/stand_edu_database.aspx

A.7 Cooperative Education

Not applicable. The program does not allow cooperative education to satisfy curricular requirements.

A.8 Materials Available for the Site Visit

The following materials will be ready for review during the visit by the ABET examiners:

1. Course files, which will include syllabi, textbook, lectures notes, homework assignments, mid-term and final examinations, and examples of student work in homework and examinations. Each file will also include a course matrix, and summary of student performance in achieving course objectives and Student Outcomes.
2. Files organized in terms of Student Outcomes. These files will include course material relevant to each Student Outcome, assessment of student performance and survey responses, and descriptions of modifications in courses to improve performance in achieving Student Outcomes.
3. Minutes of meetings and discussions held by faculty to formulate course objectives and modify program in response to assessment process.
4. Survey forms used to measure attainment of course objectives and Student Outcomes.
5. Alumni and employer survey questionnaires and results.
6. Laboratory manuals describing experimental procedures.
7. Health and safety manuals used in laboratories.
8. Equipment lists.
9. University evaluations of teaching by faculty members.

B. Course Syllabi

A syllabus for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5 or any applicable program criteria is included in the appendices.

TABLE 5-1 Curriculum
Materials Science & Engineering

MATERIALS SCIENCE & ENGINEERING COURSES		Indicate Whether Course is Required, Elective or a Selected Elective (R, E, SE)	Subject Area (Credit History)				Last Two Terms the Course was Offered:	Maximum Section Enrollment for Last Two Terms Course was Offered:
Department and Course Number	Title		Math & Basic Sciences	Engineering Topics (if contains signif. Design)	General Education	Other		
FALL QUARTER, YEAR 1								
CHEM 001A/LA	General Chemistry	R	5				W2012, F2011	539, 1140
ENGL 001A	Beginning Composition	R			4		W2012, F2011	917, 1136
MATH009A	First-Year Calculus	R	4				W2012, F2011	275, 440
MSE 001	Fundamentals of Materials Science & Engr	R		2			F2011, F2010	21, 23
WINTER QUARTER, YEAR 1								
CHEM 001B/LB	General Chemistry	R	5				W2012, S2011	978, 724
ENGL 001B	Intermediate Composition	R			4		W2012, S2011	1716, 2145
MATH 009B	First-Year Calculus	R	4				W2012, F2011	848, 756
SPRING QUARTER, YEAR 1								
CHEM 001C/LC	General Chemistry	R	5				F2011, S2011	425, 792
MATH 009C	First-Year Calculus	R	4				W2012, F2011	407, 423
Breadth __________		R			4			
FALL QUARTER, YEAR 2								
CHEM 112A	Organic Chemistry	R	4				W2012, F2011	518, 725
MATH 046	Differential Equations	R	4				W2012, F2011	272, 421
PHYS 040A	General Physics	R	4				W2012, F2011	354, 283
Breadth __________		R			4			
WINTER QUARTER, YEAR 2								
MATH 010A	Multivariable Calculus	R	4				W2012, F2011	331, 257
ME 010	Statics	R		4			W2012, S2011	150, 42
PHYS 040B	General Physics	R	4				W2012, S2011	260, 345
Breadth __________		R			4		W2012, F2011	50, 42
SPRING QUARTER, YEAR 2								
CS 030	Intro to Computational Science & Engr	R		4			S2011, S2010	12, 12
EE 001A/LA	Engineering Circuit Analysis I & Lab	R		4			F2011, S2011	175, 145
MATH 010B	Multivariable Calculus	R	4				W2012, F2011	196, 100
PHYS 040C	General Physics	R	4				F2011, S2011	289, 244
FALL QUARTER, YEAR 3								
CEE 135	Chemistry of Materials	R		4			F2011, F2010	47, 38

EE 138	Electrical Properties of Materials	R		4			F2011, F2010	28, 14
ENGR 180W	Technical Communications	R			4		F2011, W2011	48, 47
ME 114	Intro to Materials Science & Engr	R		4			F2011, F2010	128, 111
WINTER QUARTER, YEAR 3								
CHE 100	Engineering Thermodynamics	R		4			W2012, W2011	119, 55
ME 110	Mechanics of Materials	R					W2012, W2011	114, 107
Technical Elective**		R		4				
Breadth __________		R			4			
SPRING QUARTER, YEAR 3								
ME 156	Mechanical Behavior of Materials	R		4			F2011, S2011	25, 43
MSE 160	Nanostructure Characterization Lab	R		4			S2011, S2010	16, 7
Technical Elective**		R		4				
FREE ELECTIVE		R				X		
FALL QUARTR, YEAR 4								
MSE 161	Analytical Materials Characterization	R		4			F2010	11
STAT 155	Probability & Statistics for Engineers	R	4				W2012, F2011	99, 94
Technical Elective**		R		4				
Breadth __________		R			4			
WINTER QUARTER, YEAR 4								
MSE 175A	Senior Design	R		4				
Technical Elective**		R		4				
Breadth __________		R			4			
SPRING QUARTER, YEAR 4								
MSE 175B	Senior Design	R		4				
Technical Elective**		R		4				
Breadth __________		R			4			
		R						
TOTALS-ABET BASIC-LEVEL REQUIREMENTS			59	70	40			
OVERALL CREDIT HOUS FOR COMPLETION OF THE PROGRAM			169					
PERCENT OF TOTAL			35%	41%	24%			
Total must satisfy either credit hours or percentage	Minimum Quarter Credit Hours		48	72				
	Minimum Percentage		25	37.5				

TECHNICAL ELECTIVES & FOCUS AREAS

POLYMERS and BIOMATERIALS (BIEN)

BIEN 140A	Biomaterials	SE		4			W2012, S2011	48, 41

BIEN 140B	Biomaterials	SE	4	F2011, F2010	26, 21
CHE 105	Introduction to Nanoscale Engineering	SE	4	W2012, W2011	22, 32
EE 139	Magnetic Materials	SE	4	W2012, W2011	36, 39
NANOMATERIALS and SENSORS (CEE)					
CHE 105	Introduction to Nanoscale Engineering	SE	4	W2012, W2011	22, 32
CEE 147	Bio-microelectromechanical Systems	SE	4		
CHE 161	Nanotechnology Processing Laboratory	SE	4	S2011, S2010	16, 11
EE 133	Solid-State Electronics	SE	4	F2011, F2010	23, 26
EE 139	Magnetic Materials	SE	4	W2012, W2011	36, 39
EE 162	Introduction to Nanoelectronics	SE	4		
COMPUTATION and MODELING (CSE)					
MATH 113	Applied Linear Algebra	SE	4	F2011, S2011	62, 48
MATH 135A	Numerical Analysis	SE	4	F2011, F2010	31, 20
MATH 135B	Numerical Analysis	SE	4	W2012, W2011	5, 4
CS 160	Concurrent Programming & Parallel Systems	SE	4	W2011, S2009	13, 19
ELECTRONIC and MAGNETIC MATERIALS (EE)					
EE 133	Solid-State Electronics	SE	4	F2011, F2010	23, 26
EE 136	Semiconductor Device Processing	SE	4	S2011, S2008	7, 22
EE 137	Intro to Semiconductor Optoelectronic Devices	SE	4	W2012, W2011	13, 12
EE 139	Magnetic Materials	SE	4	W2012, W2011	36, 29
EE 162	Introduction to Nanoelectronics	SE	4		
STRUCTURAL MATERIALS (ME)					
ME 103	Dynamics	SE	4	F2011, S2011	41, 107
ME 113	Fluid Mechanics	SE	4	W2012, W2011	119, 85
ME 116A	Heat Transfer	SE	4	S2011, S2010	74, 70
ME 122	Vibrations	SE	4	W2011, W2010	57, 56
ME 138	Transport Phenomena in Living Systems	SE	4	F2011, F2009	15, 20
ME 153	Applied Finite Element Methods	SE	4	F2012, S2011	34, 60
ME 180	Optics and Lasers in Engineering	SE	4	W2012, S2008	46, 28

CRITERION 6. FACULTY: MSE Core Faculty

A. Faculty Qualifications

The MSE program is comprised of three different types of faculty. 1) Program committee faculty 2) leadership (Chair, UG and Grad advisors) 3) Faculty with teaching responsibilities in MSE. We refer to faculty members in one or more of these as MSE core faculty. The following are the MSE core faculty along with their department affiliation:

1. **Program Committee**
   The program committee is the main decision making body for the program. There is at least one member form each of the 5 BCOE departments. One of the roles of program committee members is to facilitate communication between MSE program and BCOE departments.

   Javier E. Garay, PhD., MSE Program Chair (Mechanical Engineering)
   Alexander A. Balandin, Ph.D., (Electrical Engineering)
   Mart Molle, Ph.D. (Computer Science and Engineering)
   Philip Christopher, Ph.D (Chemical Engineering)
   Cengiz Ozkan, Ph.D. (Mechanical Engineering)
   Valentine Vullev, Ph.D. (Bioengineering)

2. **MSE Leadership**
   Javier E. Garay, PhD., MSE Program Chair (Mechanical Engineering)
   David Kisailus, MSE UG advisor (Chemical Engineering).
   Cengiz Ozkan, PhD MSE Grad advisor (Mechanical Engineering).

3. **Faculty with teaching responsibilities in MSE**
   The following faculty were hired with the intent that some of their teaching responsibilities would be in MSE and some in their home departments. Their courses are assigned with the collaboration of MSE chair and the home department chair.

   Masaru Rao, Ph.D. (Mechanical Engineering)ME
   Elaine Haberer, Ph.D. (Electrical Engineering) EE
   Philip Christopher, Ph.D. (Chemical Engineering)CEE
   Huinan Liu, Ph.D. (BioEngineering)
   Lorenzo Mangolini, Ph.D. (Mechanical Engineering) ME

In addition the MSE program has a Course Assessment Committee composed of the following members:

Chair: David Kisailus, MSE UG advisor (Chemical Engineering).
Members: Lorenzo Mangolini, Ph.D. (ME), Philip Christopher, Ph.D (CE)

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.

B. Faculty Workload

Table 6-2 summarizes faculty workload with respect to teaching, research, and service. All BCOE faculty members have primary appointments in one of the college's five departments (Bioengineering, Chemical and Environmental Engineering, Computer Science and Engineering, Electrical Engineering, or Mechanical Engineering). Many faculty members also have formal teaching appointments in the MSE program, which includes an obligation to teach courses required for the MSE degree.

C. Faculty Size

C.1 Coverage of the Core Curriculum and Elective Courses

Between the dedicated MSE appointments (see subsection B above) and affiliated faculty, the MSE program has sufficient faculty resources to teach the core courses and electives. The MSE Chair meets regularly with the department chairs to assure that required courses are provided when needed so MSE students can make appropriate progress toward graduation.

C.2 Faculty Involvement with Students

The MSE core faculty is involved in developing curriculum, teaching courses and mentoring MSE undergraduate students. Each Fall and Spring quarter of the academic year, the undergraduate advisor provides the MSE students with an overview of the MSE program. This overview includes the following:

1. Mission of the program and its aims.
2. Description of what MSE is.
3. Identification and contact information of MSE faculty, focus area advising faculty and staff
4. Review of lower and upper division requirements
5. Description of focus areas within MSE.
6. A suggested course plan, covering Freshman through senior year.
7. Information about accessing and getting involved with professional societies
8. Advising about undergraduate research and how to get started
9. Information about levels of mentoring for MSE students, specifically:
    a. Undergraduate student affairs office
    b. Faculty mentoring (depending on focus area or area of interest)
    c. Research advisor (informal)
10. Study strategies
11. General advice about college and expectations

12. An overview of research related to MSE at UC Riverside
13. Jobs descriptions for various MSE fields.

In addition to the annual Fall and Spring advising sessions, the undergraduate advisor has held official office hours (2 per week, each quarter throughout the year) and unofficial “drop-in” hours, where students could inquire about course development, career instruction and course guidance.

Professor David Kisailus, the MSE undergraduate advisor, also let MSE students aware of different professional societies at UCR. There is a fledgling Materials Research Society (MRS) chapter at UCR. Although there is currently low student enrollment, we will continue to promote it in hopes that as the program grows so will the MRS chapter. Jun Wang, the college staff member assigned to coordinating student groups, also assisted in guiding students to various organizations related to materials science and engineering (e.g., AIChE, EWB, SWE, IEEE, etc.). Mr. Wang also arranged excursions to various regional companies (e.g., Northrop Grumman), exposing students to industrial and manufacturing aspects of MSE.

Finally, students involved in research with MSE professors were able to participate in local, regional and national conferences, presenting their research in a technical environment. This enabled them to be exposed to peer review at the college and graduate levels and enabled them to improve communication and networking skills.

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.

E. Authority and Responsibility of Faculty

The size and heterogeneity of the MSE faculty pose a challenge for maintaining strong control over the MSE program. Meetings of the entire MSE faculty are difficult to schedule because the faculty is so large, and because members come from so many departments. The most important resources for maintaining control are (a) a strong and collegial chair and (b) a designated representative to/from MSE in each department. This structure makes it possible to communicate with department chairs and faculty colleagues when questions, problems, or needs arise. In the future, we expect that annual on-site Board of Advisors meetings will be occasions for the entire MSE faculty to gather. We also will strive to schedule at least one faculty meeting per quarter and one MSE faculty retreat per year, ideally in the late summer before the start of the fall quarter. The first MSE retreat is scheduled for September 2012.

Self-governance is an important principle in the University of California. Through the BCOE Executive Committee and the UCR Faculty Senate, faculty members exercise control over the curriculum. Each department/degree program is responsible for assessing its own courses and (with the help of the Dean's Office) for surveying graduating seniors, alumni, and employers.

Table 6-1. Faculty Qualifications

Materials Science and Engineering

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: Govt./Ind. Practice	Years of Experience: Teaching	Years of Experience: This Institution	Professional Registration/ Certification	Level of Activity [4] H, M, or L: Professional Organizations	Level of Activity [4] H, M, or L: Professional Development	Level of Activity [4] H, M, or L: Consulting/summer work in industry
Reza Abbaschian	Ph.D., Materials Science and Engineering, 1971	P	T	FT		40	7	None	H TMS, ASM, MRS, ASEE	H	L
Alexander A. Balandin	Ph.D., Electrical Engineering, 1997	P	T	FT	0	13	13	None	H (IEEE, APS, OSA, SPIE, IOP, MRS, ECS)	H	H
Phillip N. Christopher	Ph.D. Chemical Engineering, 2011	AST	TT	FT	0	3	1	None	H	M	M

Javier E. Garay	PhD. MSE (2004)	ASC	T	FT		8	8	None	L	L	L
Elaine D. Haberer	Ph.D., Electrical Engineering, 2005	AST	TT	FT	0	4	4	None	L (MRS)	H	None
David Kisailus	Ph.D., Chemical Engineering, 2002	AST	TT	FT	3.5	5	4.5	None	H	L	M
Huinan Liu	Ph.D.-Biomedical Engineering, 2008	AST	TT	FT	1	6	1	Teaching Certificate Higher Ed	H	H	M
Lorenzo Mangolini	Ph.D. Mechanical Engineering, 2007	AST	TT	FT	3	2	2	None	L	M	L
Mart Molle	Ph.D., Computer Science, 1980	P	T	FT	0	21	14		M	M	M
Cengiz S. Ozkan	PhD, Materials Science and Engineering, 1997	P	T	FT	5	27	11	None	H	H	L

Masaru P. Rao	PhD	AST	TT	FT	1	5	3	None	L	L	L
Valentine I. Vullev	Ph.D. Chemistry 2001	AST	TT	FT	2	7	7	None	M	M	L

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

Materials Science and Engineering

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3] Teaching	Research or Scholarship	Other[4]	% of Time Devoted to the Program[5]
Abbaschian, Reza	FT	N/A		0	40	60
Alexander A. Balandin	FT	EE 190 (11F), EE202 (12W), EE216 (12S)	20	50	30	100
Phillip N. Christopher	FT	F-CHE 102/4, W-CEE 158/4	30	50	20	100
Javier E. Garay		FALL: ME114 (4), WINTER: ME278 (4)	40	40	20	100
Elaine D. Haberer	FT	EE138 (11F), EE203 (12S)	30	50	20	100
David Kisailus	FT	F-CEE 135/4, W-CHE 105/4	40	40	20	100
Huinan Liu	FT	BIEN 130L(2)	30	40	10 New Faculty	70
Cengiz S. Ozkan		FALL: ME270 (4), WINTER: ME180 (4), ME272 (4)	40	40	20	100
Lorenzo Mangolini	FT	FALL: ME100 (4), WINTER: ME113 (4), SPRING: ME243 (4)	40	40	20	100
Mart Molle	FT	W11) CS164, (S11) CS30, CS179I,	20	50	30	100

		(W12) CS177, (S12) CS30, CS179I				
Masaru P. Rao	FT	FALL: ME156 (4), WINTER: ME110 (4), SPRING: ME174 (4)	40	40	20	100
Valentine I. Vullev	FT	BIEN 140B (4), BIEN 140A(4), BIEN 245 (3)	40	40	20	100

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the self-study is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. Out of the total time employed at the institution.

CRITERION 7. FACILITIES

A. Offices, Classrooms and Laboratories

The MSE program has its own dedicated facilities to support MSE-specific classes. These facilities are in the newly opened Materials Science and Engineering Building (occupancy began in fall 2011). Every department in BCOE also has its own dedicated space for labs and other educational needs; since MSE core courses are provided by the departments, it is fair to say that MSE has access to these resources as well.

Classroom space is controlled by the campus, not by BCOE, and is assigned centrally. Small seminar rooms, meeting rooms, and design studios are available to faculty by reservation. Typically, the department and program chairs prepare a tentative list of course offerings in the spring quarter for the following academic year. This is done with input from Chairs of the departmental Undergraduate and Graduate Program Committees, and in coordination with program advisors in the College Student Affairs Office. Multiple-quarter offerings of key courses are decided upon at this stage, based on previous year's demand and projections for the upcoming academic year. In addition, number of discussion section offerings for each course is determined. Most classrooms offered by the campus and the college are media-equipped, facilitating computer and Internet access for the classroom instructor. Wireless Internet access is available virtually everywhere on campus, so students also can use the Internet in class.

Since MSE draws on all BCOE departments for its undergraduate curriculum, the facilities of all departments are described here. Major equipment is listed in Appendix C.

Materials Science and Engineering Facilities

Although MSE has its own faculty and some MSE-specific curriculum, most of the course delivery takes place through the constituent departments. Thus, the instructional infrastructure available to the departments also serves the MSE program. These resources are highlighted below.

The MSE program has recently established 4 teaching laboratories in the newly occupied MSE Building. These laboratories were designed to specifically teach MSE program related topics. Table 7-1 describes the locations, use and equipment available in the MSE teaching laboratories.

Table 7-1. MSE Teaching labs

Room /Name	Purpose	Equipment (Black: exists, Red: requested
MSE 150 **MSE Thermo-mechanical Lab**	Lab for teaching and research in thermal characterization and mechanical testing including: Heat treatments/etching/materials processing/ thermo-chemistry analysis) Mechanical property measurements Sample sectioning, mounting, polishing	• 4 Furnaces: Muffle furnaces, split tube , split tube • Balances • Instron • Polishing wheels • Diamond saw • Hardness tester
MSE 313 **MSE Optical Property Characterization Lab**	Lab for teaching and research in Optical Characterization including: Absorption coefficient, Reflectivity measurements.	• Optical Tables • Fluorimeter
MSE 250 **Microstructural characterization lab**	**Lab for teaching and research in microstructural characterization including:** Optical microscopy, FTIR and Raman measurements	• Bench top FTIR • Educational Raman • Optical Microscopes w/comp x 2 • High end metallographic OM (Nikon) • DSC/TGA • Mini Clean room
MSE 309 (1/2) **MSE Electrical characterization-Semiconductor lab**	**Lab for teaching and research in instrumentation/ electrical characterization**	• Probe station • Function generators • O-scopes
MSE 309 (1/2) **MSE Senior Design**	**Senior design lab**	• 5 Computers with data acquisition systems

Bioengineering Facilities

Bioengineering Computer Lab: Bourns Hall B265

This lab is equipped with 34 computers (Dell Vostro 460 Mini Tower with 21.5" monitors), total cost $34,000, and one HP Laserjet 4250 printer ($400). Instructional software installed on these computers is as follows: COMSOL 4.2a, latest version teaching license **($5821),** Matlab, Solid Work, Mathematica, and MS Office 2010. Additionally, free software to support Dr. Morikis's class includes Deep View-Swiss-PDB Viewer, Chimera, R-base, Modeller, DOCK, APBS, VMD, NAMD, and MGL Tools.

Bioinstrumentation Laboratory

The Bioinstrumentation course (BIEN 130L) provides access to the following instruments: NI ELVIS by National Instruments; Dell desktop computer and monitor; Labview; Rugged Multimeter by OMEGA; Universal Tester 100Q500 by Testresources, Inc.; Pasco Stress Strain Tester; Gravity Convection Oven 3510FC by Fisher Scientific; Ocean Optical Spectrometer by Ocean Optics; Mettler Balance 151G x0.001G; Mettler New Classic MS Balance 0.001G; Olympus Preamplifiers 5660B; Panametrics Immersion Transducers V318-SU; Tektronix Oscilloscope TDS 3054C; Vernier Lab Quest; Vernier Spirometer; Vernior O_2 sensor.

Biotechnology Laboratory

The Biotechnology Laboratory (BIEN 155) provides access to the following instruments: Pipettes sets; Eppendorf Easy Pet Motorized Pipet Dispenser; Fisher Isotemp 210 Digital water bath; Fisher Isotemp Forced Air Incubator 650F (4.5cu ft.); Fisher Scientific Isotemp 20cu. Refrigerator -20C to -12C; OHAUS Scout Pro Balance; Bio-Rad DNA Engine with Dual Well; Thermo Fisher A1 large Gel system; Biospectrum System F4300; Digital Dry Bath with Heating Block Modules (24x1.5ml); Transillum Fixed intensity 8" FBTI88A; Eppendorf Electroporator 2510; Eppendorf Model 5424 Microcentrifuge; Fermentation System BF0-110 (heat jacket and water jacket vessels) by New Brunswick; Innova 44 Floor Model Shaker; BioMate 3 UV-Vis Spectrophotometer by Thermo Scientific.

Additional Bioengineering resources available for undergraduate education include a Rapid Prototyping System by Dimension Elite; Desktop 3D Scanner by Nextengine; Labconco Class II Type A2 6' Biosafety Cabinet; Labconco Class II Type A2 4' Biosafety Cabinet; Beta Star sterilizers 20"x20"x38"; and Beta Star sterilizers 24"x36"x36".

Chemical and Environmental Engineering Facilities

The Chemical and Environmental Engineering Department, which offers all Chemical Engineering and Environmental Engineering courses, has instructional laboratory space in the A and B wings of Bourns Hall, as well as space in the newly opened Materials Science and Engineering Building. Facilities include wet labs and computer labs for students.

Computer Science & Engineering Facilities

The Computer Science 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 Computer Science and Engineering 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 CS laboratory located in Winston Chung 136 that has specialized equipment including Intel IXP 1200 and 2400 network processor cards, and for specific CE 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 Facilities

All EE lab computers (except Winston Chung Hall 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.

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.

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 this additional software: NVidia 3D Vision, NVidia CUDA Toolkit & SDK, NVidia GPU Computing SDK, and NVidia Parallel Nsight.

WCH 121 (Instruction Lab: Available to students only during lab.)

- 16 of 19inch LCD monitors
- 16 of Intel Core2 Duo E7200 @ 2.53 GHz w/ 4 GB RAM & 80 GB HD computers
- 16 of HP 54600B Oscilloscope
- 16 of HP 33120A Waveform Generator
- 16 of HP E3630A Power Supply
- 16 of HP 34401A Meter

WCH 125 (Instruction Lab. Available to students from 8am to 10 pm daily.)
- 30 of 21-23 inch LCD wide-screen monitors
- 16 of Intel Core i5-2400 @ 3.10 GHz w/ 3 GB RAM and 250 GB HD
- 14 of Intel Core i3-2100 @ 3.10 GHz w/ 3 GB RAM and 250 GB HD
- 5 of NVidia Quadro 2000 PCI-X graphics cards (installed in 5 lab computers).

WCH 126 (Instruction Lab: Available to students only during lab and 24/7 for senior design.)
- 16 of 17inch LCD monitors, Pentium 4 3.0GHz CPU, 512MB RAM, 40 GB HD computers
- 16 of Tektronix TDS420A Oscilloscope
- 16 of HP 33120A Waveform Generator
- 16 of Power Supply
- 16 of Fluke 45 Meter
- 12x ECP Model 205 Torsional Plants
- 9x ECP Model 205 ISA computer control cards
- 1x ECP Model 205 PCI computer control card

WCH 128 (Instruction Lab: Available to students only during lab.)
- 16 of 21inch LCD monitors
- 16 of Intel Core 2 Duo E6750 @ 2.66 GHz w/ 2 GB RAM & 80 GB HD computers
- 16 of Agilent DSO3102A Oscilloscope
- 16 of Agilent 33210A Waveform Generator
- 16 of HP E3630A Power Supply
- 16 of HP 34401A Meter

WCH 221 (Computational Lab. Available to students 24/7.)
- 16 of Dell E2011H 20-inch Widescreen LCD monitors
- 16 of Pentium D 2.80GHz CPU, 1GB RAM, 80GB Hard drive.

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.

Mechanical Engineering Facilities

A 1,733 sq ft laboratory (B213AA) used mostly for instruction associated with ME 170A. It houses 10 computing stations that include computers equipped with LABVIEW software for data acquisition and analysis, generators, DC power supplies, digital multimeters and oscilloscopes for signal generation, measurement, acquisition, analysis and display. The lab also houses the following additional equipment for performing basic instrumentation, data conversion, filtering, amplification and typical mechanical engineering measurements such as temperature, pressure, strain and vibration including strain gauges, strain gauge beams and holders, accelerometers, model 355 flow meter, gas regulator, high-pressure gas supplies, pressure gauges, thermocouples, thermistors, infrared thermometer, pressure transducers, water baths, blowers, air speed indicator, stirring hotplates, resistance decade box, Mettler Toledo AB104 analytical balance, Mettler Toledo AB104 topload balance, and 110V transformer, various resistors, capacitors and operational amplifiers.

In addition to equipment for data acquisition, B213AA houses a Mechatronics laboratory used mostly for instruction associated with technical elective ME133. The equipment includes:

1. GE-FANUC 23 point Programmable Logic Controllers (IC200UAL006 PLC), 10 each.

2. GE-FANUC Proficy Logic Developer software, 10 each.

3. PLC Nano/Micro/Programming Cable for interface between PLC and PC.

4. Many 18 DIP Microcontrollers (PIC16F84).

5. Micro Engineering Lab USB programmer with accessories (2 copies).

6. Micro Engineering Lab PIC Basic Pro compiler (2 copies).

7. Micro Engineering Lab integrated development environment (IDE) windows software.

8. Many electronics components (micro switches, 4 MHz microprocessor crystals, LED, Transistors, Power Transistors, Logic components (AND, OR, NAND, NOR), Motorola LS7084 chip for optical encoder interface, and operational amplifiers).

9. 10 each NI data acquisition board NI DAQ PCI-6221.

10. 10 each robotics experiments (each includes 5 arms, 2 DC motors, 2 optical encoders, and 2 power amplifier).

11. 10 each pneumatic experiments (each includes 1 linear potentiometer, 1 optical encoder, 1 pneumatic actuator, and power amplifier).

A 977 square foot laboratory (B164) used primarily for instruction associated with ME 170B. Major equipment includes:

1. 4 personal computers for data analysis.

2. A small wind tunnel.

3. Thermal radiation apparatus consisting of black aluminum plate with thermocouples, anodized steel and aluminum plates with thermocouples, polished steel and aluminum plates with thermocouples, freestanding thermocouple, Linear Laboratories C-1700 Radiometer, thermocouple temperature readout, Vernier calipers, power supply unit, anemometer, hand held thermometer.

4. Instron Universal testing machine supplied with computer, Vernier calipers, sample specimens of aluminum, plain carbon steel, stainless steel, and nylon.

5. Rope testing apparatus consisting of static rope, dynamic rope, support rope and pulley arrangements, weights for calibration, strain gage with computer, DBK-43 strain gage card, and ruler.

6. Accelerometer and accelerometer tilt table supplemented with power supply unit, cantilever beam with strain gages mounted, weights, spring, Vernier calipers, digital millimeter, meter stick, balance, stand, computer with DBK-12 multiplexer card and DBK-43 strain gage card, three-option expansion card cable, beaker, trough, and washers of 1¼'', 2'' and 2½'' diameter.

7. Hot-ball anemometer consisting of brass and aluminum spheres with K-type thermocouples attached, chromel-alumel thermocouple, thermocouple card (DBK-19). Supplemental equipment includes alcohol-in-glass thermometer, stirrer, beakers, heater, blower, ring stand and clamp for suspending thermocouple, hand held anemometer, thermocouple extension wire, and digital voltmeter.

8. (8) 3-point and 4-point configuration attachments for bending testing, in-house built apparatus for undamped and damped vibration testing, an in-house built apparatus for dynamical tensile testing.

9. A photoelasticity system for characterizing stress concentrations in engineering structures via polarization modulation.

Available teaching equipment for ME 180 includes one set of photoelastic polariscope, one 2-mW He-Ne laser, 2 linear polarizers, 2 quarter wave plates, one integrating sphere, and 8 pairs of safety goggles. These are located in the Nano Mechanics and Materials Laboratory (see Section B.6.6).

A 1,022 sq ft teaching lab (B162) shared with the Department of Chemical and Environmental Engineering. Relevant equipment utilized for instruction in ME170B includes:

1. Armfield Multi-Pump test rig model C3-00 supplemented hook and point gauge, thermocouple, and stopwatch

2. Armfield fluid friction apparatus, model C6, supplemented with thermocouple, stopwatch, Vernier caliper, sudden contraction, sudden expansion, ball valve (fully open), globe valve (fully open), gate valve (fully open, ½ open), Venturimeter, 90 degree elbow, smooth pipe

17.5 mm diameter, and rough pipe 17.5 mm diameter.

Design Studio

In 2005, the program acquired a 2665 sq ft space (B265) for design studio. It provides space for assembly, preparation of posters, and discussions. In addition, the studio is used for instruction in ME 1A.

Mechanical Engineering Research Laboratories

In addition to several computing laboratories supervised by faculty, the department has several major experimental research laboratories. These include:

(a) Laboratory of Transport Phenomena for Biomedical Applications

(b) Laboratory for Advanced Materials Processing and Synthesis

(c) Biomaterials and Nanotechnolgy Laboratory

(d) Laboratory for Environmental Flow Modeling (e) Smart Tools Laboratory

(f) Nano Mechanics and Materials Laboratory

Although these laboratories are used by faculty and graduate students for their research, program students have access to these laboratories for carrying out directed research and earning technical elective credit (ME190).

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 knowledgebase 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 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 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

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.

Two computing laboratories are dedicated to program students. Room B207 located in Bourns Hall is a 1671 square feet facility that includes 40 networked computers and a networked printer. Room B238 is a 2038 sq ft facility that was acquired in 2006 to keep pace with growth in the program enrollment. It houses 30 additional computers and a networked printer. B238 is open 24/7 for all ME students. Courses that require computer use during class time are scheduled in B207. At all other times, the lab is open to all ME students. The computers run Windows and have most recent versions of MATLAB, SOLIDWORKS, MS-OFFICE, VISUAL STUDIOS, AUTOCAD and other various engineering applications. Each lab is also equipped with LANSCHOOL – a software program that enables monitoring of all computers with an ability to broadcast material from the instructor's computer. This facilitates class room instruction and is conducive to effective learning of software tools.

C. Guidance

MSE students receive guidance on lab safety and the standard lab equipment usage, with equipment orientation documents and help from TAs, in required laboratory courses for example, in lab associated with the circuits course EE001A or the lab classes MSE 160 (Nanostructure Characterization Laboratory) and MSE 161 (Analytical Materials Characterization). For special purpose equipment or tools, the Electrical Engineering Shop provides instruction on proper operation and hands-on support. In addition in special cases (such as for certain senior design projects), MSE students have access to the Mechanical Engineering Machine shop in which case they receive training from the Machine shop manager.

The students also receive guidance of computing resources from the lab manuals. They also sign a computer usage agreement when they get their BCOE computer account.

D. Maintenance and Upgrading of Facilities

Bourns Hall is approximately 21 years old and provides more than 100,000 square feet of office, classroom, and wet laboratory space for the Bourns College of Engineering. Engineering Building II is one year old and has 98,177 assignable square feet of office, classroom, and dry lab space.

The College recently opened the Materials Science Building. This building is designed at 76,940 square feet, including laboratory, office, and classroom space. Laboratory facilities will include a larger clean room nanofabrication facility than the one currently available in the B-wing of Bourns Hall.

Formal plans for Engineering III and Engineering IV are not yet in place.

The Bourns College of Engineering provides one-time equipment funds annually to upgrade and acquire equipment. In addition, the College provides facilities to house and operate the equipment.

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 freshman 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: (Print Vols.) 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 Table Explanations 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
*Local Costs Only for Engineering Periodicals Subscriptions	$47,589	$47,706	**$21,163
E-Book Packages (EngNetbase, O'Reilly)	$7,043	$7,332	$6,483
***Research Databases	$15,185	$14,741	$15,957

* 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.

** 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.

*** Cost for Compendex and Inspec databases. Other databases such as SciFinder, Water Resources Abstracts, Web of Science support multiple disciplines, in addition to Engineering.

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.

The MSE program relies on courses taught in each of the 5 BCOE departments thus each course that requires facilities is individually managed by the corresponding department. In addition, Maggie Souder, the college's Safety & Facilities Coordinator serves as the Safety and facilities point of contact for the MSE program. She also coordinates and manages the MSE teaching laboratories.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

The MSE Program is led by a Chair who is nominated by the Engineering Dean and approved by the Faculty Senate. Although the MSE Chair does not lead a department, he or she is accorded the same privileges and given many of the same duties as a department chair. These include release time from teaching to handle administrative duties and, subject to negotiation, a stipend. The Chair attends semi-monthly meetings of the Bourns College of Engineering Deans and Program Chairs. The MSE Program also has an undergraduate coordinator, a graduate coordinator, and an ABET coordinator. One staff position (0.5 FTE) is dedicated to MSE, and additional support (staff, student workers, and technical assistants) is provided through the departments and the dean's office.

The first transition of leadership took place in MSE early in 2012. Electrical Engineering Professor Alexander Balandin, who founded the MSE Program, stepped down so he could dedicate more time to his research and to family matters. Associate Professor Javier Garay from the Department of Mechanical Engineering was appointed to succeed him. The MSE program has a good mix of senior and junior faculty members, and we anticipate that we will always have a number of faculty members who are qualified to lead.

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. David Kisailus) 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

In response to the February Budget Call Letter, the Dean's Office in the Bourns College of Engineering requests budget proposals from each academic unit in the College. These proposals include undergraduate and graduate student projections, course load information, staffing requirements and needs for additional supply, travel and miscellaneous expenses. Any additional resources requested are presented in the context of departmental Five-Year Plans. In this way, departments demonstrate their progress in attaining Five-Year goals and request the resources required for the next year to maintain that progress. In most cases, departmental current year (Permanent) budgets are the starting points for the next fiscal year's budgets. UC Permanent Budget resources do not have expiration dates and are used to fund long-term commitments from the University. In addition to Permanent funds, departments can request Temporary funds from the Dean's Office either during the budget proposal cycle or during the fiscal year for exceptional (one-time) expenses. The Dean's Office evaluates annual departmental funding requests and submits a combined budget proposal from the College in late March to the EVC's Office. After the final College budget is announced in June, any additional resources approved are allocated to the departments beginning the start of the fiscal year, July 1. Temporary funding requests approved during the fiscal year are allocated at the time of approval or are reimbursed to departments after expenses are incurred. Each department is responsible for monitoring its expenses and projected ending balances during the fiscal year.

All BCOE academic programs receive Permanent University funding for tenure track faculty, program staff, materials and supplies and travel. Table 8-1 summarizes Permanent University funding allocations to BCOE departments over the last five fiscal years.

Table 8-1. History of the Bourns College of Engineering permanent budget by degree program.

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).

Table 8-2. Temporary funding per degree program.

College of Engineering 5-year TEMP Funding Summary						
TEMP Funding	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**Totals**
Bioengineering						
Lecturers	0	0	0	3,022	0	**3,022**
Teaching Asst/Grd Stdnts	25,608	108,305	68,665	138,785	193,129	**534,492**
Instructional Equipment	5,000	20,000	46,470	0	0	**71,470**
Other	26,683	44,190	71,724	91,781	39,498	**273,876**
Totals >	**57,291**	**172,495**	**186,859**	**233,588**	**232,627**	**882,860**
Chemical Engineering						
Lecturers	57,278	57,000	47,984	63,815	55,078	**281,155**
Teaching Asst/Grd Stdnts	104,680	111,477	104,659	124,318	114,733	**559,867**
Instructional Equipment	19,000	13,500	20,000	13,000	0	**65,500**
Other	20,845	32,660	76,563	45,783	21,065	**196,915**
Totals >	**201,803**	**214,637**	**249,205**	**246,916**	**190,876**	**1,103,436**
Environmental Engineering						
Lecturers	57,278	57,000	47,984	63,815	55,078	**281,155**
Teaching Asst/Grd Stdnts	104,680	111,477	104,659	124,318	114,733	**559,867**
Instructional Equipment	19,000	13,500	20,000	13,000	0	**65,500**
Other	20,845	32,660	76,563	45,783	21,065	**196,915**
Totals >	**201,803**	**214,637**	**249,205**	**246,916**	**190,876**	**1,103,436**
Computer Science						
Lecturers	191,271	202,562	225,179	238,845	222,222	**1,080,079**
Teaching Asst/Grd Stdnts	705,498	759,944	684,066	639,820	684,945	**3,474,274**
Instructional Equipment	38,966	35,449	20,000	21,486	0	**115,901**
Other	77,283	78,908	68,020	88,449	47,647	**360,307**
Totals >	**1,013,018**	**1,076,863**	**997,265**	**988,600**	**954,814**	**5,030,560**
Electrical Engineering						
Lecturers	65,875	51,850	46,018	102,119	74,275	**340,137**
Teaching Asst/Grd Stdnts	321,434	313,379	270,354	274,592	288,312	**1,468,071**
Instructional Equipment	30,756	32,000	58,394	22,135	0	**143,285**
Other	47,067	57,586	61,998	50,162	91,260	**308,073**
Totals >	**465,132**	**454,814**	**436,764**	**449,009**	**453,847**	**2,259,566**
Computer Engineering						
Lecturers	64,286	63,604	67,800	85,241	74,124	**355,055**
Teaching Asst/Grd Stdnts	256,733	268,331	238,604	228,603	243,314	**1,235,585**
Instructional Equipment	17,430	16,862	19,598	10,906	0	**64,796**
Other	31,088	34,124	32,505	34,653	34,727	**167,097**
Totals >	**369,538**	**382,921**	**358,507**	**359,403**	**352,165**	**1,822,533**
Mechanical Engineering						
Lecturers	81,501	60,282	47,724	83,217	59,625	**332,348**
Teaching Asst/Grd Stdnts	308,637	306,214	324,148	315,198	366,875	**1,621,072**
Instructional Equipment	84,306	36,632	46,000	31,254	0	**198,191**
Other	83,077	73,636	75,742	68,461	42,120	**343,036**
Totals >	**557,520**	**476,764**	**493,614**	**498,130**	**468,620**	**2,494,648**
Materials Science & Engineering						
Lecturers	0	0	6,500	12,000	12,000	**30,500**
Teaching Asst/Grd Stdnts	1,000	0	12,000	18,000	18,887	**49,887**
Instructional Equipment	0	0	0	0	3,201	**3,201**
Other	15,880	9,947	11,732	23,572	17,723	**78,854**
Totals >	**16,880**	**9,947**	**30,232**	**53,572**	**51,811**	**162,441**
Grand Totals >	**2,882,985**	**3,003,078**	**3,001,651**	**3,076,133**	**2,895,636**	**14,859,482**

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. The instructional equipment obtained by this process over the past three fiscal years is listed below:

Bioengineering
Bioinstrumentation Laboratory (BIEN 130L):
  Lab Quest, Spirometer, O2 Sensors, etc.
  Pasco Stress Strain testers
  Balance
  Gel Columns
  Ni ELVIS
  Computers and monitors for Ni ELVIS
  BioPac MP36
  Stress-strain Experiments
  Lung Capacity Experiment
Biotechnology Laboratory (BIEN 155):
  Gene Pulser Xcell System
  Biomate 3 UV-Vis Spectrophotometer
  Pipettes
  Electrophoresis
  Combination biotech pH electrode
  Eppendorf Mastercycler
  UV/Vis/NIR Spectrophotometer
  Undergrad Computer Facility
  Micro Centrifuge
  Balance 400-500g
  Electrophoresis
  Gene Pulser Xcell Main Unit

Chemical and Environmental Engineering
Ozone Generator
Spectronic 200 Spectrophotometers
Micro 100 Lab Turbidimeters
New Brunswick Scientific Excella E5 and E10
Adjustable volume pipetters
UV Lamp
Masterflex L/S Economy Variable
Computers
Nanotechnology Processing Lab (CHE 161):
  Multi-channel potentiostat
  Antivibration table
  Electrical Measurement
  Mass Flow Controllers
  Computer controlled DC power supply

Portable fume hood
Incubator
Lab Benches and equipment for BH 235

Computer Science and Engineering
Lab Chairs
Lab Tables
Windows Terminal Server license
Remark Office OMR upgrade
Supermicro Server Chasis
AMD Server Processors
Intel SATA drives
Hitachi 3TB hard drives
8 GB RAM
Kodak i1220 scanner
MSDN AA License
File Server support contract renewal
File Server
RBC27 Batteries
Barebones server
Mac Workstations
RAM, harddrives, displays, licenses, etc
Projector mounts
Supplmental NICS
Vmware ESC+ Ingrastructure

Electrical Engineering
Instructional Clean Room (for EE 136)
Lab Equipment for WCH 126:
Digital multimeters and power supplies
Replacement PCs and monitors
Oscilloscopes
Function Generators
Metal Lab Stools
New Server
HP Laserjet P4015n networkable printer
FPGA Evaluation boards
Computers and monitors for WCH 121

Mechanical Engineering
Repair two exp. Stations and upgrade 4 (ME 170A)
SolidWorks (ME 9 and ME 175)
CNC Plasma cutter (Senior Design)
Drop Boxes
Classroom demo setups
Cutaways (IC engines and jet engine)

Refrigeration performance apparatus
Controls experiment system
Materials science experiments
Replacement computers for ME 170A
SolidWorks license renewal
Computers for ME Computer Lab (B207)
Parts for Lab Workstations for ME 170A

Materials Science and Engineering
MSE 01, MSE 100, etc.
  Educational optical microscopes
  Cabinets for chemical storage
  Supplies and materials
MSE 160 and MSE 161:
  CFAMM time for SEM (per year)
  FTIR
  Laser for RAMAN
  Board and software for TGA/DTA
  Photoluminescence system
  Multistir plates
  pH meters and probes
  Ultrasonicator with housing
  Beaker and stir bar sets
  High resolution Optical Microscope
  Composites kits
  Balances
  Portable Fume Hood
  Multimeters

In addition, most BCOE undergraduate lab courses charge a Course Materials Fee of $20 to $50 per student. Per UCR policy, these fees can only be used to purchase expendable laboratory materials and supplies including chemicals, glassware, software, computers, etc. For FY 10/11, approximately $210,000 was generated in Course Materials Fees by BCOE academic programs.

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

D.1 Faculty Recruitment Process

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 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. The University has a normal sabbatical program to maintain faculty currency. In addition, the Academic Senate provides travel assistance grants, and the campus provides grants to support innovative teaching. Also, funds area 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.

PROGRAM CRITERIA

1. Curriculum

The ABET program criteria for materials science and engineering is incorporated into the program outcomes via outcomes (a)-(k).

The students in the MSE Program students are required to undertake courses in Chemistry, Physics, Mathematics ensuring that graduates have knowledge of chemistry, and calculus based physics including multivariate calculus and differential equations. The MSE curriculum adequately prepare graduates to apply these advanced science to materials systems. **The four main elements of MSE** structure, properties, processing, and performance **(previously discussed in Criterion 2) are addressed using various courses. Table 8-1 shows how each course addresses various elements.** In addition the students take two senior design courses (MSE 175A or 175b) allowing them to apply and integrate knowledge from each of the a four elements of the field to solve materials selection and design problems, and; to utilize experimental, statistical, and computational methods consistent with the program educational objectives.

The curriculum must prepare graduates to apply advanced science (such as chemistry and physics) and engineering principles to materials systems implied by the program modifier, e.g., ceramics, metals, polymers, composite materials; to integrate the understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing, and performance related to material systems appropriate to the field; to apply and integrate knowledge from each of the above four elements of the field to solve materials selection and design problems, and; to utilize experimental, statistical, and computational methods consistent with the program educational objectives.

The four main elements of MSE (discussed in SECTION X) are addressed using various courses. Table 8-1 shows how each course addresses various MSE elements.

Table 8-1. Relations between courses required for MSE program and 4 basic elements of MSE.

Course	Structure	Synthesis/ Processing	Properties	Performance
MSE 1	X	X	X	
CEE 135 chemistry of materials	X	X		
ME 110 Mechanics of Materials			X	X
ME 114, Introduction to Materials Science & Engineering	X	X		
ME 156, Mechanical Behavior of Materials			X	X
EE 138 Electrical Properties of Materials			X	X
MSE 160, Nanostructure Characterization Laboratory;	X	X	X	
MSE 161, Analytical Materials Characterization	X	X		
MSE 175A, Senior Design	X		X	X
MSE 175B, Senior Design	X	X	X	X

2. Faculty

The MSE core faculty has the expertise to teach and mentor students in the four major elements of the field. Table 8-2 provides a list showing faculty expertise in the four elements.

Table 8-2. List of MSE core faculty showing faculty expertise mapped to the four main elements of MSE.

Faculty Member	Structure	Synthesis/ Processing	Properties	Performance
Alexander A. Balandin, Ph.D			X	X
Mart Molle, Ph.D.				X
Philip Christopher, Ph.D	X	X	X	X
Cengiz Ozkan, Ph.D.	X	X	X	X
Valentine Vullev, Ph.D.			X	X
Javier E. Garay, PhD.,	X	X	X	X
David Kisailus, Ph.D.	X	X	X	X
Masaru Rao, Ph.D.	X	X	X	X
Elaine Haberer, Ph.D.	X	X	X	X
Huinan Liu, Ph.D.	X	X	X	X
Lorenzo Mangolini, Ph.D.	X	X	X	X

APPENDICES

Appendix A – Course Syllabi

Syllabi for core and elective courses offered by the Bourns College of Engineering are included here. Syllabi for prerequisites and other electives taught by other colleges will be available at the site visit.

1. BIEN 140A Biomaterials

2. 4 units, 3 hours lecture, 1 hour discussion
Design: 1 unit

3. Professor Julia Lyubovitsky

4. Textbook

5. **a. Catalog Description** Covers the principles of materials science and engineering, with attention to topics in bioengineering. Explores atomic structures, hard treatment, fundamentals of corrosion, manufacturing processes, and characterization of materials.
b. Prerequisite(s): BCH 100, CHEM 112C, MATH 010B, PHYS 040B.
c. Required

6. **Course Goals - Student Outcomes a, b, e, f, i, j**

Specific outcomes.
i. Students will be able to understand interdisciplinary issues involved in biomaterials design, synthesis, evaluation and analysis, so that they may pursue higher-level, more focused graduate courses in biomaterials, address research problems, or pursue a job opportunities in the medical-device and tissue engineering industries.
ii. Students will understand the use of applied science and mathematics (e.g., physics, chemistry, biology and statistics) for materials engineering.
Students will learn the basic classes of biomaterials and their characteristics.
iii. Students will learn the basic bulk and surface properties required for biomaterials with various applications.
iv. Students will learn about the basic techniques for characterization of the mechanical, chemical, optical, and biological properties of biomaterials.
v. Students will learn the basic interactions between biomaterials and biological environment
vi. Students will gain familiarity with the biomaterials research literature
vii. Students will gain understanding about the ethical issues related to the biomaterials research and development
viii. Students will gain training in communication of scientific and engineering ideas via presentations and discussions

7. Syllabus
Lecture Topics:
Week 1: Introduction and Mechanical Properties of Materials
Week 2: Optical Properties of Materials
Week 3: Surface Properties of Materials and Surface Characterization
Week 4: Types of Biomaterials: Metals
Week 5: Polymers and Biodegradable Polymers
Week 6: Siloxanes, Fibers and Hydrogels
Week 7: Ceramics and Glasses (Artificial Hip Joints)
Week 8: Composites and Carbon Materials

Week 9: Response of Biological Systems to Foreign Objects
Week 10: Response to Foreign Objects and Testing for Biocompatibility. Animal Models

Discussion Topics:
Week 1: Introduction
Week 2: Biocompatible Interfaces
Week 3: Engineering of Artificial Organs
Week 4: Nanomaterials for Biological Imaging
Week 5: Materials for Dentistry
Week 6: Implants and Biocompatibility
Week 7: Immune Response to Biomaterials
Week 8: Poly(dimethylsiloxane) and Mocrofluidics
Week 9: FDA Approval and Animal Models
Week 10: Review and Summary

1. BIEN 140B Biomaterials

2. 4 units, 3 hours lecture, 1 hour discussion
Design: 1 unit

3. Professor Val Vullev

4. Textbook

5. a. Catalog Description. Covers the structure-property relations of metals, ceramics, polymers, and composites, as well as hard and soft tissues such as bone, teeth, cartilage, ligament, skin, muscle, and vasculature. Focuses on behavior of materials in the physiological environment.
b. Prerequisite(s): BIEN 140A/CEE 140A.
c. Elective

6. Course Goals
Specific outcomes. The student will;
i. demonstrate familiarity with the advantages and disadvantages of different types of biological and synthetic (organic and inorganic) materials, based on materials properties and on the physiological responses they may trigger
ii. demonstrate familiarity of physiological responses toward foreign objects composed of various materials
iii. demonstrate familiarity with different types of in vitro and in vivo testing of biomaterials and of types of model animals that are the most appropriate for different types of materials applications
iv. develop the ability to do literature search (using different data bases, such as SciFinder), to find peer-reviewed journal publications on biomaterials-related topics, and familiarize themselves on these topics from the published work
v. demonstrate the ability to recognize the values, the strengths and the weaknesses of each publication they read

7. Syllabus
Week 1: Overview of different types of materials and characterization of materials
Week 2: Overview of optical characterization of biomaterials and bioimaging
Week 3: Protein and cell adhesion; Protein and cellular mechanics
Week 4: Overview of ECM and tissues
Week 5: Project progress discussion
Week 6: Overview of cells, cell injury, and cell mechanics
Week 7: Host response to biomaterials: degradation, corrosion and calcification
Week 8: Overview of blood response to materials and devices: in vitro and in vivo testing
Week 9: Blood materials interactions: biocompatible interfaces
Week 10: Standards, regulations and ethical aspects of biomaterials research and development

1. BIEN 155 Bioengineering Laboratory

2. 2 units, 3 hours laboratory, 1 hour discussion
Design: 1 unit

3. Professor Jiayu Liao

4. Textbook (Suggested Readings)
Sambrook J and Russell D, Molecular Cloning: A Laboratory Manual. CHSL Press, 2001
Walsh G..: Proteins Biochemistry and Biotechnology. John Wiley & Sons, Inc., 2002

5. a. Catalog Description. Laboratory experience in cell culture, bioreactors, optical techniques, array techniques, and separation and purification methods.
b. Prerequisite(s): BCH 100, PHYS 040C.
c. Required

6. Course Goals - Student Outcomes b, e, g, k

Specific outcomes. The student will understand

i. plan, execution, quality control and summarize of the process to make biotechnology product
ii experimental techniques to produce biotechnology and biopharmaceutical product
iii. experimental optical techniques for fluorescence measurements.
iv. informatics tools for biotechnology
v. protein engineering techniques and quality/quantity control
vi. the project management skills and critical analysis of experimental results
vii. scientific writing skills
viii. scientific presentation skills and technique skills in searching for biotechnology jobs

7. Syllabus

Recombinant Fluorescence Protein Production and FRET Assay

Week 1. Trasfect pET 28(b)-CyPet-SUMO1 and pET 28(b)-Ypet-Ubc9, respectively, into DH5a by eletroporation.
TA Discussions: Molecular cloning;
Week 2. Purify plasmid DNA from bacterial cells by mini-prep, validate the genes by restriction enzyme digestion, and submit for sequencing.
TA Discussions: DNA sequencing and NCBI Bioinformatics Softwares;
Week 3. Verify and compare the sequencing result of clones with sequences from NCBI database.
TA Discussions: Protein expression systems in bacterial in general.
Week4. (Report due)Trasfect pET 28(b)-CyPet-SUMO1 and pET 28(b)-Ypet-Ubc9, respectively,into protein expression bacterial strain Bl21(DE3).
TA Discussion: His-tagged or other tagged protein purification.

Week5. CyPet-SUMO1 and Ypet-Ubc9 protein expression.
TA Discussions: Quantitative protein and gel electrophoresis.
Week 6. CyPet-SUMO1 and Ypet-Ubc9 protein purification. Fermentor demonstration.
TA Discussions: Fluorescence and Detections.
Week7. (Report due) Protein concentration measurements and gel electrophoresis/Coomassie staining.
TA Discussions: Protein purity checking methods.
Week8. Fluorescence protein identification by imaging and spectroscopy.
TA Discussions: Fluorescence Energy Transfer.
Week 9. Fluorescence Energy Transfer Assay.
TA Discussions: Presentation of research results.
Week10. (Report due) Presentations.

1. **CEE 135 Chemistry of Materials**

2. 4.0 units, 3 hours lecture, 1 hour discussion

3. David Kisailus

4. Textbook: P.A. Thrower, *Materials in Today's World,* (3rd Edition, Published by McGraw-Hill, 2007)

5. Specific course information
   a. Catalog description: An introduction to the synthesis, structure, properties, and performance of modern materials. Topics include the science of materials, bonding and structure, the strength of materials, electrons in materials, semiconductors, superconductors, and optical properties of materials.

   b. Prerequisite(s): PHYS 040C, CHEM 112A.

6. Specific goals for the course
   a. See attached Table for specific course objectives.
   b. Outcomes 2, 3, 6, 9, 15 are evaluates in this course.

Brief list of topics to be covered: What is Materials Science? Classes/Properties of Materials. Bonding. Crystal Structures. Synthesis Methods. Amorphous Materials. Defects. Strength of Materials **–** Dislocations. Polymers; Polyethylene. Heat. Ceramics. Electrons in Materials/Semiconductors. Color.

Contribution of course to meeting the professional component: The course provides a basic understanding of materials science with a particular emphasis on the underlying chemistry and how this translates into structure and properties. The course is designed to introduce students to the synthesis, structure, properties and performance of materials that are encountered in everyday life. The course begins with an introduction to the concepts of bonding and how it determines the arrangement of atoms or molecules in crystalline or amorphous configurations. In addition to providing a historical perspective of the processing of materials, the course covers important developments of modern technologies and novel materials. The structure-property relationships and how these relationships can be tailored via processing will be emphasized. The course will cover three major classes of materials: metals, polymers, and ceramics. Particular focus will be placed on novel (nano)materials with applications in electronics, solar cells, structural materials, and aerospace. At the end of the course, students are expected to be familiar with the underlying mechanical, thermal, magnetic, semiconducting, conducting, superconducting, and electronic properties of materials and how many materials are processed.

Relationship of course to program outcomes: The contribution of CEE 135 to program outcomes (1) – (16) is summarized in the objective-outcome matrix table on the next page.

Objective-Outcome Matrix: 1-Slightly 2-Moderately 3-Substantially

Outcome Related Learning Objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Discussion of fundamental chemical forces in bonding (primary and secondary). Diffusion in materials processing (e.g., sintering). Mechanical deformation mechanisms in metal and ceramics.		3															
Design of materials and understanding of processing-structure-function relationships.			3						3								
Analysis of stress-strain curves to determine fundamental material properties.						3											
Word problems will be assigned to students to design specific materials for pre-determined functions. Students must discuss processing and properties of materials and cost effectiveness.									3								
Student teams present on a material used in a new technological device or instrument. Each student coordinates the project from a particular aspect of interest: Fundamental properties of the elemental components; Processing routes and design; Cost effectiveness; Future developments. Intergroup communication as well as classroom presentations are incorporated.															3		

Note: The Chemical and Environmental Engineering Department has established 16 outcomes, which map to the standard 11 ABET outcomes that the Materials Science and Engineering program uses.

Outcomes (a) through (k)	UCR CHEs outcome (1) through (16)
(a) Ability to apply mathematics, science, and engineering principles	{1) Ability to apply mathematics
	(2) Ability to apply science
	(3) Ability to apply engineering principles
(b) Ability to design and conduct experiments, analyze and interpret data	(4) Ability to design experiments
	(5) Ability to conduct experiments
	(6) Ability to analyze and interpret data
(c) Ability to design a system , component, or process to meet desired needs	(7) Ability to design a system , component, or process to meet desired needs
(d) Ability to function on multidisciplinary teams	(8) Ability to function on multidisciplinary teams
(e) Ability to identify, formulate, and solve engineering problems	(9) Ability to identify, formulate, and solve engineering problems
(f) Understanding of professional and ethical responsibility	(10) Understanding of professional responsibility
	(11) Understanding of ethical responsibility
(g) Ability to communicate effectively	(12) Ability to communicate effectively
(h) The broad education necessary to understand the impact of engineering solutions in a global and societal context	(13)The broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) Recognition of the need for and ability to engage in life-long learning	(14) Recognition of the need for and ability to engage in life-long learning
(j) Knowledge of contemporary issues	(15) Knowledge of contemporary issues
(k) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	(16) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

1. **CHE 100: Engineering Thermodynamics**
2. 4.0 units, 3 hours lecture, 1 hour discussion
3. Jianzhong Wu
4. Textbook: J. M. Smith, H. C. Van Hess, M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th Ed. (2005) McGraw-Hill.
   a. Supplementary texts: Stanley I. Sandler, Chemical, Biochemical, and Engineering Thermodynamics, 4rd Edition (2005), John Wiley & Sons; B.G. Kyle, Chemical and Process Thermodynamics, 3rd edition (1999) Prentice Hall

5. Specific course information
   a. Catalog description: An introduction to engineering thermodynamics with emphasis on chemical and environmental engineering systems. Topics include concepts of equilibrium, temperature, and reversibility; the first law and concept of energy; and the second law and concept of entropy. Also examines equations of state, thermodynamic properties, and engineering applications used in the analysis and design of closed and open systems. The course is cross-listed with ENVE 100.
   b. Prerequisite(s): CHEM 001C, MATH 010A, PHYS 040B or consent of instructor
   c. Required course

6. Specific goals of the course
   a. See attached Table for specific course objectives.
   b. Outcomes 1-5, 7, 8 and 11 are evaluated in this course.

7. Brief list of topics to be covered: Definitions of equilibrium system, work, heat, internal energy, state functions; phase rule, units of thermodynamic variables; the first law and its applications to closed systems; the first law for open systems; thermodynamic properties of an ideal gas and one-component fluids; cubic equations of state, virial equation and principle of corresponding states; applications of mass and energy balance; the second law: entropy change and reversibility; entropy changes of ideal gases and one-component fluids; entropy balance for open systems; Carnot engine and Linde process for liquefaction; power generation and refrigeration; thermodynamic partial derivatives and Maxwell relations; evaluation of changes in thermodynamic properties using equation of state and heat-capacity data; heat effects; criteria for thermodynamic equilibrium and stability; phase diagrams of one-component fluids; molar Gibbs energy (chemical potential) and fugacity of a pure component; calculation of fluid-phase equilibrium for one-component fluids; thermodynamic properties of phase transitions

Contribution of course to meeting the professional component: After attending the lectures in this class, students will be able to apply the first and second laws of thermodynamics to close systems as well as to fluid-flow processes, calculate changes in thermodynamic properties, justify the conditions of thermodynamic equilibrium and stability, and perform one-component vapor-liquid equilibrium calculations.

Relationship of course to Student Outcomes: The contribution of CHE 100 to program Student Outcomes (1) – (16) is summarized in the objective-Student Outcome matrix table on page 2.

Item	STUDENT OUTCOME-RELATED LEARNING OBJECTIVES	STUDENT OUTCOMES													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	To introduce the issues of thermodynamics						1		2	1	1				
2	Apply energy balance in terms of internal energy and enthalpy; apply the 1st law for open systems and flow processes	3													
3	Find or calculate thermodynamic properties of ideal gases and real matters including steam	3				1									
4	Apply the problem-solving skills				3	3		2							
5	Explain in none technical terms 1) Clausius' statement of the 2nd law 2) Carnot Cycle 3) Carnot Theorem 4) Kelvin-Planck's statement of the 2nd law							3			1				
6	Understand maximum work output; Helmholtz energy and Gibbs energy, microscopic meaning of entropy and entropy balance	3													
7	Apply the 2nd law for flow processes	3													
8	Able to perform thermodynamic calculations for steady-state engineering devices and thermodynamic cycles	3		3								2			
9	Able to apply a general procedure for the calculation of the changes in thermodynamic properties using an equation of state	3													
10	To establish the concepts of thermodynamic equilibrium and stability	3													
	SUBTOTALS	**21**	**0**	**3**	**3**	**4**	**1**	**5**	**2**	**1**	**2**	**2**	**0**	**0**	**0**

CS 030 Introduction to Computational Science and Engineering
Most recent Instructor: Mart Molle, - Spring 2012
Four Unit Class: Lecture, 3 hours; laboratory, 3 hours.
Textbook: Either one of the following is acceptable:

Mastering Matlab 7, by Hanselman and Littlefield (ISBN 0131430181, 2005 edition)
Mastering Matlab, by Hanselman and Littlefield (ISBN 0136013309, 2012 edition)

Lecture topics:
Chapter 2: Basic Matlab Features: command prompt, command separators (, ;) and continuation (...), variable names / reserved words / special variables, arithmetic expressions, number representation in floating point
Chapter 4: Script M-files: using the editor to create/modify them, execution environment, getting user input, controlling output
Chapter 5: Arrays and Array Operations: Matlab treats everything like a 2-dimensional matrix (even if it is a single scalar value), construction using [ ], accessing using ( ), the colon : operator and ranges, array expressions - element-by-element vs. matrix oriented
Chapter 6: Multi-dimensional arrays and matrix operations: changing the shape of an array, generating arrays with special structure, using matrix oriented expressions
Chapter 7: Numeric Data Types: Alternative methods for representing numbers (integers vs. floating point, amount of memory), conversion between representation
Chapter 8: Cell Arrays and Structures: how to construct them, how to access them
Chapter 9: Character Strings: representation as character arrays, type conversion, searching and modifying
Chapter 10: Relational and Logical Operations:
Chapter 11: Control Flow: if, while, for, break
Chapter 12: Functions: parameters, environments and scope of variables, recursion, file access (Chapter 14)
Chapters 19, 20, 21: Interpolation, Polynomials, Splines:
Chapter 22: Fourier Transform:
Chapters 26, 27: Two and Three Dimensional Graphics:

Grading:
Midterm exam: 30% -Written, closed-book (Covers all material up to chapter 9, except structures)
Final exam: 45%
Lab exercises: 10%
Lab project(s): 15%

Catalog Description
CS 030. Introduction to Computational Science and Engineering (4) Lecture, 3 hours; laboratory, 3 hours.
Prerequisite(s): MATH 009C (may be taken concurrently); consent of instructor if credit has been awarded for CS 010. Examines fundamental programming concepts using the Matlab language, including problem decomposition, control structures, elementary data structures, file input/output, graphics, and code libraries. Focuses on applications problems in engineering and science, such as numerical equation solvers; matrix operations; searching and sorting; and data analysis. Emphasizes good programming style and computational efficiency

EE 001A: Engineering Circuits Analysis

Credits and Contact Hours

4.0 Units
Lecture: TR 2.10 pm – 3.30pm; BRNHL B118
Laboratory:

Sect 002	M	11:10 a.m. - 02:00 p.m.	CHUNG 121
Sect 003	M	02.10 p.m. – 05:00 p.m.	CHUNG 121
Sect 004	T	08:10 a.m. - 11:00 a.m.	CHUNG 121
Sect 006	T	06:10 p.m. - 09:00 p.m.	CHUNG 121
Sect 007	W	11:10 a.m. - 02:00 p.m.	CHUNG 121
Sect 008	W	02.10 p.m. – 05:00 p.m.	CHUNG 121
Sect 009	W	06:10 p.m. - 09:00 p.m.	CHUNG 121
Sect 011	R	11:10 a.m. - 02:00 p.m.	CHUNG 121
Sect 012	R	06:10 p.m. - 09:00 p.m.	CHUNG 121
Sect 014	F	02.10 p.m. – 05:00 p.m.	CHUNG 121

Instructor and TA

Roman Chomko, Lecturer, Dept. of Electrical Engineering;
WCH 411
TA: Yuan Tian (Sections 6, 9), WCH 109; Armen Gholian (Sections 3, 7), WCH 109; Muhammad Morshed (Sections 8, 11), WCH 109; Hui Zhao (Section 14), WCH 109

Textbooks and Related Materials

1. (Text) Charles Alexander, Albert Matthew Sadiku, "Fundamentals of Electric Circuits", 5th ed., McGraw-Hill
2. (Text) J. W. Nilsson and S. A. Riedel, "Introduction to PSpice Manual for Electric Circuits", Prentice Hall, 2000

Specific Course Information

A. Course Description (Catalog description)

Ohm's law and Kirchoff's laws; nodal and loop analysis; analysis of linear circuits; network theorems; transients in RLC circuits. Application of Spice to circuit analysis.

B. Prerequisite(s)

MATH 046, PHYS 040C (both may be taken concurrently); concurrent enrollment in EE 01LA.

C. Course Type

Electrical Engineering, required.

Specific Goals

A. Course Objectives

1. Introduction: overview, basic concepts, circuit elements, Ohm's law, Kirchhoff's law.
2. Resistive Circuit: series connection, parallel connection, bridge circuit.
3. Methods of Circuit Analysis: node-branches, node-voltage method, mesh-current (or "loop-current") method, equivalent circuits, maximum power transfer, source transformation, superposition principle.

4. Operational Amplifiers: op-amp terminals, terminal voltage and current, inverting and non-inverting amplifier circuits, summing and difference circuit.
5. Capacitors and Inductors: characteristics of capacitors and inductors, interconnections of capacitors and inductors.
6. RLC Circuits: RC, RL, and RLC circuits, natural and step responses, and their solution and analysis.

B. Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	B	C	D	E	F	G	H	I	J	K
1	Know and be able to use the definition of generators (sources of electric power), voltage, current, energy											
2	Understand the operation and voltage-current relationships for resistors, dependent and independent generators, inductors, capacitors											
3	Understand miscellaneous reference voltage and current assignments for circuit analysis	1										
4	Understand Kirchhoff's Voltage and Current Laws	1										
5	Understand the origin and be able to apply various circuit analysis techniques such as (E)NBM (node-branches method), (E)NVM (node voltage method) and LCM (loop current method)	1										
6	Be able to apply equivalent transformations such equivalent resistances (both fundamental and special), Thevenin's equivalent circuits, source transformations and other network theorems	1		1		1					1	
7	Understand the operation of simple sensor circuits such as a bridge circuit		1	1								
8	Understand the operation of OpAmps both Ideal and Practical and their application for analog computers	1		1								
9	Understanding of intrinsic properties (voltage/current characteristics) of capacitors and inductors											
10	Be able to derive transient step responses of RL, RC, RLC circuits											

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.

B. 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 136: Semiconductor Device Processing

Credits and Contact Hours
4.0 Units
Lecture: TR 12:40 pm – 2pm; HMNSS1404
Lab: F 5:10pm-8:00pm; Pierce Hall 1441

Office Hours:
Instructor: R 3:10 pm – 4:00 pm; WCH 439

Instructor and TA
Jianlin Liu, Professor, Dept. of Electrical Engineering; WCH 439
TA: Jian Huang, WCH 228

Textbooks and Related Materials
1. (Text) Richard C. Jaeger, Introduction to Microelectronic Fabrication, Modular Series on Solid State Devices, second edition, ISBN: 0-201-44494-1; Coverage to include chapters 1-9, etc.
1. (Reference) a) Lecture handouts at ilearn ; b) Lab lecture handouts at ilearn; c) Peter Van Zant, Microchip Fabrication, fifth edition, ISBN: 0-07-143241-8; d) S. Wolf and R. N. Tauber, Silicon Processing for the VLSI Era, Volume 1 Process Technology, Second Edition, ISBN: 0-9616721-6-1; e) Online reading: nanohub.org

Course Description (Catalog Description)
This EE undergraduate course presents device/process simulations and hands-on experience in Integrated Circuit (IC) fabrication and characterization techniques. Students will work in the Microelectronics Laboratory (teaching clean room) to learn fabrication processes of NMOSFET transistors. Electrical evaluation of these devices and simulations of these devices will be performed.

Prerequisite(s)
EE133 or consent of instructor

Course Type
Electrical Engineering, technical elective course for undergraduate students and graduate students in the Nano-materials and Devices area

A. Course Objectives
1. Learn basic theories/skills required for semiconductor device fabrication, characterization and simulation.
2. Learn processes and process modules such as lithography, oxidation, film deposition, etching and metallization.
3. Learn process integration of metal-oxide-semiconductor-field-effect transistors.
4. Learn device characterization techniques.
5. Learn device simulation and process simulation.
6. Learn how to write technical reports and technical papers (IEEE-type).

7. Learn the importance of teaming in a project.
8. Learn how a graduate student normally does research.

B. Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	In one or two sentences explain what are: semiconductors, Si, doping, metal oxide semiconductor field effect transistor					3		3	1	1		
2	Understand the current density equations and continuity equations to simulate output and trasfer characteristics of a MOSFET	3										
3	Understand the technology node and scaling limits	3		1								
4	Define photolithography process steps to fabricate a NMOSFET	2										
5	Understand Si oxidation		3					3				
6	Understand film deposition methods	3		1								
7	Understand ion implantation process					1		2				
8	Understand theory and process of metal contact to MOSFET	3										
9	Photolithography and metalization process and fabrication/characterization		3									

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.

EE137- Introduction to Semiconductor Optoelectronic Devices

Credits and Contact Hours
4.0 Units
Lecture: Tu-Th 11:10am-12:30 pm; SURGE 172
Discussion: M 3.10 pm – 4.00 pm; PRCE 3374

Office Hours:
Instructor: W 1-2pm
Reader: TR 1-3pm

Instructor and Reader
Mihri Ozkan, Professor, Dept. of Electrical Engineering;
MSE 319
Reader: Isaac Ruiz, WCH 207

Textbooks and Related Materials
1. (Text book) Optoelectronics an Introduction, 3rd edition by John Wilson and John Hawkes
2. Coldren, and Corzine. Diode Lasers and Photonic Integrated Circuits. 1st ed. New York, NY: Wiley-Interscience, October 16, 1995. ISBN: 0471118753.
3. Chuang, S. L. Physics of Optoelectronic Devices. New York, NY: Wiley-Interscience, September 8, 1995. ISBN: 0471109398.
4. Pallab Bhattacharya, Semiconductor optoelectronic devices, 1994
5. S.C. Gupta, Optoelectronic devices and systems, 2005
6. Wallace B. Leigh, Devices for optoelectronics, 1996

Course Description (Catalog Description)
An introduction to semiconductor optoelectronic devices for optoelectronic communications and signal processing. Topics include basic optical processes in semiconductors, semiconductor light-emitting diode, semiconductor heterojunction lasers, photodetectors, solar cells, optoelectronic
modulation, and switching devices.

Prerequisite(s)
EE 133

Course Type
Electrical Engineering, technical elective.

Course Objectives
1. Introduction to basic concepts of semiconductors
2. Introduction to basic concepts of light and semiconductor interaction
3. Understanding the role of types of semiconductors on optoelectronic device fabrication
4. Introduction to p-n junctions
5. Introduction to forward biased p-n junction devices
6. Introduction to reverse biased p-n junction devices

7. Learning of real-life applications of semiconductor optoelectronic devices
8. Design of new semiconductor optoelectronic devices for better performance

Student Outcomes Addressed

		OUTCOMES										
Item	**COURSE OBJECTIVES**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Introduction to basic concepts of semiconductors	1										
2	Introduction to basic concepts of light and semiconductor interaction	1										
3	Understanding the role of types of semiconductors on optoelectronic device fabrication											
4	Introduction to p-n junctions											
5	Introduction to forward biased p-n junction devices	1		1								
6	Introduction to reverse biased p-n junction devices	1										
7	Learning of real-life applications of semiconductor optoelectronic devices	1				1						
8	Design of new semiconductor optoelectronic devices for better performance					1		1				
Subtotals		5		1		3		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 the techniques, skills, and modern engineering tools necessary for engineering practice.

EE 138: Electrical Properties of Materials

Credits and Contact Hours
4.0 Units
Lecture: MWF 3:10 pm – 4:00 pm ENGR2 139
Discussion: W 5:10 pm – 6:00 pm OLMH 1127

Office Hours:
Instructor: T 3:00 – 4:00 pm
TA: R 2:00 – 3:00 pm

Instructor and TA
Elaine D. Haberer, Assistant Professor, Dept. of Electrical Engineering;
WCH 418
TA: Zhonglin Li, WCH 109
Textbooks and Related Materials
(Text) Electronic Properties of Engineering Materials
James D. Livingston, John Wiley & Sons, Inc. New York, NY 1999
(1 copy on RESERVE in the Science Library)

Course Description (Catalog Description)
Introduces the electrical properties of materials. Includes the electron as a particle and a wave; hydrogen atom and the periodic table; chemical bonds; free-electron theory of metals; band theory of solids; semiconductors and dielectrics; measurements of material properties; and growth and preparation of semiconductors.

Prerequisite(s)
Upper division standing; PHYS 040C or equivalent

Course Type
Electrical Engineering, technical elective; Materials Science and Engineering, required.

Course Objectives
1. Understand conduction mechanisms (free and bound electrons) in metals and dielectrics.
2. Understand electromagnetic wave (light) interactions with metals and dielectrics.
3. Understand the difference in treating electrons as particles or waves.
4. Understand and analyze 1D quantum mechanical problems such as potential walls and wells.
5. Understand the origin of the periodic table of elements based on the model of the hydrogen atom.
6. Learn principles of the band theory of solids and differentiate between metals, semiconductors, and insulators
7. Understand intrinsic and extrinsic semiconductors and the physical principles of conduction for each (majority and minority carriers)
8. Understand the basic principles of semiconductor devices
9. Understand basic principles of magnetic materials and differentiate between soft and hard magnets

Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES										
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	Understand conduction mechanisms in metals and dielectrics	1										
2	Understand electromagnetic wave (light) interactions with metals and dielectrics	1										
3	Understand the difference in treating electrons as particles or waves	1										
4	Understand and analyze 1D quantum mechanical problems	1										
5	Understand the origin of the periodic table of elements	1										
6	Learn principles of the band theory of solids					1						
7	Understand intrinsic and extrinsic semiconductors and the physical principles of conduction for each	1										
8	Understand basic principles of semiconductor devices					1						
9	Understand basic principles of magnetic materials and differentiate between soft and hard magnets					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 139: Magnetic Materials

Credits and Contact Hours

4.0 Units
Lecture: TR 5.10 pm – 6.30pm; MSE 113
Discussion: M 4.10 pm – 5.00 pm; MSE 003

Instructor and TA

Roman Chomko, Lecturer, Dept. of Electrical Engineering;
WCH 411
TA: Zhong Yan, WCH 109

Textbooks and Related Materials

1. (Text) B. D. Cullity and C. D. Graham, "Introduction to Magnetic Materials", 2nd edition, Wiley-IEEE, 2009
2. (Reference) Sóshin Chikazumi, "Physics of Ferromagnetism", 2nd edition, Oxford University Press, 2009

Specific Course Information

A. Course Description (Catalog description)

Introduces fundamentals of magnetic materials for the next-generation magnetic, nanomagnetic, and spintronics-related technologies. Includes basics of magnetism, models of the equivalent magnetic charge and current, paramagnetic and diamagnetic materials, soft and hard magnetic materials, equivalent magnetic circuits, and magnetic system design foundations.

B. Prerequisite(s)

Upper-division standing; **PHYS 040C** or equivalent

C. Course Type

Electrical Engineering, elective.

Specific Goals

A. Course Objectives

1. Electromagnetics with Magnetic Materials (Inductors, Magnetic Circuits).
2. Types of Magnetism.
3. Magnetic Phenomena.
4. Magnetic Measurements.
5. Magnetic Materials and Metallurgy.
6. Introduction to random processes and their applications.
7. Application of Magnetic Materials.

B. Student Outcomes Addressed

Item	COURSE OBJECTIVES	OUTCOMES A	B	C	D	E	F	G	H	I	J	K
1	Generation of Magnetic Fields: coils, electromagnets, magnetic circuits	1										
2	Origin of magnetization, magnetic moment of atoms											
3	Susceptibility and Permeability, Demagnetizing fields, and shape anisotropy	1										
4	Understanding of the origin of diamagnetism, Larmor's precession of atomic magnetic moments											
5	Understanding that paramagnetism is due to thermal interactions, Curie Law	1										
6	Understanding of origin of ferromagnetism according to the Weiss molecular fields, exchange interactions											
7	Understanding of the Weiss molecular fields approach to explain antiferromagnetism and ferrimagnetism, composition of ferrites and their properties	1										
8	Understanding of crystalline anisotropy, hard and easy axes of magnetization	1	1	1								
9	Understanding the origin of magnetic domains, hysteresis. Soft and hard magnetic materials	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.

ENGR 180W Technical Communication

Instructors: Sharon Burton and Bonni Graham
Contact info:
Sharon email: sharon@anthrobytes.com or
Sharon Yahoo IM only: sharonvburton
Bonni email: bgraham@manuallabour.com
Bonni Yahoo IM only: esotericabjg

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.

1. **ME 010- Statics**

2. Credits and contact hours:
   4 Credits: Lecture, 3 hours; discussion, 1 hour
   Lecture: TR- 6:40PM- 8:00PM
   Discussion: Monday and Tuesday - 5:10PM-6:00PM; Friday - 4:10PM- 5:00PM

3. Instructor's or course coordinator's name: Dr. Tsutsui Hideaki

4. Textbook, title, author, and year:
   J.L. Meriam and L.LD. Kraige, Engineering Mechanics- Staitics, 6th Ed., John Wiley & Sons, Inc., 2007. ISBN 0-471-73932-4.
   a. Other supplemental material: none

5. Specific course information:
   a. Covers equilibrium of coplanar force systems; analysis of frames and trusses; non-coplanar force systems; friction; and distributed loads.
   b. Prerequisites: MATH 009; PHYS 040A.
   c. Required Course

6. Specific goals for the course:
   a. Upon completion of this course, students should be able to:
      1. Replace a given general system of forces with a resultant force and couple.
      2. Construct two- and three- dimensional free body diagrams.
      3. Apply the principles of equilibrium to determine the reactions at supports for two and three- dimensional problems.
      4. Determine the forces acting in place, trusses, frames, and machines components.
      5. Determine the location of the centroid of lines, areas and volumes in the analysis of distributed forces.
      6. Formulate and solve statics problems involving fry friction.
   b. These course objectives contribute to the following Student Outcomes:
      1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.
      2. Outcome (b): An ability to design and conduct experiments, as well as analyze & interpret data.
      3. Outcome (c): An ability to design a system, component, or process to meet desired needs.
      4. Outcome (d): An ability to function on multidisciplinary terms.
      5. Outcome (e): An ability to identify, formulate, and solve engineering problems.

7. Brief list of topics to be covered:
   Introduction to Statics, Force Systems: Forces and Moments and Couples, Equilibrium: System Isolation and Equilibrium Condition (2D and 3D), Force Systems: Resultants, Review: Force Systems and Equilibrium, Frames & Machines, Structures: Plane Trusses,

Distributed Forces: Center of Mass, Centroids/ Composite Sections, Beams, Friction Principles, Friction in Machines, Ethics case study

1. **ME 110- Mechanics of Materials**

2. Credits and contact hours:
   4 Credits: Lecture, 3 hours; discussion, 1 hour
   Lecture: TR- 5:10PM- 6:30PM (LFSC 1500)
   Discussion: Monday- 12:10PM-1:00PM (ENGR2 142)
   Monday- 9:10AM- 10:00AM (WAT 1111)
   Friday- 3:10PM- 4:00PM (ENGR2 142)

3. Instructor's or course coordinator's name: Dr. Masaru Rao

4. Textbook, title, author, and year:
2. *Mechanics of Materials*, J.M. Gere & B.J. Goodno, 7^{th} Edition, Cengage, 2009. ISBN: 0-534-55397-

   a. Other supplemental material: none

5. Specific course information:
   a. Topics include mechanics of deformable bodes, subjected to axial, torsional, shear, and bending loads; combines stresses; columns; energy design; and their applications to the design of structures.
   b. Prerequisites: Math 046, ME 010 with a grade of "C-" or better, ME 018.
   c. Required Course

6. Specific goals for the course:
   a. Upon completion of this course, students should be able to:
      1. Understand basic concepts of stress, strain and their relations based on linear elasticity.
      2. Understand and know how to calculate stresses and deformation of a bar due to an axial loading under uniform and non-uniform conditions.
      3. Understand and know how to calculate stresses and deformation of a torsional bar.
      4. Understand how to develop shear-moment diagram of a beam and find the maximum moment/shear and their locations.
      5. Understand how to calculate normal and shear stresses on any cross-section of a beam.
      6. Understand and know how to calculate deflections of a beam under combined loads by using methods of moment-area and superposition.
      7. Understand and know how to calculate deflection of a beam, when a beam is statically indeterminate.
      8. Understand and how to use Mohr's circle to calculate principal stresses and angles in plane stress cases.
      9. Able to apply all knowledge learned in the course to calculate stresses on pressure vessels, beams and structures under combined loadings
   b. These course objectives contribute to the following Student Outcomes:
      1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.

2. Outcome (b): An ability to design and conduct experiments, as well as analyze & interpret data.
3. Outcome (c): An ability to design a system, component, or process to meet desired needs.
4. Outcome (d): An ability to function on multidisciplinary terms.
5. Outcome (e): An ability to identify, formulate, and solve engineering problems.
6. Outcome (f): An ability to understand of professional and ethical responsibility.
7. Outcome (g): An ability to communicate effectively.
8. Outcome (h): The broad education necessary to understand the impact of engineering solution in a global and societal context.
9. Outcome (i): Recognition of the need for and an ability to engage in lifelong learning.
10. Outcome (j): Knowledge of contemporary issues.
11. Outcome (k): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Brief list of topics to be covered:
   Normal stress & strain; Mechanical properties of materials, Linear elasticity; Shear stress & strain; Allowable stresses, Elongation of axially loaded members, Statically indeterminate axial members & Thermal effects, Torsion of circular bars & Nonuniform torsion, Statically indeterminate torsion, Beams - Loads, & reactions, shear & bending moment diagrams, Beams - Normal stress & longitudinal strain , Beams - Shear stress, Beam deflection - M(x) integration method, Beam deflection - Superposition method, Beams - Statically indeterminate beams**,** Stress transformations for plane stress, Principal stresses, max shear stresses, & Mohr’s circle, Pressure vessels, Combined loadings

1. **ME 113- Fluid Mechanics**

2. Credits and contact hours:
   4 Credits: Lecture, 3 hours; discussion, 1 hour
   Lecture: TR- 3:40PM- 5:00PM (WAT 1000)
   Discussion: Wednesday- 3:10PM-4:00PM (SPR 2339)
   Friday- 8:10AM- 9:00AM (WAT 2240)
   Friday- 4:10PM- 5:00PM (SPR 2339)

3. Instructor's or course coordinator's name: Dr. Lorenzo Mangolini

4. Textbook, title, author, and year:
   Introduction to Fluid Mechanics by R.W. Fox and A.T. McDonald, 8th edition, New York, Wiley. ISBN 9780470547557
   a. Other supplemental material: none

5. Specific course information:
   a. Introduces principle of fluid mechanics relevant to mechanical engineering. Topics include shear stresses and viscosity, fluid statics, pressure, forces on submerged surfaces, Bernoulli and mechanical energy equations, control volume approach, mass conservation, momentum and energy equations, the differential approach, turbulent flow in pipes, and lift and drag.
   b. Prerequisites: ME 046, PHYS 040B, ME 010 with a grade of "C-"or better, ME 018.
   c. Required Course

6. Specific goals for the course:
   a. Upon completion of this course, students should be able to:
      1. Distinguish fluids from solids and develop an ability to understand basic fluid properties such as density, viscosity, surface tension, etc.
      2. Correctly identify and analyze fluid statics (hydrostatics) problems involving forces and moments on planar and curved surfaces, including concept of centroid, center of pressure, and buoyancy.
      3. Identify conditions under which Bernoulli equation may be applied, and correctly apply this principle in problem solving. Demonstrate an understanding of the mechanical energy equation.
      4. Apply basic principles of conservation of mass (COM), Newton's second law (NSL), and conservation of energy (COE or I Law of Thermodynamics) to properly identified control mass and control volumes, involving stationary and moving reference frames.
      5. Demonstrate some familiarity with differential forms of equations of motion.
      6. Carry out calculations involving energy loss in pipe flow, successfully utilizing the Moody diagram.
      7. Display an understanding of lift, drag, lift coefficient, and drag coefficient associated with external flow dynamics.
   b. These course objectives contribute to the following Student Outcomes:

1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.
2. Outcome (b): An ability to design and conduct experiments, as well as analyze & interpret data.
3. Outcome (c): An ability to design a system, component, or process to meet desired needs.
4. Outcome (d): An ability to function on multidisciplinary terms.
5. Outcome (e): An ability to identify, formulate, and solve engineering problems.
6. Outcome (f): An ability to understand of professional and ethical responsibility.
7. Outcome (g): An ability to communicate effectively.
8. Outcome (h): The broad education necessary to understand the impact of engineering solution in a global and societal context.
9. Outcome (i): Recognition of the need for and an ability to engage in lifelong learning.
10. Outcome (j): Knowledge of contemporary issues.
11. Outcome (k): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Brief list of topics to be covered:

   Introduction, Fluid Statics, Integral Equations, Different form of Motion Equations, Bernoulli & Energy, Inviscid Flow, Flow in Pipes, Internal viscous flow, Drag and Lift, External viscous flow, Compressible Flows

ME 114- Introduction to Material Science and Engineering

1. Credits and contact hours:
   4 Credits: Lecture, 3 hours; discussion, 1 hour
   Lecture: MWF- 1:10AM-2:00PM (MSE 104)
   Discussion: Wednesday- 8:10AM- 9:00AM (MSE 003)
   Wednesday- 5:10PM- 6:00PM (INTN 1006)
   Friday- 8:10AM- 9:00AM (MSE 103)

2. Instructor's or course coordinator's name: Dr. Javier Garay

3. Textbook, title, author, and year: *Introduction to Materials Science and Engineering*, J. Schackelford, 7^{th} Edition
   a. Other supplemental material: none

4. Specific course information:
   a. Covers materials classification, atomic structure and interatomic bonding, crystal structure of metals, imperfections in solid, diffusion, mechanical properties of engineering materials, strengthening mechanisms, basic concepts of fracture and fatigue.
   b. Prerequisites: CHEM 001B, PHY 040; Upper-division standing
   c. Required Course

6. Specific goals for the course:
   a. Upon completion of this course, students should be able to:
      1. Demonstrate an understanding of and the ability to draw cubic crystal structures.
      2. Understand and draw phase diagrams.
      3. Apply and understand Fick's laws.
      4. Calculate and understand the importance of defects.
      5. Explain the concepts behind X-ray diffraction, scanning electron microscopy, and transmission electron microscopy.
      6. Draw and understand stress-strain diagrams and fatigue diagrams. Perform fracture calculations.
      7. Understand the principles behind functional properties such as thermal, electrical, optical and magnetic.
   b. These course objectives contribute to the following Student Outcomes:
      1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.
      2. Outcome (b): An ability to design and conduct experiments, as well as analyze & interpret data.
      3. An ability to design a system, component, or process to meet desired needs.
      4. Outcome (d): An ability to function on multidisciplinary terms.
      5. Outcome (e): An ability to identify, formulate, and solve engineering problems.
      6. Outcome (f): An ability to understand of professional and ethical responsibility.
      7. Outcome (g): An ability to communicate effectively.

8. Outcome (h): The broad education necessary to understand the impact of engineering solution in a global and societal context.
9. Outcome (i): Recognition of the need for and an ability to engage in lifelong learning.
10. Outcome (j): Knowledge of contemporary issues.
11. Outcome (k): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Brief list of topics to be covered:
   Overview of material property-structure relationships, Material structure, Mechanical Behavior, Electrical Properties, Magnetic Properties, Thermal properties, Optical properties, Material Processing, Solid state mass transfer—Diffusion, Material characterization.

1. **ME 116A – Heat Transfer**

2. Credits and contact hours:
   4 Credits: Lecture, 3 hours; discussion, 1 hour
   Lecture: TR- 9:40AM- 11:00AM (MSE 116)
   Laboratory: Monday- 10:10AM-11:00AM (INTN 1002)
   Monday- 4:10PM- 5:00PM (PHY 2104)
   Wednesday- 3:10PM- 4:00PM (BOYHL 1471)

3. Instructor's or course coordinator's name: Dr. Kambiz Vafai

4. Textbook, title, author, and year:
3. Incropera, David P. Dewitt, Theodore L.Bergman and Adrienne S. Lavine, *Fundamentals of Heat and Mass Transfer*, John Wiley & Sons, 6th edition.

   a. Other supplemental material: none

5. Specific course information:
   a. Introduces the analysis of steady and transient beat conduction, fin and heat generating systems, two-dimensional conduction, internal and external forced convection, natural convection, radiation heat transfer, heat exchanges, and mass transfer
   b. Prerequisites: ME 046, ME 100A, ME 113
   c. Co-requisites: ME 113
   d. Required Course

6. Specific goals for the course:
   a. Upon completion of this course, students should be able to:
      1. Demonstrate comprehensive derivation of the conduction equation and its ramifications.
      2. Analyze heat generating systems.
      3. Illustrate enhanced cooling extended surface assemblies.
      4. Display two-dimensional heat conduction.
      5. Illustrate the numerical simulation of two dimensional steady state and one-dimensional transient conduction problems utilizing finite difference formulation.
      6. Demonstrate the transient heat transfer and lumped capacitance method as well as the spatial and transient analysis
      7. Demonstrate laminar and turbulent external forced convection over a plane external boundary and other body shapes.
      8. Establish laminar and turbulent internal forced convection with uniform wall temperature and uniform wall heat flux.
      9. Exhibit the general aspects of radiation interaction: processes for black and gray bodies and radiation properties such as emissivity, absorptivity, reflectivity and transmissivity.
      10. Study radiation exchange between surfaces (black and diffuse-gray surfaces) and learn the engineering use of view of factor

11. Illustrate heat transfer interactions and log mean temperature computations
12. Demonstrate natural convection heat transfer.

b. These course objectives contribute to the following Student Outcomes:
    1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.
    2. Outcome (b): An ability to design and conduct experiments, as well as analyze & interpret data.
    3. Outcome (c): An ability to design a system, component, or process to meet desired needs.
    4. Outcome (d): An ability to function on multidisciplinary terms.
    5. Outcome (e): An ability to identify, formulate, and solve engineering problems.
    6. Outcome (f): An ability to understand of professional and ethical responsibility.
    7. Outcome (g): An ability to communicate effectively.
    8. Outcome (h): The broad education necessary to understand the impact of engineering solution in a global and societal context.
    9. Outcome (i): Recognition of the need for and an ability to engage in lifelong learning.
    10. Outcome (j): Knowledge of contemporary issues.
    11. Outcome (k): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Brief list of topics to be covered:

   Energy production and conservation, design and analysis of various engineering systems, generation of electrical power, engine components, boilers, condensers, turbines, electronic cooling, biological and environmental applications, manufacturing applications, nuclear energy production, combustion, geothermal operations, heat exchanger performance and propulsion systems to name a few.

1. **ME 138- Transport Phenomena in Living Systems**

2. Credits and contact hours:
   4 Credits: Lecture, 3 hours; discussion, 1 hour
   Lecture: TR- 2:10PM- 3:30PM (INTN 1006)
   Discussion: Friday- 9:10AM- 10:00AM (BOYHL 1421)

3. Instructor's or course coordinator's name: Dr. Akula Venkatram

4. Textbook, title, author, and year:

4. *Fundamentals of Heat and Mass Transfer* by Incropera, DeWitt, Bergman, Lavine
5. (ID), Wiley
6. *Introduction to Fluid Mechanics* by Fox, McDonald, and Pritchard (FM), Wiley
7. *Fundamentals of Engineering Thermodynamics* by Moran and Shapiro (MS), Wiley

   a. Other supplemental material: none

5. Specific course information:
   a. An introduction to the application of the basic conservation laws of mechanics (mass, linear, momentum, and energy) to the modeling of complex biological systems. Emphasizes how these concepts can explain and predict life processes.
   b. Prerequisites: BIEN 105 or ME 113, MATH 046, PHYS 040B.
   c. Elective Course

6. Specific goals for the course:
   a. Upon completion of this course, students should be able to:
      1. Learn about the physical properties of body fluids and how diverse solutes are transported across cell membranes and capillaries.
      2. Understand the mechanisms of blood flow and oxygen transport in biological systems
      3. Understand the mechanics mechanisms of blood flow in biological systems.
      4. Understand the mechanisms of heat transfer within the human body and use the Pennes bioheat transport equation to pose and solve simple problems of tissue heating, freezing and thawing.
      5. Learn what the relevant optical properties of biological tissues are and understand the mechanisms of light transport within the human body (e.g. Beer's law)
      6. Learn how to estimate the overall thermal damage induced on human tissues based on a 1st order kinetic model (Arrhenius)
      7. Develop the basic skill to write short computer codes to solve transport problems in living systems.
      8. Learn how to seek cutting-edge research, understand it and explain those topics orally in class.
   b. These course objectives contribute to the following Student Outcomes:
      1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.
      2. Outcome (d): An ability to function on multidisciplinary terms.

3. Outcome (e): An ability to identify, formulate, and solve engineering problems.
4. Outcome (j): Knowledge of contemporary issues.

7. Brief list of topics to be covered:
   HPL Methodology and Fundamental Concepts in Biotransport, theology of biological fluids/ biofluids transport, biofluid transport, bioheat transport, biomass transport, light transport within tissue (Beer's law), 1st order kinetic model (Arrhenius) to compute overall thermal damage.

1. **ME 153- Finite Element Methods**

2. Credits and contact hours:
   4 Credits: Lecture, 3 hours; discussion, 1 hour.
   Lecture: TR- 3:40PM- 5:00PM (WAT 1101)
   Discussion: Monday- 5:10PM- 6:00PM (SPTH 1222)
   Thursday- 10:10AM- 11:00AM (WAT 1111)

3. Instructor's or course coordinator's name: Dr. Guanshiu Xu

4. Textbook, title, author, and year:
   The Finite Element Method Linear Static and Dynamic Finite Element Analysis by Thomas J.R. Hughes, Prentice Hall, 1987 or Dover, 2000.
   a. Other supplemental material: none

5. Specific course information:
   a. Covers weak form formulation, the Galerkin method and its computational implementation, mesh generation, data visualization, as well as programming finite element codes for practical engineering applications.
   b. Prerequisites: ME 118
   c. Elective Course

6. Specific goals for the course:
   a. Upon completion of this course, the student should be able to:
      1. Strong and weak form formulation of differential equations
      2. Basics of the finite element method: Galerkin method
      3. Discretization: Mesh generation and shape functions
      4. Computational implementation of the finite element method
      5. Program FEM codes to solve engineering problems
      6. Apply the commercial FEM software to solve engineering problems
   b. These course objectives contribute to the following Student Outcomes:
      1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.
      2. Outcome (b): An ability to design and conduct experiments, as well as analyze & interpret data.
      3. Outcome (c): An ability to design a system, component, or process to meet desired needs.
      4. Outcome (d): An ability to function on multidisciplinary terms.
      5. Outcome (e): An ability to identify, formulate, and solve engineering problems.
      6. Outcome (f): An ability to understand of professional and ethical responsibility.
      7. Outcome (g): An ability to communicate effectively.
      8. Outcome (h): The broad education necessary to understand the impact of engineering solution in a global and societal context.
      9. Outcome (i): Recognition of the need for and an ability to engage in lifelong learning.
      10. Outcome (j): Knowledge of contemporary issues.

11. Outcome (k): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Brief list of topics to be covered:
   Basic concepts of the Finite Element Method, A one-dimensional boundary-value problem, Galerkin approximation method, solving a finite element problem by hand, linear algebra, computational implementation of the finite element method, two dimensional boundary value problems

1. **ME 156- Mechanical Behavior of Materials**

2. Credits and contact hours:
   4 Credits: Lecture, 3 hours; laboratory, 1 hour
   Lecture: MWF- 10:10AM- 11:00AM (SPTH 1307)
   Laboratory: Friday- 11:10AM- 2:00PM (BRNHL B213AA)

3. Instructor's or course coordinator's name: Dr. Masa Rao

4. Textbook, title, author, and year:
   Mechanical Behavior of Materials, T.H. Courtney, 2nd Ed., Waveland Press, 2000, ISBN: 1-57766-425-6
   a. Other supplemental material:
      Introduction to Materials Science and Engineering, W. D. Callister, 7th Edition, Wiley, 2007

5. Specific course information:
   a. Introduces the theory and experimental techniques for testing the mechanical behavior of materials and structures. Covers the fundamental mechanisms of deformation and failure of metals, ceramics, polymers, composite materials, and electronic materials as well as structural design and materials selection.
   b. Prerequisites: Senior standing, ME 110, ME 114
   c. Elective Course

6. Specific goals for the course:
   a. Upon completion of this course, students should be able to:
      1. Provide an overview of mechanical behavior of material classes.
      2. Familiarize with concept of crystalline material mechanical behavior.
      3. Analyze material stress-stain behavior.
      4. Provide a basis for students to assess plastic deformation in materials.
      5. Familiarize with key dislocation concepts.
      6. Familiarize with concepts fracture mechanics.
      7. Familiarize with important concepts in composite material behavior.
      8. Provide an overview of mechanical behavior of polymers.
      9. Assess high temperature behavior of materials]
      10. Properly select materials in mechanical design.
   b. These course objectives contribute to the following Student Outcomes:
      1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.
      2. Outcome (b): An ability to design and conduct experiments, as well as analyze & interpret data.
      3. An ability to design a system, component, or process to meet desired needs.
      4. Outcome (d): An ability to function on multidisciplinary terms.
      5. Outcome (e): An ability to identify, formulate, and solve engineering problems.
      6. Outcome (f): An ability to understand of professional and ethical responsibility.
      7. Outcome (g): An ability to communicate effectively.

8. Outcome (h): The broad education necessary to understand the impact of engineering solution in a global and societal context.
9. Outcome (i): Recognition of the need for and an ability to engage in lifelong learning.
10. Outcome (j): Knowledge of contemporary issues.
11. Outcome (k): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Brief list of topics to be covered:

   Overview of mechanical behavior, elastic behavior, dislocations, plastic deformation in metals, strengthening mechanisms, plastic deformation in polymers, fracture mechanics, toughening, fatigue, high temperature deformation.

   At the first lab session of the quarter, Lab Safety Training will be provided and it will include the following: First Aid/Emergency rules; instruction on appropriate lab attire: no sandals or open toe shoes allowed, personal protective equipment (PPE) such as safety eyewear provided for use in lab; safety training on machines/instrumentation used in lab; general lab housekeeping; review of department CHP and SOP for instructional labs.

1. **ME 180- Optics and Lasers in Engineering**

2. Credits and contact hours:
   4 Credits: Lecture, 3 hours; laboratory, 3 hours
   Lecture: TR- 12:40AM-2:00PM (SPR 2343)
   Laboratory: Friday- 8:10AM-9:00AM (BRNHL B213AA)

3. Instructor’s or course coordinator’s name: Dr. Cengiz Ozkan

4. Textbook, title, author, and year:
8. Introduction to Optics, Pedrotti, Addison-Wesley, 2007, ISBN-10: 0131499335

   a. Other supplemental material: none

5. Specific course information:
   a. Focuses on principles of optics and lasers, wave equations, interferometry, diffraction, laser-material interactions. Applications in analytical characterization including confocal microscopy, Raman spectroscopy, mechanical deformation analysis, scanning probe microscopy, ultraviolet-visible spectrophotometry, photoluminescence, optical detectors, and lasers in materials processing.
   b. Prerequisites: Senior standing, ME 010, ME 110, ME 170A.
   c. Elective Course

6. Specific goals for the course:
   a. Upon completion of this course, students should be able to:
      1. Understand the physical nature of light
      2. Learn the fundamental knowledge of optics and lasers
      3. Learn the working principles of various optical elements and optical instrumentation
      4. To be able to evaluate the availability of optical methods for solving given problems
      5. Understand the fundamentals of lasers and different types
      6. Learn the contemporary applications of optics and lasers in the state of the art technology and research
      7. Understand the basic principles of optical and laser based material characterization techniques (lab modules)
   b. These course objectives contributes to the following Student Outcomes:
      1. Outcome (a): An ability to apply knowledge of mathematics, science, and engineering.
      2. Outcome (b): An ability to design and conduct experiments, as well as analyze & interpret data.
      3. Outcome (c): An ability to design a system, component, or process to meet desired needs.
      4. Outcome (d): An ability to function on multidisciplinary terms.
      5. Outcome (e): An ability to identify, formulate, and solve engineering problems.
      6. Outcome (f): An ability to understand of professional and ethical responsibility.
      7. Outcome (g): An ability to communicate effectively.

8. Outcome (h): The broad education necessary to understand the impact of engineering solution in a global and societal context.
9. Outcome (i): Recognition of the need for and an ability to engage in lifelong learning.
10. Outcome (j): Knowledge of contemporary issues.
11. Outcome (k): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Brief list of topics to be covered:
   Geometrical optics, Optical instrumentation, Wave equations, Properties of lasers, Optical interferometry**,** Fiber optics, Diffraction and gratings, Micromachined devices - optical MEMS, Laser processing of materials

   At the first lab session of the quarter, Lab Safety Training will be provided and it will include the following: First Aid/Emergency rules; instruction on appropriate lab attire: no sandals or open toe shoes allowed, personal protective equipment (PPE) such as safety eyewear provided for use in lab; safety training on machines/instrumentation used in lab; general lab housekeeping; review of department CHP and SOP for instructional labs.

1) **MSE 001 Fundamentals of Materials**

2) 2.0 units, 1 hour lecture, 1 hour discussion

3) David Kisailus

4) Textbook: P.A. Thrower, *Materials in Today's World,* (3rd Edition, Published by McGraw-Hill, 2007) and journal papers

5) Specific course information
6) Catalog description: An introduction of properties and applications of different types of materials essential for various areas of engineering. Explores the relationship between the structure and properties as well as processing of the materials. Illustration of a wide range of properties required for different types of applications. Specific topics include the science of materials, bonding and structure, the strength of materials, electrons in materials, semiconductors, superconductors, and optical properties of materials.

7) Prerequisite(s): None.

8) Specific goals for the course
9) See attached Table for specific course objectives.
10) Outcomes 2, 3, 6, 9, 15 are evaluates in this course.

Brief list of topics to be covered:
What is Materials Science?
Classes of Materials
Bonding
Crystalline/Amorphous Materials
Strength of Materials
Polymers
Heat
Ceramics
Electrons in Materials
Nanomaterials
Biomaterials

Contribution of course to meeting the professional component: MSE 001 is a 2-unit beginning course in materials science and engineering that introduces the fundamentals of materials science and engineering by reference to the world we inhabit. The course is designed to introduce freshman students to the wide variety of materials classes and their impact in multiple applications. The course objective is to provide a basic understanding of materials science with a particular emphasis on the underlying chemistry and how this translates into structure and properties. The course is designed to introduce students to materials that are encountered in everyday life. The course begins with an introduction to the concepts of bonding and how it determines the arrangement of atoms or molecules in crystalline or amorphous configurations. In addition to providing a historical perspective of the processing of materials, the course covers important developments of modern technologies and novel materials. The course will cover three major classes of materials: metals, polymers, and ceramics. Particular focus will be placed on novel (nano)materials with applications in electronics, solar conversion, structural materials, and aerospace. At the end of the course, students will be exposed to the underlying mechanical, thermal, semiconducting, conducting, and electronic properties of materials.

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Relationship of course to program outcomes: The contribution of MSE001 to program outcomes (1) – (16) is summarized in the objective-outcome matrix table on page 2.

Objective-Outcome Matrix: 1-Slightly 2-Moderately 3-Substantially

Outcome Related Learning Objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Discussion of fundamental chemical forces in bonding (primary and secondary). Diffusion in materials processing.		3															
Design of composite materials and multifunctional devices.			3						3								
Analysis of stress-strain curves to determine fundamental material properties.						3											
Word problems will be assigned to students to design specific materials for pre-determined functions. Students must discuss processing and properties of materials and cost effectiveness.									3								
Students are exposed to current technological challenges and asked to come up with engineering solutions using fundamental properties of the elemental components and proposed processing routes and design.															3		

MSE 160, Nanostructure Characterization Laboratory;

Most recent instructor: Nissim Amos, Ph.D.
Winston Chung Hall, Room 462
Department of Electrical Engineering
University of California, Riverside
Riverside, CA 92521
Tel: (951) 827-5216
Email: Nissim.Amos@ee.ucr.edu (**preferred communication**)

TA: Jianxin Zhu - jzhu005@ucr.edu

Objective-Outcome Matrix

Item	Outcome related learning objective	Outcomes										
		A	B	C	D	E	F	G	H	I	J	K
1	An ability to understand the Fundamentals of Analytical Data Analysis	1										1
2	An ability to understand Electromagnetic Radiation and Its Interaction with Matter					1						1
3	An ability to analyze material structure with common spectroscopy techniques					1						1
4	An ability to analyze material microstructure with common microscopy techniques					1						1
5	Develop technical writing skills through report writing							1				1
6	An ability to conduct experiments and analyze data		1									1

Class Activities:

Lecture - MW: 5:10 p.m. - 6:30 p.m., MSE 113
Laboratory - F: 09:10 a.m. - 12:00 p.m., MSE 250 or as announced in class
Office Hours - W: 3:00 p.m. – 5:00 p.m., MSE 311 (please schedule in advance via email)

Mid-term Exam Date: TBA in class
Final Exam Date: TBA in class

Catalog Description:

MSE 160 Nanostructure Characterization Laboratory (4 units) - 3 hrs. lecture and 3 hrs. lab, per week.

Prerequisite(s): ME 114 (Properties of Engineering Materials)

Covers structure of materials at the nanoscale, including semiconductors, ceramics, metals, and carbon nanotubes. Explores relationships among morphology, properties, and processing. Addresses primary methods of characterization, including scanning electron microscopy, scanning probe microscopy, X-ray diffraction, and transmission electron microscopy. Also covers elementary discussions of X-ray, vibrational, and electron waves in solids and introductory diffraction theory.

Grading:

Laboratory Attendance:	15%
Assignments:	15%
Midterm Exam:	30%
Final Exam:	40%
Class Participation:	(extra) 5%

Required Text Book:

[1] Materials Characterization: Introduction to Microscopic and Spectroscopic Methods
Author - Yang Leng, ISBN: 978-0-470-82298-2

Reference Text Books:

[1] Materials Science and Engineering: An Introduction, 8th Edition
Author - William D. Callister and David G. Rethwisch, ISBN: 978-0-470-41997-7

[2] Introduction to Magnetic Materials, 2nd Edition
Author - B. D. Cullity, C. D. Graham, ISBN: 978-0-471-47741-9

[3] Elements of X-Ray Diffraction, 3rd Edition
Author - B.D. Cullity and S.R. Stock, ISBN: 978-0-201-61091-8

[4] Fundamentals of Microfabrication: The Science of Miniaturization, 2nd Edition
Author - Diane Kauzlarick, ISBN: 978-0-849-30826-0

Core Class Topics:

- Light Microscope
- Scanning Electron Microscope (SEM)
    - Electron Spectroscopy for Surface Analysis
- X-ray Diffraction (XRD)
- Tunneling Electron Microscope (TEM)
- Scanning Probes Microscope (SPM)
    - Scanning Tunneling Microscope (STM)
    - Atomic Force Microscope (AFM)
    - Magnetic Force Microscope (MFM)
    - Electric Force Microscope (EFM)
    - Scanning Thermal and Near-field Optical Microscope (SThM and NSOM)
- Vibrational Spectroscopy
    - Fourier Transform Infrared Spectroscopy
    - Raman Microscopy

- Focused Ion Beam (FIB)

9. *Coverage will depend on class progress

<u>Core Lab Topics:</u>

- Cleanroom Tour and Protocols
- Optical Microscope
- Atomic Force Microscope (AFM)
- Magnetic Force Microscope (MFM)*
- Scanning Electron Microscope (SEM)
- Raman Spectroscopy*
- Infrared (FTIR & IR) Spectroscopy*

*Coverage will depend on class progress and/or availability

MSE 161 Analytical Materials Characterization

Recent instructor: Roman Chomko, Ph.D., E.P.
Room 411, Engineering Building Unit 2
Department of Electrical Engineering
University of California, Riverside
Riverside, CA 92521-0429
Tel : (951) 827-7109
Email: chomko@ee.ucr.edu

Objective-Outcome Matrix

Item	Outcome related learning objective	Outcomes										
		A	B	C	D	E	F	G	H	I	J	K
1	An ability to understand the Fundamentals of Analytical Data Analysis	1										1
2	An ability to understand Electromagnetic Radiation and Its Interaction with Matter					1						1
3	An ability to analyze material structure with common spectroscopy techniques					1						1
4	An ability to analyze material microstructure with common microscopy techniques					1						1
5	Develop technical writing skills through report writing							1				1
6	An ability to conduct experiments and analyze data		1									1

Quarter: Fall 2010
Prerequisite: MSE 160 with a grade of "D-" or better
Room: OLMH 1122 (Olmsted Hall)
Time: TR 5.10 p.m. - 6.30 p.m.
Office Hours: W 2:00 p.m. - 3:00 p.m.
Laboratory:
Room: EBU II, Room 125
Time: R 9.10 a.m. – 12.00 p.m.
Class Website: http://ilearn.ucr.edu

COURSE DESCRIPTION
MSE 161 Analytical Materials Characterization, 4 units, Lecture, 3 hours; Laboratory, 3

Catalog Description:
Analysis of the surfaces of materials via ion, electron, and photon spectroscopies. Includes Rutherford back scattering; secondary ion mass spectroscopy; electron energy loss spectroscopy; Auger electron spectroscopy; X-ray photoelectron spectroscopy; photoluminescence; extended

X-ray absorption fine structure; Fourier transform infrared spectroscopy; and Raman spectroscopy. Also covers sputtering, high-vacuum generation, and focused ion beam milling.

Topics

1) Fundamentals of Analytical Data Analysis
2) Classification of Analytical Methods of Measurement and Characterization
3) Structure of Materials
4) High-Vacuum Technology, Material and Device Fabrication Methods
5) Electromagnetic Radiation and Its Interaction with Matter
6) Light Sources, Optical Components and Optical Techniques
7) Absorption Methods (atomic, infrared, UV), Polarimetry and, Refractometry
8) Methods based upon Light Scattering: Nephelometry, Raman Scattering
9) Fluorescence and Emission Spectroscopy
10) X-ray Spectroscopy
11) Electron Detection and Characterization Methods
12) Ion Detection and Characterization Methods
13) Surface Analysis by Laser Ablation and other Photon Detection based Methods
14) Scanning Probe Microscopy
15) Thermal Conductivity Measurements
16) Magnetic Materials and Measurement

Homework

Homework will be assigned bi-weekly (4-5 HW's in total). Discussion of homework problems with the instructor, TA, and/or classmates is highly encouraged. Nevertheless, all homework must be completed independently.
No late homework will be accepted

Laboratory

There will be 6 (six) laboratories in total. Laboratory work will include: Matlab based Data analysis; measurement of optical, thermal and, magnetic properties of materials, field trips and report writing of characterization instrumentation kindly provided by miscellaneous research groups of the Bourns College of Engineering. Due to multiple locations there is no pre-assigned lab room for our course. Time and location will be preannounced and posted on iLearn. Guidelines for lab reports must be followed. The emphasis will be placed on 1) neatness, 2) precision and conciseness along with descriptive comments.
Discussion of lab experiments with the instructor, TA, and/or other students is encouraged. Again, lab work will be done in groups of 2-4 students (equipment and time allowing), however, ***lab reports** must written by groups of **no more** then 2 students*.

MSE 175A B Senior Design

Prerequisites

The students must have senior standing in Materials Science and Engineering.

Objectives

The Senior Design Project is the culmination of coursework in the bachelor's degree program in MSE. In this comprehensive two-quarter course, students are expected to apply the concepts and theories of materials science and 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 (Table 5-4):

9. Ability to understand the engineering design process, working in teams.
10. Ability to formulate design specifications and evaluation criteria; determining methodologies and performing solution analyses
11. Develop skills in project management including organization, teamwork, planning, scheduling, and budgeting
12. Develop skills in library techniques such as literature and information searching
13. Develop technical writing and oral communication skills through proposal and report writing, as well as mid-course and final presentations
14. Ability to design and conduct experiments and analyze data
15. Understanding of professional and ethical responsibility
16. Obtain a general understanding of engineering economics, marketing, career strategies, and resume preparation

Course objectives and their relationship to Student Outcomes for the MSE capstone design course.

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 Senior Design Project class 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 are 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, materials selection or synthesis, hardware and software design, test plan and test, broad impact and ethical issues, among other things. Note 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:

14. **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)?

15. **Experiment Design, Materials Selection 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.

16. **A Detailed Design Specification** (Due in week 7 of the winter quarter): Describes the functions and quantitatively measurable design objectives, design methods, materials properties, 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).

17. **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 (e.g. reusable materials), enhance entertainment, education, globalization etc? Are there any ethical or political debates, laws and regulations that are related to your project?

18. 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.

19. **Materials Characterization and 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.

20. **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.

21. **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.

22. **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.

23. **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).

24. **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 meet the specifications under the defined constraints, and present the results in this report.

25. **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.

26. **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 a convincing evidence that you 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:

3. **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).

4. **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 your 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 a 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 instructor. 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

Typical capstone design course organization.

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 project definition and feasibility study, and go through one or more iterations of specification, design review, prototyping, testing and revision. Students are also responsible to 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 to follow 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. Assembly of project subsystems requires a preparation of test plans and test reports; requires conducting relevant data analysis and a development of subsystems' specifications.

3. 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.

The selected topics for MSE Senior Design Projects should have a clear materials science component. Examples of recent projects with materials focus (in Professor A.A. Balandin's lab) include Design of Thermoelectric Element with High-ZT Material, Nanostructure-Based Photovoltaic Solar Cell; Design of the Thermal Interface Materials for Thermal Management of Electronics.

Engineering Standards and Multiple Design Constraints

Every design project involves industry standards, some more and some less, depending on what is being designed. The most widely involved standards are interfacing standards, e.g., I2C, SPI, RS232/UART, USB, etc. The based on modern system engineering practices adopted by both industry and government [1], and includes elements of

5. ISO 9000 standards on "*Quality Management*",
6. ISO/TC 207 "***Environmental management"*** [2] and similar,
7. Standards specific to the electrical and computer engineering discipline [3] or,
8. Standards related to health and safety government regulation standards [4].

[1]Frank Hoban, Ed Hoffman, "NASA Systems Engineering Handbook", SP-610S, STD-8739-8, NASA Headquarters, 1995
[2] International Organization for Standardization, http://www.iso.org
[3] IEEE Standards Association, http://standards.ieee.org/
[4] ANSI Standards Education Database, http://www.ansi.org/education_trainings/stand_edu_database.aspx

Syllabi for non-engineering courses will be available during the site visit:

- CHEM 001A, CHEM 01LA, CHEM 001B, CHEM 01LB, CHEM 001C, CHEM 01LC, General Chemistry lecture and lab, 3 quarters.

- CHEM 112A, Organic Chemistry

- MATH 009A, MATH 009B, MATH 009C, Calculus (three quarters); MATH 010A, MATH 010B, Multivariable Calculus (two quarters); MATH 010B, MATH 046, Differential Equations.

- PHYS 040A, PHYS 040B, PHYS 040C, General Physics (Newton’s laws, waves and heat, elasticity, fluids, and electricity/magnetism).

- STAT 155, Probability and Statistics for Science and Engineering.

Appendix B – Faculty Vitae

Reza Abbaschian
Dean, Bourns College of Engineering
William R. Johnson Jr. Family Professor
Distinguished Professor of Mechanical Engineering

Education

- Ph.D., Materials Science & Engineering, University of California, Berkeley, 1971
- M.S., Materials Science & Engineering, Michigan Technological University, 1968
- B.S., Mining & Metallurgy, University of Tehran, 1965

Academic Experience

- 2005-present. Distinguished Professor, Department of Mechanical Engineering, UCR
- 2000-2005. Vladimir A. Grodsky Professor of Materials Science & Engineering, UFL
- 1983-2000. Professor, Materials Science & Engineering, UFL
- 1980-1983. Associate Professor, Materials Science & Engineering, UFL

Current Memberships in Professional Organizations

- American Association for the Advancement of Science
- American Society of Metals
- The Mineral, Metals & Materials Society
- American Society of Engineering Education
- Materials Research Society

Honors and Awards

- 2010 "Symposium in Honor of Professor Reza Abbaschian: Processing, Crystal Growth," Materials Science and Technology (MS&T) Conference and Exhibition
- 2010-2011 Mayor's Outstanding Service Award from the City of Riverside for leadership in international education and sister university relationships.
- 2007 Eminent Engineer Tau Beta Pi.
- 2007 AAAS Fellow.
- 2006 Distinguished Life Time Membership of Alpha Sigma Mu.
- 2003 ASEE Donald E. Marlowe Award in recognition of "creative and distinguished administrative leadership in engineering and engineering technology education".
- 2002 Davis Productivity Award of the State of Florida for the department for "Outstanding Research Funding to Enhance Higher Education".
- 2000 Academy of Materials Science and Engineering, Michigan Technological University.
- 2000 Fellow of the Minerals, Metals &Materials Society
- 1999 TMS Leadership Award for "outstanding leadership in the fields of metallurgy and materials".
- 1998 Structural Material Division's Distinguished Scientist/Engineer Award.
- 1998 TMS Educator Award for "outstanding educator, leader, researcher and inventor who provides a modern standard for today's academician".
- 1995 The New York Academy of Sciences, Member.
- 1993 TMS Certificate for outstanding service as a symposium organizer.

- 1992 ASM Fellow for “Outstanding research in the science of solidification and materials processing, for leadership in education, and for extensive contributions to the ASM Phase Diagram program".

Service Activities

- 2005-present. Dean, Bourns College of Engineering, UCR
- 1987-2002. Chairman, Materials Science & Engineering, UFL

Selected Publications, Past 5 Years

- A. Munitz, A. Venkert, P. Landau, M.J. Kaufman and R. Abbaschian: “Microstructure and Phase Selection in Supercooled Copper Alloys Exhibiting Metastable Liquid Miscibility Gaps,” Journal of Materials Science, 2012, Vol.10, 16 pages.
- H. Kalaantari, S. Amini, J. Hong and R. Abbaschian: “Investigating the Effects of Bulk Supercooling and Rapid Solidification on Co-Ni-Ga Ferromagnetic Shape Memory Alloys,” Journal of Materials Science, 2011, Vol. 46, 6224-6234.
- J.R. Kim and R. Abbaschian: “Influence on Solidification Variables on the Microporosity Formation on Al-Cu (4.5 wt%) Alloy with Axial Heat Processing,” Journal of Materials Science, 2011, Vol. 46, 6213-6223.
- S. Amini, H. Kalaantari, J. Garay, A. Balandin and R. Abbaschian: “Growth of Graphene and Graphite Nanocrystals from a Molten Phase,” Journal of Materials Science, 2011, Vol. 46 6255-6263.
- D. Kim, H. Zhu and R. Abbaschian: “High Pressure and High Temperature Annealing on Nitrogen Aggregation in Lab-Grown Diamonds,” Journal of Materials Science, 2011, Vol. 46, 6264-6272.
- S. Amini, J. Garay, G. Liu, A. Balandin and R. Abbaschian: “Growth of the Large Area Graphene Films form the Metal-Carbon Melts,” Journal of Applied Physics, 2010, Vol. 108, No. 9, 7 pages.
- F. Parvizi, D. Teweldebrhan, S. Ghosh, I. Calizo, A. Balandin, H. Zhu and R. Abbaschian: “Properties of Graphene Produced by the High Pressure – High Temperature Growth Process”, Micro Nano Letters, 2008, Vol. 3, No. 1, 29-34.
- Munitz, M. Bamberger, A. Venkert, P. Landau and R. Abbaschian: “Phase Selection in Supercooled CU-Nb Alloys”, Journal of Materials Science, 2008, Vol.44, 64-73.

Recent Professional Activities

- 2010-present Board, International Relations Council
- 2010-present Board, ASEE PSW
- 2006-present Science Advisor, Gemesis Corporation
- 2006 Program Organizer - Materials Science & Technology Conference
- 2006 Program Organizer – Frontiers of Materials Science and Engineering
- 2005-present Board, SmartRiverside
- 2005-06 President, ASM International
- 2004-05 UF Council on Academic Freedom, Faculty Quality & Faculty Welfare

ALEXANDER A. BALANDIN
Professor, Department of Electrical Engineering

Education

Ph.D., Electrical Engineering, University of Notre Dame	1996
M.S., Electrical Engineering, University of Notre Dame	1995
M.S., Applied Physics, Moscow Institute of Physics and Technology	1991
B.S., Applied Mathematics, Moscow Institute of Physics and Technology	1989

Academic Experience

- Founding Chair (2006 – 2012), Materials Science & Engineering, University of California – Riverside (UCR), Riverside, California, USA
- Professor (2005 – present), Department of Electrical Engineering, University of California – Riverside (UCR), Riverside, California, USA
- Visiting Professor (2005 – 2006), Department of Engineering, University of Cambridge, Cambridge, United Kingdom
- Associate Professor (2001 – 2005) and Assistant Professor (1999 – 2001), Department of Electrical Engineering, University of California – Riverside (UCR), California, USA
- Research Engineer (1997 – 1999), Electrical Engineering Department, University of California – Los Angeles (UCLA), Los Angeles, California, USA
- Research Associate (1996 – 1997), Department of Electrical Engineering, University of Nebraska – Lincoln (UNL), Lincoln, Nebraska, USA
- Research & Teaching Assistant (1993 – 1996), Department of Electrical Engineering, University of Notre Dame (ND), Notre Dame, Indiana, USA
- Research Engineer (1991 – 1993), Moscow Institute of Physics and Technology (MIPT) and The Russian Space Agency (RSA), Moscow, Russia
- Research Assistant (1989 – 1991), Institute of Radio-Engineering and Electronics (IRE), Russian Academy of Sciences (RAS), Moscow, Russia

Non-Academic Experience

Consultant for several US high-tech companies

Certifications or Professional Registrations

n/a

Current Memberships in Professional Organizations

- Fellow of APS - The American Physical Society, 2012
- Fellow of IOP – The Institute of Physics, U.K., 2012
- Fellow of SPIE - The International Society for Optical Engineering, 2011
- Fellow of OSA - The Optical Society of America, 2011
- Fellow of AAAS - The American Association for Advancement of Science, 2007

Honors and Awards

- Pioneer of Nanotechnology Award, IEEE, 2011
- Semiconductor Research Corporation (SRC) Inventor Award, USA, 2009, 2010
- Distinguished IEEE Lecturer, University of Texas, Arlington, USA, 2006
- Distinguished Lecturer, CNRS, Pierre and Marie Curie Institute, Paris, France, 2005
- Elected Visiting Fellow, Pembroke College, University of Cambridge, UK, 2005
- Office of Naval Research (ONR) Young Investigator Award, Arlington, USA, 2002
- National Science Foundation (NSF) Faculty CAREER Award, 2001
- University of California Regents Faculty Award, USA, 2000
- US Civil Research and Development Foundation (CRDF) Award, Arlington, USA, 1999
- Merrill Lynch Innovative Engineering Research Award, WTC, New York, USA, 1998
- Outstanding Teaching Assistant Award, University of Notre Dame, USA, 1996
- *Summa Cum Laude*, Moscow Institute of Physics and Technology (MIPT), Russia, 1991

Service Activities

Editor for IEEE Transactions on Nanotechnology

Selected Publications - Past 5 Years

A.A. Balandin, Thermal properties of graphene and nanostructured carbon materials, Nature Materials, 10, 569 (2011)

X. Yang, G. Liu, M. Rostami, A.A. Balandin and K. Mohanram, Graphene ambipolar multiplier phase detector, IEEE Electron Device Letters, 32, 1328 (2011)

S. Ghosh, W. Bao, D.L. Nika, S. Subrina, E.P. Pokatilov, C.N. Lau and A.A. Balandin, Dimensional crossover of thermal transport in few-layer graphene, Nature Materials, 9, 555 (2010)

D. Teweldebrhan, V. Goyal, M. Rahman and A.A. Balandin, Atomically-thin crystalline films and ribbons of bismuth telluride, Applied Physics Letters, 96, 053107 (2010) - Issue's Cover

D. Teweldebrhan, V. Goyal and A.A. Balandin, Exfoliation and characterization of bismuth telluride atomic quintuples and quasi-two-dimensional crystals, Nano Letters, 10, 1209 (2010)

G. Liu, W. Stillman, S. Rumyantsev, Q. Shao, M. Shur and A.A. Balandin, Low-frequency electronic noise in the double-gate single-layer graphene transistors, Applied Physics Letters, 95, 033103 (2009)

D.L. Nika, E.P. Pokatilov, A.S. Askerov and A.A. Balandin, Phonon thermal conduction in graphene: Role of Umklapp and edge roughness scattering, Physical Review B, 79, 155413 (2009) - Editors' Selection

A.A. Balandin, S. Ghosh, W. Bao, I. Calizo, D. Teweldebrhan, F. Miao and C.N. Lau, Superior thermal conductivity of single-layer graphene, Nano Letters, 8, 902 (2008) - cited more than 800 times in three years

Phillip Christopher
Assistant Professor

Education

Ph.D. Chemical Engineering, University of Michigan, Ann Arbor	2011
M.S. Chemical Engineering, University of Michigan, Ann Arbor	2008
B.S. Chemical Engineering, University of California, Santa Barbara	2006

Academic Experience

2011-Present. Assistant Professor II, Department of Chemical and Environmental Engineering & Materials Science and Engineering, UC Riverside.

Current Memberships in Professional Organizations

American Institute of Chemical Engineers, American Chemical Society, American Society of Engineering Education

Honors and Awards

Outstanding Ph.D. Student Research Award: Inaugural University of Michigan College of Engineering award (1 award for the College of Engineering), 2010.
Outstanding Poster Presentation: Gordon Research Conference on Catalysis, 2010.
Rackham Predoctoral Fellowship: Rackham Graduate School, University of Michigan 2010-2011
Best Poster Presentation: Walt Weber Sustainability Symposium, University of Michigan, 2009.
Kokes Award Winner: 21st National Annual Meeting: North American Catalysis Society.
Outstanding Poster Presentation: Gordon Research Conference on Catalysis, 2008.
Outstanding Student Presentation: Michigan Catalysis Society Annual Symposium, 2008.
Dean's Named Fellow: University of Michigan, 2006-2007

Service Activities

NSF review panel committee member for Solid State and Materials Chemistry: Energy-Related Materials.

Invited Speaker at TEDxUCR conference, December 3 2011. Title: "Manipulating atoms for your everyday life".

Reviewer for Journal of the American Chemical Society, Journal of Physical Chemistry (2011-Present)

Organizer/Judge, Science Olympiad held at UC Riverside, Feb 2012.

Selected Publications, Past 5 Years

Phillip Christopher and Suljo Linic, "Engineering Selectivity in Heterogeneous Catalysis: Ag Nano-wires as Selective Ethylene Epoxidation Catalysts", *Journal of the American Chemical Society*, **2008**, 130, 11264.

Phillip Christopher and Suljo Linic, "Shape and Size Specific Chemistry of Ag Nanoparticles in Catalytic Ethylene Epoxidation". *ChemCatChem*, **2010**, 2, 78-83.

Phillip Christopher, David B. Ingram, and Suljo Linic, "Enhancing Photo-chemical activity of semiconductor nanoparticles with optically active Ag nano-structures: Photo-chemistry mediated by Ag surface plasmons". *J. Phys. Chem. C*, **2010**, 114, 9173.

Phillip Christopher, Hongliang Xin Suljo Linic, "Catalysis at lower temperatures: visible light enhanced oxidation catalysis on plasmonic Ag nanostructures". *Nature Chemistry*, **2011**, 3, 467.

Suljo Linic, **Phillip Christopher**, David B. Ingram, "Plasmonic metal nanostructures for efficient conversion of solar to chemical energy". *Nature Materials*, **2011**, 10, 9.

Selected Professional Development Activities

Attended grant writing seminar at UCR put on by Stephen Russell, "Grant Writers': Seminars and Workshops", Jan 2012.

Organizer/session chair of "Catalysis and Surface Science" session at American Chemical Society annual meetings, March and August 2012.

Organizer/session chair in Catalysis division in American Institute of Chemical Engineers meeting, Nov 2012.

Organizer/session chair of "Catalysis and Surface Science" symposium at Colloids Division ACS symposium, UCR 2013.

Javier E. Garay
Associate Professor
Chair, Materials Science and Engineering Program

Education
University of California, Davis
Mechanical Engineering/Materials Science and Engineering B.S. 1999
University of California, Davis
Materials Science and Engineering M.S. 2002
University of California, Davis
Materials Science and Engineering PhD. 2004

Academic Experience

7/2004- 6/2010	*Assistant Professor*, Department of Mechanical Engineering, University of California, Riverside.
7/2010- Present	*Associate Professor*, Department of Mechanical Engineering, University of California, Riverside.
1/2012-Present	*Chair*, Materials Science and Engineering Program University of California, Riverside

Certifications or Professional Registrations
None

Current Memberships in Professional Organizations
TMS International (TMS)
Materials Research Society (MRS)
The American Ceramic Society (Acers)

Recent Awards and Honors
- Army Research Office Young Investigator Program Award (ARO-YIP), 2005.
- Air Force Office of Scientific Research Young Investigator Program Award (AFOSR-YIP), 2009.
- National Science Foundation early career award (NSF CAREER), 2010.
- Faculty Marshall, Bourns College of Engineering Commencement, June 2010
- Department of Mechanical Engineering, 10th Anniversary Outstanding Research Award, June 2010.

Service Activities
<u>*Internal (at UCR)*</u>
Department of Mechanical Engineering
Mechanical Engineering graduate committee (9/2005-8/2006, 7/2010-1/2012 Chair)
Mechanical Engineering undergraduate committee (9/2004-8/2005)
Faculty Search Committee (9/2007-9/2008)
ME Development Committee (9/2007-6/2010), Chair (9/2008-6/2010)

University
Senate Committee on Diversity and Equal Opportunity (9/2007-6/2011)

External
NSF panel reviewer for DMI-MPM and DMR-Ceramics
ARO proposal reviewer

Selected Publications, Past 5 Years
Journal Publications

1. Z. Wang, J. E. Alaniz, W. Jang, J.E. Garay and C. Dames, "Thermal Conductivity of Nanocrystalline Silicon: Importance of Grain Size and Frequency-Dependent Mean Free Paths" *Nano Letters* (2011) **11**, 2206-2213
2. J. R. Morales, S. Tanju, W. P. Beyermann and J. E. Garay, "Exchange bias in large three dimensional iron oxide nanocomposites" *Applied Physics Letters* (2010), **96**, 013102.
3. S. Ghosh, D. Teweldebrhan, J. R. Morales, J. E. Garay and A. A. Balandin, "Thermal properties of the optically transparent pore-free nanostructured yttria-stabilized zirconia." *Journal of Applied Physics* (2009), **106** 113507.
4. J. R. Morales, J. E. Garay, M. Biasini and W. P. Beyermann, "Magnetic characterization of bulk nanostructured iron oxides." *Applied Physics Letters* (2008), **93**, 022511.
5. X. Wang, S. R. Casolco, G. Xu and J. E. Garay, "Finite Element Modeling of Electric Current Activated Sintering: The effect of coupled electrical potential, temperature and stress." *Acta Materialia* (2007), **55**, 3611-3622.
6. J. R. Morales, N. Amos, S. Khizroev and J. E. Garay, "Magneto-optical Faraday Effect in Nanocrystalline Oxides," *Journal of Applied Physics* (2011) **109**, 093110.
7. J. R. Morales, J. E. Garay, M. Biasini and W. P. Beyermann, "Magnetic characterization of bulk nanostructured iron oxides." *Applied Physics Letters* (2008), **93**, 022511.
8. S. R. Casolco, J. Xu and J. E. Garay, "Transparent/translucent polycrystalline nanostructured yttria stabilized zirconia with varying colors." *Scripta Materialia* (2008) **58,** 516-519.
9. J. E. Garay, "Current Activated Pressure Assisted Densification of Materials," *Annual Reviews of Materials Research* (2010), **40**, 445-468.
10. J. E. Alaniz, F. G. Perez-Gutierrez, G. Aguilar and J. E. Garay, "Optical properties of transparent nanocrystalline yttria stabilized zirconia." *Optical Materials* (2009), **32**, 62-68.

Selected Professional Development
Meetings of the Materials Research Society (MRS)
The Minerals Metals and Materials Society (TMS) The
American Ceramic Society (ACerS).

ELAINE D. HABERER
Assistant Professor, Department of Electrical Engineering

Education

Ph.D., Materials, UC-Santa Barbara	2005
M.S., Materials Science & Engineering, MIT	1998
B.S., Materials Science & Engineering, MIT	1997

Academic Experience

2005-2008. Postdoctoral Fellow, California NanoSystems Institute, UC-Santa Barbara
2005-2006. Visiting Researcher, Department of Materials Science and Engineering, MIT
2008-2010. Assistant Professor III, Department of Electrical Engineering, UCR
2010-Present. Assistant Professor IV, Department of Electrical Engineering, UCR

Non-Academic Experience

Intel Corporation, Co-op Student, Full-Time
Worked with sustaining engineering group to reduce particle generation in a production plasma-enhanced chemical vapor deposition (PECVD) system

Hewlett-Packard, Intern, Full-Time
Designed and tested feasibility of iterative wet etching technique for use in MESFET gate definition in a production environment.

Certifications or Professional Registrations

None.

Current Memberships in Professional Organizations

IEEE, Materials Research Society, AIChE Society for Biological Engineering, and Society of Women Engineers

Honors and Awards

University of California President's Postdoctoral Fellowship 2005-2006, finalist

Service Activities

- Symposium Organizer for Materials Research Society Spring Meeting 2012 (Symposium T: Bio-inspired Materials for Energy Applications)
- Reviewer: Advanced Functional Materials, IEEE Transactions on Nanotechnology, Solid State Electronics, Bioinspiration & Biomimetics
- Developed and co-taught a service-learning course (HNPG 098I – Inspiring Young Scientists with Solar Energy) with Prof. Marsha Ing (UCR Graduate School of Education) through the
- UCR Honors program and the UnderGraduate Research in the Community program. The course centered on the implementation of 3 solar cell lessons in an eighth grade classroom at Mira Loma Middle School.
- EE Undergraduate/ABET Committee, 09/10 – 06/11
- MSE Colloquium Coordinator, 07/10 – present
- MSE Recruiting and Publicity Co-Coordinator, 07/10 – present

- UCR Academic Senate Scholarship and Honors Committee, 09/09 – present
- Society of Women Engineers, UCR Chapter Faculty Co-Advisor, 06/09 – present
- Lead Judge for the Riverside Unified School District Science Fair in the area of Electricity & Electromagnetics, 02/09, 02/10

Selected Publications, Past 5 Years

Enhanced Photogenerated Carrier Collection in Hybrid Films of Bio-Templated Gold Nanowires and Nanocrystalline CdSe, **E. D. Haberer**, J. H. Joo, J. F. Hodelin, E. L. Hu, Nanotechology 20, 415206 (2009).

Room-temperature continuous-wave lasing in GaN/InGaN microdisks, A. C. Tamboli, **E. D. Haberer**, R. Sharma, K. H. Lee, S. Nakamura, E. L. Hu, Nature Photonics 1, 61 (2007)

Electrical Characterization of Bio-templated Nanostructured Photovoltaic Material, J. H. Joo, **E. D. Haberer**, J. C. Hsieh, C-Y. Chiang, A. M. Belcher, and E. L. Hu, Materials Research Society Fall Meeting, Boston, Massachusetts, November 25-29 2007.

Photoelectrochemical etching of m-plane GaN for smooth, low damage etching of optical devices, A. C. Tamboli, M. C. Schmidt, **E. D. Haberer**, K. C. Kim, J. S. Speck, S. P. DenBaars, S. Nakamura, E. L. Hu, 7th International Conference of Nitride Semiconductors, Las Vegas, Nevada, September 16- 21 2007.

Optical properties of GaN microdisks fabricated by photoeleectrochemical etching, A. C. Tamboli, **E. D. Haberer**, R. Sharma, K. H. Lee, S. Nakamura, E. L. Hu, Fourth International School and Conference on Spintronics and Quantum Information Technology, Maui, Hawaii, June 17-22 2007.

Selected Professional Development Activities

UC Export Control Training, 2011
NSF Career Development for New Engineering Faculty Workshop, 2011
CAREER Proposal Workshop, 2011
Grant Writer’s Workshop, 2012

David Kisailus
Assistant Professor

Education
Ph.D., Materials Science and Engineering, UC Santa Barbara, 2002
M.S., Materials Science and Engineering, University of Florida, 1999
B.S., Chemical Engineering, Drexel University, 1993

Academic Experience

2002 – 2005	Post-Doctoral Researcher, California NanoSystems Institute, UC Santa Barbara
2007 – Present	Assistant Professor, Chemical and Environmental Engineering, UC Riverside
2007 – Present	Participating faculty, Materials Science and Engineering Program, UC Riverside
2008 – Present	Undergraduate Chair, Materials Science and Engineering Program, UC Riverside
2011 – Present	Winston Chung Endowed Chair of Energy Innovation, UC Riverside

Non-Academic Experience

2005 – 2007	Research Scientist, HRL Laboratories, LLC, Malibu, CA

Certifications or Professional Registrations
N/A

Current Memberships in Professional Organizations
American Ceramic Society
American Chemical Society
American Institute of Chemical Engineers
Materials Research Society

Honors and Awards
Winston Chung Endowed Chair of Energy Innovation, UC Riverside 2011

Service Activities
-Served on department faculty hiring committees (2009, 2011, 2012)
-Served on Materials Science and Engineering faculty hiring committee (2011)
-Served as outside member of Chemistry department faculty hiring committee (2012)
-Served on department development engineer hiring committee (2011)
-Served on department ABET committee (2011- present)
-Served on department Undergraduate committee (2008- present)
-AIChE faculty advisor (2008-present)
-Department seminar organizer (2010-2011)
-Materials Science and Engineering Building Committee (2010-2011)
-Honors program advisor for Chemical and Environmental Engineering (2008- present)
-Honors program advisor for Materials Science and Engineering Program (2008- present)

-Undergraduate advisor for Materials Science and Engineering Program (2008-present)
-Spearheaded $10,000,000 Endowment for UC Riverside from Chinese Donor
-Conference Organizer (Chair), American Association for Crystal Growth, June 2012
-Symposium Organizer (Chair), Materials Research Society, Spring 2009, San Francisco
-Collaborator: Alliance for Education, Outreach to San Bernardino County High Schools
-American Institute for Chemical Engineers (AICHE) Faculty Advisor
-Mentored more than 50 graduate, undergraduate and high school students as part of academic training
-Public Outreach at Riverside Metropolitan Museum (2011)
-Public Outreach at San Diego Zoo (2011)

Selected Publications, Past 5 Years
Crystal Growth of $Li[Ni_{1/3}Co_{1/3}Mn_{1/3}]O_2$ as a Cathode Material for High-Performance Lithium Ion Batteries, J. Zhu, T. Vo, D. Li, N. Kinsinger, L. Xiong, Y. Yan, D. Kisailus, Crystal Growth and Design, in press (2012).

Solvothermal Synthesis of a Highly Branched Ta-doped TiO_2, S. Arab, D. Li, N. Kinsinger, F. Zaera, D. Kisailus, Journal of Materials Research, 26 (20) (2011) 2653-2659.

Photocatalytic Titanium Dioxide Composite, N. Kinsinger, A. Tantuccio, Minwei Sun, Yushan Yan, D. Kisailus, J. Nanoscience and Nanotechnology, 11 (8) (2011) 7015-7021.

Hierarchically Ordered Macro-Mesoporous TiO_2-Graphene Composite Films: Improved Mass Transfer, Reduced Charge Recombination, and Their Enhanced Photocatalytic Activities, J. Du, X. Lai, N. Yang, J. Zhai, D. Kisailus, F. Su, D. Wang, L. Jiang, ACS Nano, v.5 (1) (2011) 590-596.

Nucleation and crystal growth of nanocrystalline anatase and rutile phase TiO_2 from a water soluble precursor, N. Kinsinger, A. Wong, D. Li, F. Villalobos, D. Kisailus, Crystal Growth and Design, v.10 (12) (2010) 5254-5261.

Unifying Design Strategies in Demosponge and Hexactinellid Skeletal Systems, J. Weaver, G. Milliron, P. Allen, A. Miserez, A. Rawal, J. Garay, P. Thurner, J. Seto, B. Mayzel, L. Friesen, B. Chmelka, P. Fratzl, J. Aizenberg, Y. Dauphin, D. Kisailus, D. Morse, Journal of Adhesion, 86 (2010) 72-95.

Porous Platinum Nanotubes for Oxygen Reduction and Methanol Oxidation Reactions, S. Alia, G. Zhang, D. Kisailus, D. Li, S. Gu, K. Jensen, and Y. Yan, Adv. Funct. Mat., 20, (2010) 3742-3746.

Analysis of an ultra hard magnetic biomineral in chiton radular teeth, J. Weaver, QQ. Wang, A. Miserez, A. Tantuccio, R. Stromberg, KN. Bozhilov, P. Maxwell, R. Nay, ST. Heier, E. DiMasi, D. Kisailus, Materials Today, 13 (2010) 42-52.

Selected Professional Development Activities
UC Export Control training (2011)

Huinan Liu
Assistant Professor

Education
Ph.D., Biomedical Engineering, Brown University, 2008
M.S., Materials Science and Engineering, Purdue University, 2005
B.S./M.S., Materials Science and Engineering, Materials Processing Specialty, University of Science and Technology Beijing, 2000

Academic Experience
2009-2010. Research Assistant Professor, Department of Bioengineering, University of Pittsburgh
2011-now. Assistant Professor II, Department of Bioengineering, Materials Science and Engineering, at UCR

Non-Academic Experience (Full Time)
2000-2003. Research Engineer, Laboratory of Titanium Alloys, Institute for Nonferrous Metals, Beijing, China
2008-2009. Senior Scientist, Principal Investigator of Biomedical Sector, NanoMech Corporation, Fayetteville, AR.

Certifications or Professional Registrations
Teaching Certificate I, II and III, The Harriet W. Sheridan Center for Teaching and Learning in Higher Education, Brown University, Providence, RI, 2006-2008

Current Memberships in Professional Organizations
Secretary/Treasurer of Nanomaterials Special Interest Group (Nano SIG), Society for Biomaterials, Elected 2011-.
Member of ASME (American Society of Mechanical Engineers), 2009-present
Member of Sigma Xi (The Scientific Research Society), 2008-present
Member of MRS (Materials Research Society), 2005-present
Member of BMES (Biomedical Engineering Society), 2005-present
Member of SFB (Society for Biomaterials), 2005-present

Recent Selected Honors and Awards
2011 National Science Foundation BRIGE Award.
International Journal of Nanomedicine Certificate of Merit Award, October, 2011. Presented at 2011 Biomedical Engineering Society Annual Meeting in Hartford, CT.
MARC/SRC Faculty Travel Award, Federation of American Societies for Experimental Biology (FASEB), September 2011.
Acta Annual Award for Primary Contributions to the Paper Published in Acta Biomaterialia, The Acta Journals, 2009.
Graduate Excellence in Materials Science (GEMS) Award, The American Ceramic Society, 2008.
The Joukowsky Family Foundation Outstanding Dissertation Award, Brown University, 2008.

Service Activities

Symposium co-Chair and Organizer. 46: Translating Emerging Biomaterials to Clinical Applications, *2012 World Bio materials Congress*, Chengdu, China, June 2012.

Track Organizer and Session Chair. Nanoengineering for Regenerative Medicine, *2011 ASME Annual Meeting*, Denver, CO, October 2011.

Symposium Organizer and Tutorial Instructor. Symposium YY: Compatibility of Nanomaterials, *2009 MRS Fall Meeting*, Boston, MA, December 2009.

Journal Manuscript Reviewer, JBMR, Biomaterials, Nanomedicine, etc.

Bioengineering Graduate Admission Committee, August 2011-.

MSE Academic Review Committee, member, June 2011-.

MSE Graduate Program Review, member, June 2011-

Contributing ideas to ALPHA center/Society of Women Engineers (SWE) NanoDays Public Educational Program, February 2011.

Served the Career Fair Booth for Bioengineering Faculty Recruitment at the BMES annual meeting, Hartford, CT, October 2011.

Served the Student Recruitment Booth at the BMES annual meeting, Hartford, CT, October 2011.

Recent Selected Publications (out of 22 Journal Articles, 2 books, 6 book chapters, 46 conference abstracts)

21. Guan R, Johnson I*, Cui T, Zhao T, Zhao Z, Li X, and **Liu H**. Electrodeposition of Hydroxyapatite Coating on Mg-4.0Zn-1.0Ca-0.6Zr Alloy and In Vitro Evaluation of Degradation, Hemolysis and Cytotoxicity. *Journal of Biomedical Materials Research Part A*. 100A: 999-1015, 2012.

20. Johnson I*, Perchy D*, **Liu H**. In vitro Evaluation of the Surface Effects on Magnesium-Yttrium Alloy Degradation and Mesenchymal Stem Cell Adhesion. *Journal of Biomedical Materials Research*. Available online (DOI: 10.1002/jbm.a.33290) 29 November 2011.

19. Lock JY*, **Liu H**. Nanomaterials Enhanced Osteogenic Differentiation of Human Mesenchymal Stem Cells Similar to a Short Peptide of BMP-7. *International Journal of Nanomedicine*. 6: 2769-2777, 2011.

18. **Liu H**. The Effects of Surface and Biomolecules on Magnesium Degradation and Mesenchymal Stem Cell Adhesion. *Journal of Biomedical Materials Research Part A*. 99A: 249-260, 2011.

17. **Liu H** and Webster TJ. Enhanced Biological and Mechanical Properties of Well-Dispersed Nanophase Ceramics in Polymer Composites: From 2D to 3D Printed Structures. *Materials Science and Engineering: C*. 31(2): 77-89, 2011.

16. **Liu H** and Webster TJ. Mechanical Properties of Dispersed Ceramic Nanoparticles in Polymer Composites for Orthopedic Applications. *International Journal of Nanomedicine*. 5: 299-313, 2010. (PMID: 20463945)

15. **Liu H** and Webster TJ. Ceramic/Polymer Nanocomposites with Tunable Drug Delivery Capability at Specific Disease Sites. *Journal of Biomedical Materials Research Part A*. 93(3): 1180-1192, 2010. Epub ahead of print, Sep 23, 2009. (PMID: 19777574)

Selected Professional Development Activities

UC Export Control training in 2011

UCR Proposal Workshop 01/2012

Lorenzo Mangolini
Assistant Professor

Education
Ph.D., Mechanical Engineering, University of Minnesota, Minneapolis, 2007
M.S., Mechanical Engineering, Polytechnic University of Milan, Milan, Italy, 2003
M.S., Mechanical Engineering, University of Minnesota, Minneapolis, 2002

Academic Experience
2011-present Assistant Professor IV, Department of Mechanical Engineering, UCR
2010-2011 Assistant Professor III, Department of Mechanical Engineering, UCR

Non-Academic Experience
2007-2010 Senior Researcher, Cima Nanotech Inc., Saint Paul Minnesota

Certifications or Professional Registrations
None

Current Memberships in Professional Organizations
ASME, MRS

Recent Honors and Awards
- Inventor Recognition Award, Patents and Technology Marketing, University of Minnesota (09/2005)
- Doctoral Dissertation Fellowship, University of Minnesota (2005-2006)
- Best Paper Award, ISPC 17th International Symposium on Plasma Chemistry (08/2005)
- Ente Nazionale Idrocarburi (E.N.I.) National Study Abroad Scholarship (2000-2002)
- UC Riverside Regents Faculty Fellowship (2011)

Service Activities
Internal (at UCR)
- Member, Undergraduate Committee, ME, AY2010-2012

External
- Reviewer for the Journal of Vacuum Science and Technology, Journal of Physical Chemistry, Nanotechnology, Plasma Processes and Polymers

Selected Publications, Past 5 Years

Journal Publications

1. **Mangolini, L.** and U. Kortshagen (2009). "*Selective nanoparticle heating: another form of nonequilibrium in dusty plasmas*." Physical Review E 79: 026405 1-8.
2. **Mangolini, L.** and U. Kortshagen (2007). "*Plasma-assisted synthesis of silicon nanocrystal inks*." Advanced Materials 19: 2513-2519.
3. **Mangolini, L**., D. Jurbergs, E. Rogojina and U. Kortshagen (2006). "*Plasma synthesis and liquid-phase surface passivation of brightly luminescent Si nanocrystals*." Journal of Luminescence 121(2): 327-334.
4. **Mangolini, L.,** E. Thimsen and U. Kortshagen (2005). "*High-yield plasma synthesis of luminescent silicon nanocrystals*." Nano Letters 5(4): 655-659.
5. **Mangolini, L**., C. Anderson, J. Heberlein and U. Kortshagen (2004). "*Effects of current limitation through the dielectric in atmospheric pressure glows in helium*." Journal of Physics D: Applied Physics 37: 1021-1030.

Patents and Patent Applications

1. U. Kortshagen, E.J. Thimsen, L. Mangolini, A. Bapat, D. Jurbergs, *Process and apparatus for forming semiconductor nanoparticles using radio frequency plasma CVD.* US Pat. No. 7446335.
2. V. Rosendand, E.L. Granstrom, L. Mangolini, *Process for producing powders of germanium*, WIPO Appl. No. WO/2009/137680.
3. A. Garbar, F. De La Vega, E.L. Granstrom, L. Mangolini, *Transparent conductive coating with filler material*, WIPO Appl. No. WO/2009/086161.
4. L. Mangolini, U. Kortshagen, R.J. Anthony, D. Jurbergs, X. Li, E. Rogojina, *Nanoparticles with grafted organic molecules*, WIPO Appl. No. WO/2008/091581.

Selected Professional Development Activities

Materials Research Society Meetings

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,1994-present

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.
Patents

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 methods for carrier sense multiple access with collision detection network medium access control protocols

Selected 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

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

Cengiz S. Ozkan
Professor

Education

Ph.D., Materials Science and Engineering, Stanford University, 1997
M.S., Materials Science and Engineering, Stanford University, 1993
M.S., Metallurgical Engineering and Materials Science, Middle East Technical University, 1989
B.S., Metallurgical Engineering and Materials Science, Middle East Technical University, 1986

Academic Experience

2010-present	Graduate Program Advisor, Materials Science and Engineering
2009-present	Professor of Mechanical Engineering, UC-Riverside
2009-present	Executive Committee Member, Bourns College of Engineering
2006-2009	Associate Professor of Mechanical Engineering, UC-Riverside
2001-2006	Assistant Professor of Mechanical Engineering, UC-Riverside
2002-present	Faculty Advisor, UCR Student Chapter of the Materials Research Society

Non-Academic Experience

1997-2001 Senior Staff Engineer, Applied Micro Circuits Corporation, San Diego, CA

Current Memberships in Professional Organizations

AAAS, American Association for the Advancement of Science
ECS, Electrochemical Society
MRS, Materials Research Society
ASME, American Society for Mechanical Engineers
ACS, American Chemical Society
CHI, Cambridge HealthTech Institute
BMES, Biomedical Engineering
Society

Selected Honors and Awards

- Placket of Appreciation, NANO-TR 2011 Conference, Istanbul, Turkey
- Research Award, World Congress of the International Academy of Nanomedicine (IANM), Antalya, Turkey
- Inventor Recognition Award, The Focus Center Research Program, by the Semiconductor Research Corporation
- Frontier Engineering Article, Featured in "The Bridge" Magazine by the National Academy of Engineering
- Member of the United States Delegation to Korea, Fifth United States-Korea Forum on Nanotechnology: Nano-Biotechnology, Jeju Island, Korea
- 26. Research Recognition Award, The International Workshop on New Trends in Science and Technology, The Southeastern European Network (SEENET) and The Scientific and Technical Research Council of Turkey (TUBITAK), Ankara, Turkey
- 24. Invited panel participant to Department of Defense (DOD) Nanotechnology for Chemical and Biological Defense in 2030 Workshop, The Defense Threat Reduction Agency (DTRA), Santa Fe, New Mexico

- Participant to the National Academy’s Keck Future Initiatives Conference on Smart Prosthetics by invitation from the National Academies (2006)

Selected Publications, Past 5 Years

1. S. Ravindran, S. Chaudhary, B. Colburn, M. Ozkan, C.S. Ozkan, "Covalent Coupling of Quantum Dots to Multiwalled Carbon Nanotubes for Electronic Device Applications", NANO LETTERS, 3, 4, 447-453, 2003. (has been cited 215 times)

2. H. Gao, Y. Kong, D. Cui, C.S. Ozkan, "Spontaneous Insertion of DNA Oligonucleotides into Carbon Nanotubes", NANO LETTERS, 3, 4, 471-473, 2003. (has been cited 245 times)

3. X. Wang, F. Liu, G.T. Senthil Andavan, X. Jing, N. Bruque, R.R. Pandey, M. Ozkan, R. Lake, K.L. Wang and C.S. Ozkan, "Carbon Nanotube-DNA Nanoarchitectures and Electronic Functionality", SMALL, Volume 2, Issue 11, pages 1356-1365, September 2006.

4. R.J. Tseng, C. Tsai, L. Ma, J. Ouyang, C.S. Ozkan, Y. Yang, “Digital memory device based on tobacco mosaic virus conjugated with nanoparticles”, NATURE NANOTECHNOLOGY, Vol 1, 72-77, 2006. (has been cited 172 times)

5. M. Ozkan and C.S. Ozkan, “Role of DNA in Nanoarchitectonics”, THE BRIDGE, Journal of the National Academy of Engineering (NAE) of the the National Academies, volume 38, number 4, pages 25-31, 2008.

Selected Professional Development Activities

Lead symposium organizer, “De Novo Carbon Nanomaterials,” Spring 2012 Meeting of The Materials Research Society, San Francisco, CA 2012

Member of the Program Committee, 2012 CMOS Emerging Technologies Workshop, July 18-20, 2012, Vancouver, Canada

Member of the Program Committee and Invited Speaker, 2011 CMOS Emerging Technologies Workshop, June 15-17, 2011, Whistler, Canada

Member of the Program Committee and Section Chair, “Nano and Giga Challenges in Electronics, Photonics and Renewable Energy” (NGC 2009)

Masaru Palakurthi Rao
Assistant Professor

Education
Ph.D., Materials Engineering, University of California, Santa Barbara, 2001
B.S., Materials Science & Engineering, University of Florida, 1995

Academic Experience
2007-2008 Assistant Professor, School of Mechanical Engineering, Purdue University
2009-2010 Assistant Professor III, Department of Mechanical Engineering, UCR
2010-2012 Assistant Professor IV, Department of Mechanical Engineering, UCR

Non-Academic Experience
2005-2006 Senior Scientist & Co-Founder, DynaFluidics, Santa Barbara, CA. Part-time. Responsible for advanced R&D, market analysis, opportunity identification, and industrial engagement.

Current Memberships in Professional Organizations
ASME, IEEE, MRS

Recent Honors and Awards
- Travel to Scholarly Meetings Award, UCR (2009)
- Travel to Scholarly Meetings Award, UCR (2010)
- Regents' Faculty Fellowship Award, UCR (2011)

Service Activities
Internal (at UCR)
- Coordinator, Preliminary Exam, ME, AY2008-2009
- Member, Planning & Development Committee, ME, AY2009-2010
- Member, ME Ad hoc committee for BCOE MSE/Energy Faculty Search, AY2009-2010
- Member, Graduate Committee, ME: AY2008-2009, AY2010-2011, AY2011-2012
- Member, MSE Academic Review Committee, AY2011-2012
- Member-at-Large, BCOE Executive Committee, AY2011-2012
- Co-Chair, Faculty Search Committee, ME, AY2011-2012

External
- Chair, Symposium on Advances in Medical Micro/Nano Manufacturing and its Applications, 2008 ASME International Manufacturing Science and Engineering Conference, Evanston, IL, October 7-10, 2008.
- Panelist, Stage 1, Challenge Grant Panel #29, NIH Healthcare Delivery & Methodologies (HDM) IRG, July 2009
- Panelist, Stage 1, Challenge Grant Panel #23, NIH Surgical Sciences, Biomedical Imaging, & Bioengineering (SBIB) IRG, June 2009

Selected Publications, Past 5 Years

Journal Publications

1. ER Parker, MP Rao, KL Turner, CD Mienhart, and NC MacDonald. Bulk micromachined titanium microneedles. *J Microelectromech S* 16(2):289-95, 2007.
2. J Lu, MP Rao, NC MacDonald, D Khang, and TJ Webster. Improved endothelial cell adhesion and proliferation on patterned titanium surfaces with rationally designed, micrometer to nanometer features. *Acta Biomater* 4(1):192-201, 2008.
3. YT Zhang, F Bottausci, MP Rao, ER Parker, I Mezic, and NC MacDonald. Titanium-based dielectrophoresis devices for microfluidic applications. *Biomed Microdevices* 10(4):509-517, 2008.
4. PT McCarthy, KJ Otto, and MP Rao. Robust penetrating microelectrodes for neural interfaces realized by titanium micromachining. *Biomed Microdevices* 13(3):503-515, 2011.
5. PT McCarthy, MP Rao, and KJ Otto. Simultaneous recording of rat auditory cortex and thalamus via a titanium-based, microfabricated, multi-nucleus, microelectrode device. *J Neural Engr* 8(4):046007 (9pp), 2011.

Conference Presentations & Proceedings

1. PT McCarthy, R Madangopal, KJ Otto, and MP Rao. Titanium-based multi-channel, micro- electrode array for recording neural signals. *31st Annual International Conference of the IEEE Engineering in Medicine & Biology Society,* Minneapolis, MN, Sept. 2-6, 2009.
2. CT Smith, P Wei, M Mojarrad, M Chiappetta, B Ziaie, and MP Rao. Elastomeric reservoir for MEMS-based transdermal drug delivery systems. *2010 Solid-State Sensor, Actuator, and Microsystems Workshop,* Hilton Head Island, SC, Jun. 6-10, 2010.
3. PT McCarthy, MP Rao, and KJ Otto. Corticothalamic neural recording via penetrating titanium microelectrodes. *39th Neural Interfaces Conference,* Long Beach, CA, Jun. 21-23, 2010.
4. O Khandan, A Famili, MY Kahook, and MP Rao. In-plane, bulk micromachined titanium microneedles for passive ocular drug delivery. *ASME 6th Frontiers in Biomedical Devices Conference & Exhibition,* Irvine, CA, Sept. 26-27, 2011.
5. SC Gott, HP Aguilar, and MP Rao. Recent progress towards realization of vascular stents with rationally-designed surface nanopatterning. *ASME 6th Frontiers in Biomedical Devices Conference & Exhibition,* Irvine, CA, Sept. 26-27, 2011.

Selected Professional Development Activities

- Attended *31st Annual International Conference of the IEEE Engineering in Medicine & Biology Society*, Minneapolis, MN, Sept. 2-6, 2009.
- Attended *2010 Solid-State Sensor, Actuator, and Microsystems Workshop,* Hilton Head Island, SC, Jun. 6-10, 2010.
- Attended *39th Neural Interfaces Conference*, Long Beach, CA, Jun. 21-23, 2010.
- Attended *ASME 6th Frontiers in Biomedical Devices Conference & Exhibition,* Irvine, CA, Sept. 26-27, 2011.

Valentine I. Vullev
Assistant Professor of Bioengineering

Education

Ph.D., Chemistry, Boston University, 2001
B.S., Chemistry and Physics, Keene State College, 1993

Academic Experience

2001-2002,	Research Associate, Department of Chemistry, Boston University
2002-2004,	Postdoctoral Fellow, Department of Chemistry and Chemical Biology, Harvard University
2004-2006,	Research Associate, Photonics Center, Boston University
2006-present,	Assistant Professor, Department of Bioengineering, UCR
2007-present,	Assistant Professor, Materials Science and Engineering Program, UCR
2008-present,	Cooperating Assistant Professor, Department of Biochemistry, UCR
2010-present,	Cooperating Assistant Professor, Department of Chemistry, UCR

Non-Academic Experience

2004-2006, Senior Chemist, PhotoSecure, Inc., Boston, MA

Current Memberships in Professional Organizations

Biomedical Engineering Society, American Society for Microbiology, American Chemical Society, Biophysical Society

Selected Honors and Awards

1998	Boston University, Sugata Ray Award
2001	American Chemical Society, Northeastern Section, Philip L. Levins Memorial Prize
2009	University of California, Riverside, Medical School Program, Student Research Mentoring Recognition
2009	Regents of University of California, Faculty Development Award

Selected Service Activities

- Chaired and/or organized sessions for different scholarly meeting (e.g., 2010 Gordon Research Conference (GRC) on *Electron Donor-Acceptor Interactions*; 2011 GRC on *Photochemistry*; 2008 and 2010 UC Systemwide Bioengineering Symposium; 2007 National BMES Meeting);
- Invited talks (e.g., 2008 Department of Biomedical Engineering, UC, Davis; 2008 Department of Chemical & Nuclear Engineering, University of New Mexico; UCR; 2011 First International Congress on Bioinspired Materials for Solar Energy, Crete, Greece); 2011 Department of Mechanical and Aerospace Engineering, Princeton University);

- Reviewed research proposals for different agencies (e.g., participated in NSF review panels; ad hoc reviewer for NSF and for U.S. Army SBIR and STTR research proposals);
- Reviewed manuscripts for peer-reviewed journals (e.g., *J. Am. Chem. Soc.*, *J. Phys. Chem.*, *Ann. BME*, *Inorg. Chem.*, *Optics Express*). Ranked in the top 20% among the *J. Phys. Chem.* reviewers for 2009;
- Member of campus committees (e.g., BCOE Executive Committee, UCR Campus Biosafety Committee, Faculty Search Committees in Bioengineering and in Chemistry Departments).

Selected Recent Peer-Reviewed Journal Publications

- Upadhyayula, et al. *Journal of Physical Chemistry B* **2011**, *115*, 9473-9490.
- Vullev, V. I. *Journal of Physical Chemistry Letters* **2011**, *2*, 503-508 (**Journal cover**).
- Bahmani, et al. *Journal of Biomedical Optics* **2011**, *16*, 051303-1 – 051303-10.
- Xia, et al. *Journal of Clinical Microbiology* **2011**, *49*, 2966-2975.
- Chau, et al. *Microfluidics and Nanofluidics* **2011**, *10*, 907-917.
- Thomas, et al. *Langmuir* **2010**, 26, 9756-9765.
- Thomas, et al. *Annals of Biomedical Engineering* **2010**, *38*, 21-32.
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Selected Professional Development Activities

- Participated in workshops, such as the 3rd national Biomedical Engineering Education Summit (Chicago, IL, 2008), organized by the BMES;
- Presented at URM Principal Investigator Workshop (Arlington, VA, 2011), organized by NSF;
- Participated in the Research Frontiers on Bioinspired Energy Workshop (Washington, DC, 2011), organized by the National Academies.

Appendix C – Equipment

Please list the major pieces of equipment used by the program in support of instruction.

Materials Science and Engineering

Room /Name	Purpose	Equipment (Black: exists, Red: requested
MSE 150 **MSE Thermo-mechanical Lab**	Lab for teaching and research in thermal characterization and mechanical testing including: Heat treatments/etching/materials processing/ thermo-chemistry analysis) Mechanical property measurements Sample sectioning, mounting, polishing	• 4 Furnaces: Muffle furnaces, split tube , split tube • Balances • Instron • Polishing wheels • Diamond saw • Hardness tester
MSE 313 **MSE Optical Property Characterization Lab**	Lab for teaching and research in Optical Characterization including: Absorption coefficient, Reflectivity measurements.	• Optical Tables • Fluorimeter
MSE 250 **Microstructural characterization lab**	**Lab for teaching and research in microstructural characterization including:** Optical microscopy, FTIR and Raman measurements	• Bench top FTIR • Educational Raman • Optical Microscopes w/comp x 2 • High end metallographic OM (Nikon) • DSC/TGA • Mini Clean room
MSE 309 (1/2) **MSE Electrical characterization-Semiconductor lab**	**Lab for teaching and research in instrumentation/ electrical characterization**	• Probe station • Function generators • O-scopes

MSE 309 (1/2) **MSE Senior Design**	**Senior design lab**	• 5 Computers with data acquisition systems

Representative equipment list:

Educational optical microscopes

Cabinets for chemical storage
Supplies and materials

CFAMM time for SEM (per year)
FTIR
Laser for RAMAN

Board and software for TGA/DTA
Photoluminescence system
Multistir plates
pH meters and probes
Ultrasonicator with housing
Beaker and stir bar sets
High resolution Optical Microscope
Composites kits
Balances
Portable Fume Hood
Multimeters

Bioengineering

<u>Bioinstrumentation (BIEN130L): Spring Quarter</u>

Instrument/Manufacturer	**Labs**	**Quantity**	**Unit Cost ($)**	**Cost ($)**
NI ELVIS by National Instrument	Lab 1-4: ECG circuit design and data acquisition	10	2,300	23,000
Dell Desktop & Monitor by Dell	Lab 1-4: ECG circuit design and data acquisition Lab 6: Biomechanical Lab	12	1,000	12,000
Labview Academic Site License by National Instrument	Lab 1-4: ECG circuit design and data acquisition	1	5,000	5,000
Rugged Multimeter by OMEGA	Lab 1-3: ECG circuit design	11	67	737
Universal Tester 100Q500	Lab 6: Biomechanical Lab	2	13,000	26,000

by Testresources, Inc.				
Pasco Stress Strain Tester (Apparatus, sensors, USB links, Calipers) by Pasco	Lab 6: Biomechanical Lab	9	1,500	13,500
Gravity Convection Oven 3510FC by Fisher Scientific	Lab 6: Biomechanical Lab	1	700	700
Ocean Optical Spectrometer by Ocean Optics	Lab 7: Optical Methods for Hemoglobin Characterization and Blood Oxygen Provided by Professor Schultz	1	$3,000	
Mettler Balance 151G x0.001G by Mettler Toledo	Lab 7: Optical Methods for Hemoglobin Characterization and Blood Oxygen	1	1,100	1,100
Mettler New Classic MS Balance 0.001G by Mettler Toledo	Lab 7: Optical Methods for Hemoglobin Characterization and Blood Oxygen	1	1,500	1,500
Olympus Preamplifiers 5660B by Olympus	Lab 7: Ultrasonic Imaging Lab	20	760	15,200
Panametrics Immersion Transducers V318-SU by Olympus	Lab 7: Ultrasonic Imaging Lab	20	430	8,600
Tektronix Oscilloscope TDS 3054C by Tektronix	Lab 7: Ultrasonic Imaging Lab Professor Hyle Park's research instrument. Usage: 6hrs/Spring Quarter	3	$11,400	
Vernier Lab Quest by Vernier	Lab 8: Lung Capacity & Oxygen Measurements	8	329	2,632
Vernier Spirometer by Vernier	Lab 8: Lung Capacity & Oxygen Measurements	9	199	1,791
Vernior O2 sensor by Vernier	Lab 8: Lung Capacity & Oxygen Measurements	12	188	2,256
			total	**$114,016**

<u>Biotechnology Laboratory (BIEN155): Fall Quarter</u>

Instrument/Manufacturer	Labs	Quantity	Unit Cost ($)	Cost ($)
Pipettes sets (PR-10: 10ul, PR-200:200ul, PR-100:	All labs	11	630	6,930

1000ul) by Rainin				
Eppendorf Easy Pet Motorized Pipet Dispenser by Eppendorf	All labs	1	280	280
Fisher Isotemp 210 Digital water bath by Fisher Scientific	All labs	1	710	710
Fisher Isotemp Forced Air Incubator 650F (4.5cu ft.) Fisher Scientific	All labs	1	2,000	2,000
Fisher Scientific Isotemp 20cu. Refrigerator -20C to -12C by Fisher Scientific	All labs	2	1,300	2,600
OHAUS Scout Pro Balance Accu622, 620g/0.01g by OHAUS	All labs	1	1,000	1,000
Bio-Rad DNA Engine with Dual Well by Bio Rad	PCR amplification	1	6,300	6,300
Thermo Fisher A1 large Gel system by Thermo Fisher	Cloning lab	2	770	1,540
Biospectrum System F4300 by UVP LLC	Cloning lab	1	37,853	37,853
Digital Dry Bath with Heating Block Modules (24x1.5ml) by Labnet International	Cloning lab	1	400	400
Transillum Fixed intensity 8" FBTI88A By Fisher Scientific	Cloning lab & protein purification	1	1,100	1,100
Eppendorf Electroporator 2510 Eppendorf	Transform fusion genes into pTOPO vector and transform into Top10 bacterial	3	1,000	3,000
Eppendorf Model 5424 Microcentrifuge by Eppendorf	Purify plasmid DNA from bacterial cells	2	1,654	3,308
Frementation System BF0-110 (heat jacket and water jacket vessels) by New Brunswick	Protein expression	1	42,463	42,463
Innova 44 Floor Model	Protein expression	1	15,333	15,333

Shaker by New Brunswick				
BioMate 3 UV-Vis Spectrophotometer by Thermo Scientific	Measure cell growth and protein concentration Professor Jiayu Liao's research instrument. Usage: 6hrs/Fall	1	4500	
Ultrasonic Liquid Processor by Misonix	Protein purification	1	4,000	4,000
S-4000 Dug 110V Sonicator by Fisher Scientific	Protein purification	1	3,700	3,700
Beckman J-E centrifuge with three rotors by Beckman	Protein purification	2	30,839	61,678
Digital Vortex Genie 2 By Scientific Industry	Protein Purification	1	400	400
Corning Hot Plate By Corning	Protein characterization	2	1,000	2,000
PowerPac Basic Power Supply 164-5050 by Bio Rad	Protein characterization	2	350	700
Mini-Protean Tetra Cell by Bio Rad	Protein characterization	2	410	820
FLEX Station II 384R by Molecular Devices	Fluorescence Energy Transfer Assay Professor Jiayu Liao's research instrument. Usage: 6hrs/Fall Quarter	1	151,518	
			total	$202,615

<u>Bioengineering Departmental Support Instrument List</u>

Instrument/Manufacturer	Course	Quantity	Unit Cost ($)	Cost ($)
Rapid Prototyping System by Dimension Elite	Senior Design BIEN 175A&B	1	30,200	30,200
Desktop 3D Scanner by Nextengine	Senior Design BIEN 175A&B	1	3,280	3,280
Labconco Class II Type A2	Biotechnology Laboratory	3	12,000	36,000

6’ Biosafety Cabinet byLabconco	BIEN155			
Labconco Class II Type A2 4’ Biosafety Cabinet by Labconco	Biotechnology Laboratory BIEN155	2	10,000	20,000
Beta Star sterilizers 20”x20”x38” by Beta Star	Biotechnology Laboratory BIEN155	1	68,622	68,622
Beta Star sterilizers 24”x36”x36” by Beta Star	Biotechnology Laboratory BIEN155	1	44,622	44,622

Appendix D – Institutional Summary

a. **The Institution** University of California, Riverside
   (Legal name: The Regents of the University of California)
   900 University Avenue
   Riverside, CA 92521

b. Name and title of the chief executive officer of the institution
   Timothy P. White, Chancellor

c. Name and title of the person submitting the self-study report.
   Reza Abbaschian, Dean, Bourns College of Engineering

d. Name 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.

1. Type of Control

The University is a state-controlled institution of higher education and an accredited Hispanic Serving Institution (HSI).

2. **Educational Unit**

Describe the educational unit in which the program is located including the administrative chain of responsibility from the individual responsible for the program to the chief executive officer of the institution. Include names and titles. An organization chart may be included.

3. **Academic Support Units**

List the names and titles of the individuals responsible for each of the units that teach courses required by the program being evaluated, e.g., mathematics, physics, etc.

4. **Non-academic Support Units**

UCR Libraries: Dr. Ruth Jackson, University Librarian
Computing & Communications: Charles J. Rowley, Associate Vice Chancellor & Chief Information Officer, C&C Associate Vice Chancellor
Learning Center: Michael P. Wong, Director
Career Center: Randy Williams, Director

5. **Credit Unit**

It is assumed that one semester or quarter credit normally represents one class hour or three laboratory hours per week. One academic year normally represents at least 28 weeks of classes, exclusive of final examinations. If other standards are used for this program, the differences should be indicated.

6. **Tables**

Complete the following tables for the program undergoing evaluation.

Table D-1. Program Enrollment and Degree Data

Materials Science and 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	6	13	10	6	0	35	23	N/A			
		PT	0	0	1	1	2	4	0				
2010-11		FT	21	12	11	6	1	51	11	N/A	6	2	
		PT	0	1	0	0	1	2	0				
2009-10		FT	15	8	6	1	1	31	0	N/A	1		
		PT	0	0	0	0	0	0	0				
2008-09		FT	15	0	1	0	1	17	0	N/A			
		PT	0	0	0	0	0	0	0				

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

Materials Science and Engineering

Year[1]: 2011-12

	HEAD COUNT		FTE
	FT	PT	
Administrative[4]	0	0	-
Faculty (tenure-track)	6*	0	3.00
Other Faculty (excluding student Assistants)	0	1	0.33
Student Teaching Assistants[2]	0	1	0.50
Student Research Assistants[3]	11	0	11.00
Technicians/Specialists	0	0	-
Office/Clerical Employees	1	0	1.00
Others[5]	0	0	-

* MSE has filled six faculty lines with appointments in the Bourns College of Engineering departments: Bioengineering, Chemical/Environmental, Electrical, and Mechanical.

Report data for the program being evaluated.

1 Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.

2 For student teaching assistants, 1 FTE equals 20 hours per week of work (or service). For undergraduate and graduate students, 1 FTE equals 15 semester credit-hours (or 24 quarter credit-hours) per term of institutional course work, meaning all courses — science, humanities and social sciences, etc. For faculty members, 1 FTE equals what your institution defines as a full-time load.

3 Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.

4 Specify any other category considered appropriate, or leave blank.

Signature Attesting to Compliance

By signing below, I attest to the following:

That the Materials Science and 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.*

Reza Abbaschian
Dean's Name (As indicated on the RFE)

Signature **June 27, 2012**
Date