ABET
Self-Study Report

for the

Materials Science and Engineering Program

at

North Carolina State University
Campus Box 7907
Raleigh, NC 27695-7907

July 1, 2010

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING
NORTH CAROLINA STATE UNIVERSITY
ABET SELF-STUDY REPORT 2010

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BACKGROUND INFORMATION

A. Contact information

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B. Program history

1920 The program was originally founded as the Department of Ceramic Engineering
1925 Name and focus changed to the Mining Engineering Department
1927 Became the Geology Department
1954 Became the Department of Mineral Industries
1969 Became the Materials Engineering Department
1983 Undergraduate curriculum underwent a major revision to modernize its content
1986 Name was changed to the Department of Materials Science and Engineering
2009 Undergraduate curriculum underwent another major revision (see Section 4).

C. Options

There are no specialized concentrations or tracks in the Materials Science and Engineering program. However, the latest curriculum provides five technical electives which allow students to customize the curriculum somewhat according to their interests.

D. Organizational structure

The University of North Carolina is a sixteen campus system governed by a General Administration located in Chapel Hill, NC. NC State University is the largest of the sixteen universities in the system based on student numbers. NC State's primary focus areas are engineering, textiles, agriculture and veterinary medicine. NC State consists of ten academic colleges of which the College of Engineering (COE) is largest. The COE consists of twelve departments offering seventeen different engineering or computer science programs. This organizational structure is shown in the charts in section G below.

E. Program delivery modes

Currently the MSE program is offered only on-campus. Most of the courses are taught during the day, Monday through Friday. A few laboratory sessions extend into the early evening. Some of the non-MSE classes are available via distance education. Co-op opportunities are also available to students through the University Co-op Office and occasionally via direct communication from industrial contacts to MSE faculty.

F. Deficiencies, weaknesses or concerns from previous evaluations and actions taken to correct them

The ABET EAC team visited and evaluated the Materials Science and Engineering (MSE) program at North Carolina State University on October 24–26, 2004. As a result of this evaluation, the MSE program was cited with two shortcomings. Criterion 3, Program Outcomes and Assessment, was cited with a *weakness* and Criterion 6, Facilities, was cited with a *concern*. Both of these shortcomings were related to the ceramics courses in the MSE program:

MSE 434: Ceramics Engineering Laboratory
MSE 435: Physical Ceramics
MSE 445 Ceramics Processing

The responsible instructor did not provide assessment data for these courses over the 2-year assessment data collection period prior to the ABET visit. This led to the *weakness* for Criterion 3. This *weakness* was resolved by assigning a different instructor to these courses and collecting the missing assessment data in the Spring 2005 semester.

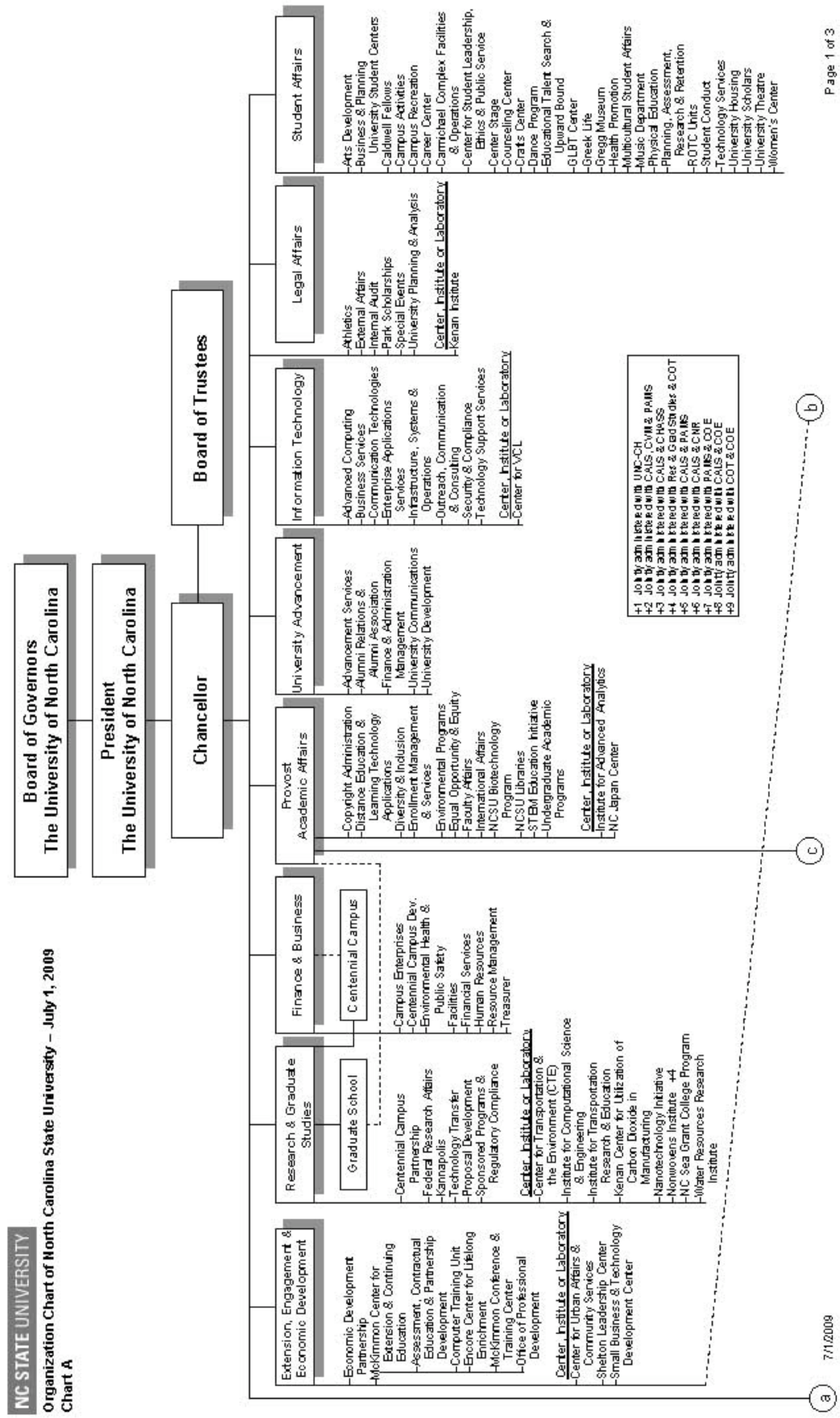
The *concern* for Criterion 6 was a result of equipment in the ceramics laboratory (MSE 434) being in need of repair and/or replacement. This *concern* was addressed by completely changing the focus of MSE 434, replacing or refurbishing old equipment and purchasing some new equipment. These changes are itemized below.

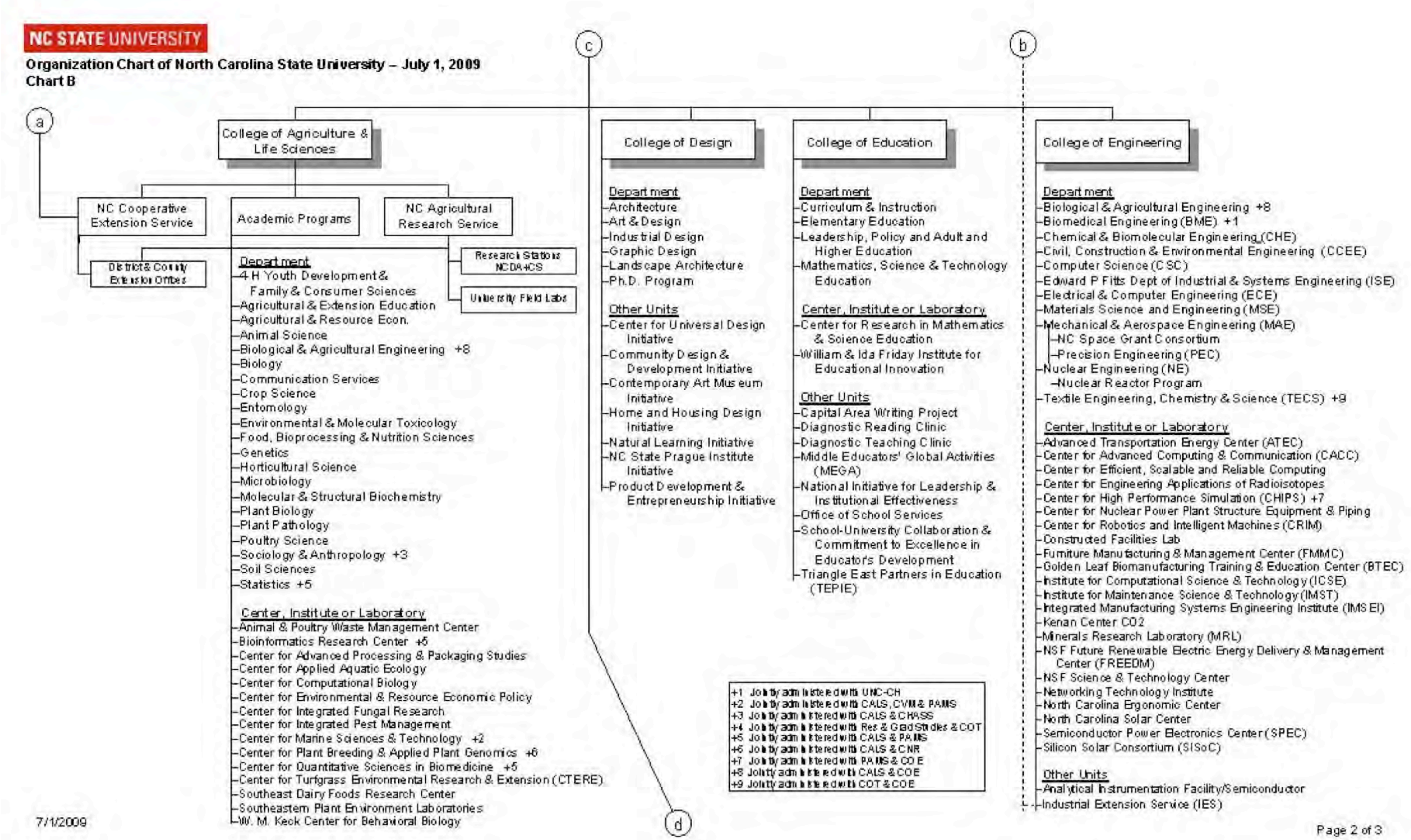
- The focus of MSE 434 has historically been restricted to ceramics processing. The revised version of the course has a broader focus, and while one processing experiment is still included (sintering of ceramic powders), new experiments involving crystal structure, electrical and optical properties of ceramics were been added. Upgrading this laboratory was significantly facilitated by the move of the Materials Science and Engineering department to a new building on the Centennial Campus in December 2004. All MSE undergraduate laboratories are now housed in more comfortable, ergonomic and safer working environments.
- Ten new eMac computers were purchased for visualization and manipulation of ceramic crystal structures.
- Three existing furnaces were refurbished with new heating elements, controllers or power supplies as needed.

- Red and green lasers and calcite crystals were purchased for the optical properties experiment.
- A dielectric properties experiment was added. An impedance analyzer available in an MSE research lab was used for this experiment.
- The fracture mechanics experiment was restructured and old alumina plate samples were replaced with glass rods having different well-controlled surface treatments. Weibull statistics were used to analyze the fracture strengths and compare the effects of the different surface treatments.

These actions were summarized in a special report submitted to ABET in June 2005 which was considered at the ABET general meeting in July 2005. Based on this report and the favorable evaluations from the other Criteria, the ABET committee decided that the *concern* and *weakness* cited during the visit had been resolved. They voted to award the MSE program at NCSU a NGR rating for the 2004 visit.

G. Organizational charts




NC STATE UNIVERSITY
Organization Chart of North Carolina State University – July 1, 2009
Chart B
a
b
c
d
College of Agriculture & Life Sciences
NC Cooperative Extension Service
District & County Extension Offices
Academic Programs
NC Agricultural Research Service
Research Stations NCDA+CS
University Field Labs
Department
4 H Youth Development & Family & Consumer Sciences
Agricultural & Extension Education
Agricultural & Resource Econ.
Animal Science
Biological & Agricultural Engineering +8
Biology
Communication Services
Crop Science
Entomology
Environmental & Molecular Toxicology
Food, Bioprocessing & Nutrition Sciences
Genetics
Horticultural Science
Microbiology
Molecular & Structural Biochemistry
Plant Biology
Plant Pathology
Poultry Science
Sociology & Anthropology +3
Soil Sciences
Statistics +5
Center, Institute or Laboratory
Animal & Poultry Waste Management Center
Bioinformatics Research Center +5
Center for Advanced Processing & Packaging Studies
Center for Applied Aquatic Ecology
Center for Computational Biology
Center for Environmental & Resource Economic Policy
Center for Integrated Fungal Research
Center for Integrated Pest Management
Center for Marine Sciences & Technology +2
Center for Plant Breeding & Applied Plant Genomics +6
Center for Quantitative Sciences in Biomedicine +5
Center for Turfgrass Environmental Research & Extension (CTERE)
Southeast Dairy Foods Research Center
Southeastern Plant Environment Laboratories
W. M. Keck Center for Behavioral Biology
College of Design
Department
Architecture
Art & Design
Industrial Design
Graphic Design
Landscape Architecture
Ph.D. Program
Other Units
Center for Universal Design Initiative
Community Design & Development Initiative
Contemporary Art Museum Initiative
Home and Housing Design Initiative
Natural Learning Initiative
NC State Prague Institute Initiative
Product Development & Entrepreneurship Initiative
College of Education
Department
Curriculum & Instruction
Elementary Education
Leadership, Policy and Adult and Higher Education
Mathematics, Science & Technology Education
Center, Institute or Laboratory
Center for Research in Mathematics & Science Education
William & Ida Friday Institute for Educational Innovation
Other Units
Capital Area Writing Project
Diagnostic Reading Clinic
Diagnostic Teaching Clinic
Middle Educators' Global Activities (MEGA)
National Initiative for Leadership & Institutional Effectiveness
Office of School Services
School-University Collaboration & Commitment to Excellence in Educator's Development
Triangle East Partners in Education (TEPIE)
+1 Jointly administered with UNC-CH
+2 Jointly administered with CALS, CVM & PAMS
+3 Jointly administered with CALS & CHASS
+4 Jointly administered with Res & Grad Studies & COT
+5 Jointly administered with CALS & PAMS
+6 Jointly administered with CALS & CNR
+7 Jointly administered with PAMS & COE
+8 Jointly administered with CALS & COE
+9 Jointly administered with COT & COE
College of Engineering
Department
Biological & Agricultural Engineering +8
Biomedical Engineering (BME) +1
Chemical & Biomolecular Engineering (CHE)
Civil, Construction & Environmental Engineering (CCEE)
Computer Science (CSC)
Edward P Fitts Dept of Industrial & Systems Engineering (ISE)
Electrical & Computer Engineering (ECE)
Materials Science and Engineering (MSE)
Mechanical & Aerospace Engineering (MAE)
NC Space Grant Consortium
Precision Engineering (PEC)
Nuclear Engineering (NE)
Nuclear Reactor Program
Textile Engineering, Chemistry & Science (TECS) +9
Center, Institute or Laboratory
Advanced Transportation Energy Center (ATEC)
Center for Advanced Computing & Communication (CACC)
Center for Efficient, Scalable and Reliable Computing
Center for Engineering Applications of Radioisotopes
Center for High Performance Simulation (CHIPS) +7
Center for Nuclear Power Plant Structure Equipment & Piping
Center for Robotics and Intelligent Machines (CRIM)
Constructed Facilities Lab
Furniture Manufacturing & Management Center (FMMC)
Golden Leaf Biomanufacturing Training & Education Center (BTEC)
Institute for Computational Science & Technology (ICSE)
Institute for Maintenance Science & Technology (IMST)
Integrated Manufacturing Systems Engineering Institute (IMSEI)
Kenan Center CO2
Minerals Research Laboratory (MRL)
NSF Future Renewable Electric Energy Delivery & Management Center (FREEDM)
NSF Science & Technology Center
Networking Technology Institute
North Carolina Ergonomic Center
North Carolina Solar Center
Semiconductor Power Electronics Center (SPEC)
Silicon Solar Consortium (SISoC)
Other Units
Analytical Instrumentation Facility/Semiconductor
Industrial Extension Service (IES)
7/1/2009
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NC STATE UNIVERSITY

Organization Chart of North Carolina State University – July 1, 2009
Chart C

(d)

College of Natural Resources

Department
- Forestry & Environmental Resources
- Parks, Recreation & Tourism Management
- Wood & Paper Science

Center, Institute or Laboratory
- Brandon P Hodges Wood Products Lab
- CAMCORE
- Center for Earth Observation
- Center for Plant Breeding & Applied Plant Genomics +6
- Industry Research Programs in Forestry
- Southern Center for Sustainable Forests

Other Units
- Christmas Tree Genetics
- College Forests
- Environmental Technology
- Fish & Wildlife Program
- Forest Biotechnology
- Forest Nutrition Cooperative
- Forestry Educational Outreach Program
- Forestry Extension
- Paper Science & Engineering
- Professional Golf Program
- PRTM Extension
- Recreation Resources Service
- Robertson Lab Service Center
- Robertson Pilot Plant Service Center
- Southern Forest Resource Assessment Consortium
- Tree Improvement Cooperative
- Wood Chemistry Service Center
- Wood Machining & Tooling Program
- Wood Products
- Wood Products Extension

College of Humanities & Social Sciences

Department
- Communication
- English
- Foreign Languages & Literature
- History
- Interdisciplinary Studies
- Philosophy & Religion
- Psychology
- School of Public & International Affairs (SPIA)
  - Public Administration
  - Political Science
- Social Work
- Sociology & Anthropology +3

Center, Institute or Laboratory
- Center for Family and Community Engagement (CFACE)
- Institute for Nonprofit Education, Research and Engagement (INPREE)

College of Management

Department
- Accounting
- Business Management
- Economics
- Management, Innovation & Entrepreneurship

Center, Institute or Laboratory
- Center for Innovation Management Studies

Other Units
- BioSciences Management Initiative
- Enterprise Risk Management Initiative
- TEC Program
- Supply Chain Resource Cooperative

College of Physical & Mathematical Sciences

Department
- Chemistry
- Marine, Earth & Atmospheric Sciences
- Mathematics
- Physics
- Statistics +5

Center, Institute or Laboratory
- Bioinformatics Research Center +5
- Center for High Performance Simulation +7
- Center for Marine Sciences & Technology +2
- Center for Quantitative Sciences in Biomedicine +5
- Center for Research in Scientific Computation
- Institute of Statistics
- State Climate Office of NC

Other Units
- The Science house
- Triangle Universities Nuclear Laboratory (TUNL)

College of Textiles

Department
- Textile & Apparel Technology & Management (TATM)
- Textile Engineering, Chemistry & Science (TECS) +9

Center, Institute or Laboratory
- Nonwovens Institute (NWI) +4
  - Nonwovens Cooperative Research Center (NCRC)
- Textile Protection & Comfort Center (TPACC)

Other Units
- Textile Extension Education for Economic Development (TEXEd)
  - TexLabs

College of Veterinary Medicine

Department
- Clinical Sciences
- Molecular Biomedical Sciences
- Population Health & Pathobiology

Center, Institute or Laboratory
- Center for Chemical Toxicology Research & Pharmacokinetics
- Center for Comparative Medicine & Translational Research
- Center for Marine Sciences & Technology +2

Other Units
- Animal Welfare, Ethics & Public Safety (includes Shelter Medicine Initiative)
- Educational Media and Design
- Laboratory Animal Resources
- NC State Equine Health Center at Southern Pines
- Office of Continuing Education and Outreach
- Teaching Animal Unit (TAU)
- Veterinary Teaching Hospital

+1 Jointly administered with UNC-CH
+2 Jointly administered with CALS, CVM & PAMS
+3 Jointly administered with CALS & CHASS
+4 Jointly administered with Res & Grad Studies & COT
+5 Jointly administered with CALS & PAMS
+6 Jointly administered with CALS & CNR
+7 Jointly administered with PAMS & COE
+8 Jointly administered with CALS & COE
+9 Jointly administered with COT & COE

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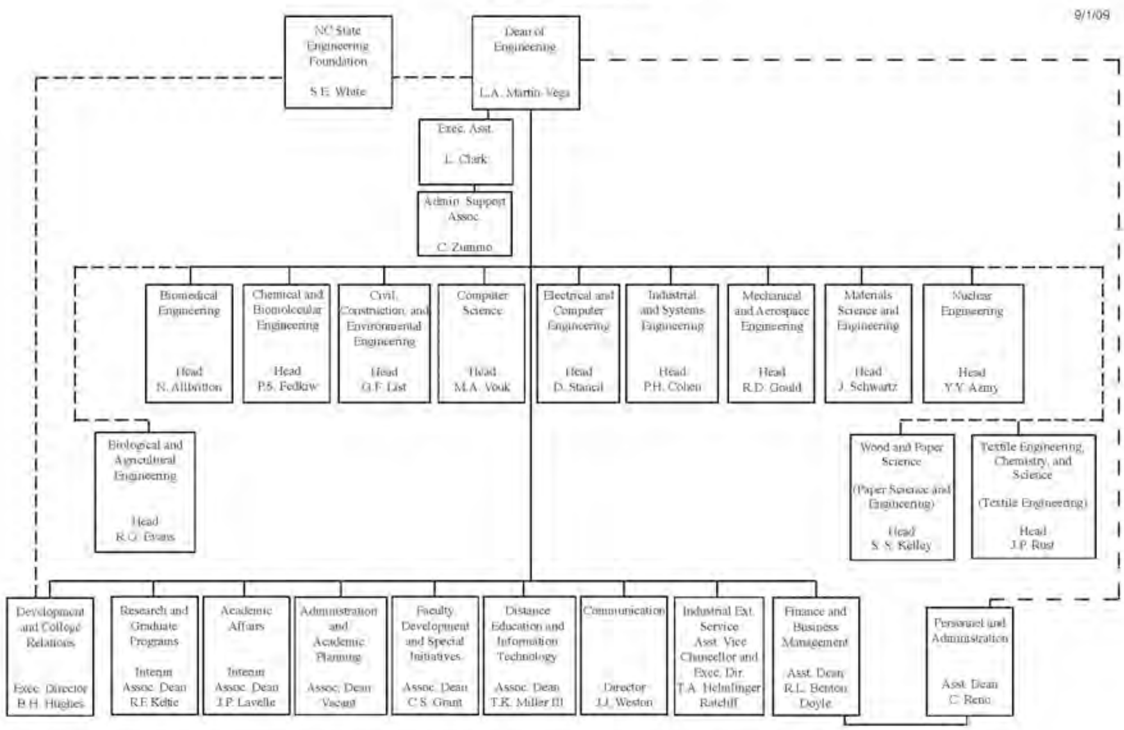
College of Engineering
Organizational Chart



CRITERION 1. STUDENTS

A. Student admissions

Admission to the University: Admission to NC State University has become very competitive as demand for admission continues to outpace available space. As can be seen on the University Planning and Analysis website, in 2002, approximately 59% of applicants were admitted to NC State University. In 2009, only 55.7% of applicants were accepted. In determining an applicant's likelihood of success, the major factors given consideration are as follows:

- High School Grade Point Average
- High School Class Rank
- SAT Critical Reading score
- SAT Math score

The University Admissions Office individually reviews the applications of all students. During the review, the quality of courses are taken into account as well as other factors such as recommendations, extra-curricular activities, the NC State University performance of previous students from the same high school, etc. The fall 2009 statistics of 4,644 incoming students to the University are as follows:

- 75% of incoming first-year students have a high school ranking above the 78th percentile. 25% have a high school rank above the 93rd percentile.
- 75% of incoming first-year students had a high-school-weighted GPA of 3.97 or higher. 25% had a GPA of 4.4 or higher.
- 75% of incoming first-year students had an SAT score of 1110 or higher. 25% had a score of 1270 or higher.

Admission to the College of Engineering: NC State University uses a centralized admissions process; thus, students with interest in engineering apply to be admitted through NC State University's undergraduate admissions process. Engineering is highly selective in its admissions. Successful candidates typically meet or exceed the following criteria: top 10 to 15% of their high school class in the most rigorous college prep courses, B+ to A- GPA, and highly competitive standardized test scores (SAT or ACT). Students who have taken advanced courses, particularly in math, chemistry, and physics, are best prepared for the academic rigor of the COE and are more competitive in the admissions process. Also considered are standardized test scores (SAT or ACT) and, to a lesser extent, extracurricular activities and leadership experiences. The fall 2009 statistics of the 1,389 incoming students to the COE are as follows:

- 75% of incoming engineering first-year students have a high school ranking above the 84th percentile. 25% have a high school rank above the 95th percentile.
- 75% of incoming first-year students had a high-school-weighted GPA of 4.09 or higher. 25% had a GPA of 4.56 or higher.
- 75% of incoming first-year students had an SAT score of 1160 or higher. 25% had a score of 1340 or higher.

Students who know which engineering major they want may indicate it on the admissions application. Those students are enrolled as unmatriculated students in that department, with a faculty member from that department serving as their academic adviser during the freshman year. Students who plan to major in an engineering discipline but are undecided on a specific major when they apply can indicate "Engineering Undecided" on the application. Those students will have an academic adviser in the COE Office of Academic Affairs until they matriculate into a department. Either of these first-year options will ensure that a student takes the required courses for matriculation into any engineering department.

Admitted freshmen take a common first year as "Engineering Unmatriculated" or "Departmental Unmatriculated" students and choose their majors (matriculate) after the second or third semester. In the common first year, students should successfully complete English, calculus, chemistry, physics, and introductory engineering and computer courses before enrolling in an academic department (matriculation). Typically, first-year students also begin enrolling in their humanities and social sciences electives. Table 1-1 below details the admissions standards for engineering students over the last five years.

TABLE 1-1. College of Engineering first-year student admissions standards

Academic year	Composite ACT		Composite SAT		Percentile rank in high school		New students enrolled
	Min.	Avg.	Min.	Avg.	Min.	Avg.	
2009-2010	19	26.8	860	1251	38	88.6	1389
2008-2009	17	26.7	930	1247	51	88.2	1370
2007-2008	18	26.3	870	1228	46	86.4	1412
2006-2007	17	24.8	880	1234	41	86.9	1397
2005-2006	19	27.7	920	1251	45	87.7	1176
2004-2005	19	26.5	870	1249	44	88.3	1235

B. Evaluating student performance

Monitoring: On a semester-to-semester basis, students must demonstrate academic progress toward their intended major. The University has instituted a Progress Toward Undergraduate Degree Policy that requires undergraduate students to have a degree plan on file with their academic adviser. This degree plan may be crafted in such a way as to incorporate study abroad, co-operative education, part-time enrollment, and other events. However, once a student commits to a degree plan, the student must satisfy minimum requirements toward completing the plan. If a student fails to make adequate progress, he or she may be placed on "Progress Warning" and ultimately suspended. The details of the policy may be found at

www.ncsu.edu/policies/academic_affairs/pols_regs/REG205.00.20.php.

In addition to this university-level policy, the College currently has in place a requirement that all engineering students *must* matriculate before they earn 60 semester credit hours at NC State University. If students fail to matriculate by this time, they are moved into the Engineering Transition Program (TRU degree code). The COE Office of Academic Affairs (along with other resources on campus) works with TRU students to find a degree path at NC State University outside of engineering. Dr. Mary Clare Robbins, Coordinator of Advising for the College, oversees the Engineering Transition Program.

Prerequisite Checking: Many courses taken by engineering students have prerequisites. It is the responsibility of the student to know these requirements and constraints when planning their academic courses in consultation with their academic advisors. The new PeopleSoft-based student records system at the university (called SIS-Student Information System) allows for departments to block students from enrolling in courses who do not have the course prerequisites or other course restrictions (such a senior standing, etc.). In addition, many departments allow instructors, at their discretion, to exempt qualifying students from stated prerequisites or restrictions. In these cases, for students who fall under our ABET accredited programs, the instructor is asked to document the exception and place it in the student's file.

C. Advising students in MSE

Matriculation into MSE: All freshmen in the College of Engineering (COE) at NCSU are initially undesignated. However, many freshmen want to indicate a preference for a particular major and are given an appropriate curriculum code ending in "U" (unmatriculated). For example, freshmen planning to matriculate into the Materials Science and Engineering Department are assigned the code MSU. Freshmen who don't choose a preferred major are given the code EU (Engineering Unmatriculated). EU students are advised by personnel in the COE Dean's office, as noted in section B. Students designated as MSU are advised by faculty in the MSE department. MSU students are automatically eligible to matriculate into MSE if they achieve a GPA of 2.5 or higher and complete CH 101, CH 102, E 101, ENG 101, MA 141, MA 241, and PY 205 with a C- or higher grade, and E 115 with an S grade. Under the current curriculum (14MSE097), MSE majors must also complete MSE 201 with a C- or higher grade before they can register for 300-level MSE courses in the junior year. Although not required for matriculation, MSE majors are required to take CH 201 and CH 202, which is typically done during the spring semester of the freshman year. MSU and other undesignated freshmen wishing to transfer into MSE are advised to take this second chemistry course in the summer freshman orientation sessions and in the fall semester pre-registration advising sessions.

Students who do not meet the GPA requirement may still be considered for matriculation into MSE on a case-by-case basis by the MSE Director of Undergraduate Programs. These students are allowed to enroll in sophomore-level MSE courses and must complete these courses with a grade of C- or better to matriculate into MSE. Students must maintain a 2.0 GPA overall and a 2.0 GPA in their major through graduation to maintain degree-seeking status in the MSE department and in the COE.

MSE Faculty Advisors: Students are assigned faculty advisors as soon as they designate themselves as MSU or matriculate into the MSE curriculum. Generally, students keep the same advisor throughout their tenure in the MSE department. This allows each advisor to become more familiar with his/her advisees and any special needs they may have, which promotes more effective advising. However, students are allowed to switch to a different advisor if they so desire. A common reason for switching advisors is to match an advisor's area of research and expertise with a student's career goals. MSE faculty members who advise MSE students are listed in Table 1-2.

TABLE 1-2. Faculty advisors for MSE undergraduates

Faculty Advisor	Rank and administrative title (if any)
J. Schwartz	Professor and Department Head
C. M. Balik	Professor and Director of Undergraduate Programs
R. O. Scattergood	Professor and Director of Graduate Programs
K. Dawes	Teaching Professor
D. Irving	Assistant Professor
J. Tracy	Assistant Professor
C. C. Koch	Professor
J. M. Rigsbee	Professor

The advising process in MSE: The advising and pre-registration process is initiated each semester with an email from the Director of Undergraduate Programs to all MSE undergraduates which reviews the advising procedures. Ms. Edna Deas (Student Services Assistant), puts a copy of each student's current automated degree audit (ADA) report, an MSE Advising Planning Form (Exhibit 1-1) and other pertinent information in the students' mailboxes located in EB1 3037. Ms. Deas also distributes current ADAs, updates to course listings, MSE advising policies, the COE Humanities and Social Sciences requirements and other related materials to faculty advisors. NC State recently changed its general education requirements, resulting in a change in the Humanities and Social Science course requirements. This change officially went into effect for freshmen entering NCSU in the fall 2009 semester. The H&SS requirements before and after the change are illustrated in Exhibits 1-2 and 1-3, respectively.

At the start of the pre-registration period, students pick up their advising materials and prepare a tentative schedule of classes for the next semester by filling out the MSE Advising Planning Form. The NCSU registration system puts an "advising hold" on each student which prevents a student from registering for courses until they meet with their advisor. Students sign up for a 30-minute advising session using sign-up sheets posted outside each advisor's office or via email. During the advising session, the advisor reviews the student's tentative schedule and either approves it or makes recommendations for changes to keep the student on track in the MSE curriculum and on schedule for graduation. After the completion of pre-registration advising, the MSE Advising Form is signed by the student and his/her advisor, and returned to Edna Deas who places the Advising Form in the student's personal file. The student's advising hold is then released by Ms. Deas and the student is cleared to pre-register for courses.

The ADA is available to students and advisors through MyPack Portal, which is a secure online connection to most of their university records. The ADA is interactive and allows students to plan their schedules for future semesters. It shows all of the courses required for graduation, it provides links to course lists that satisfy electives, it shows grades received in completed courses, and provides summary GPA information. This online tool makes it easy for students to prepare their pre-registration schedules each semester if they are on track in the MSE curriculum.

Students who are not on track require special attention during advising since most of the MSE courses are taught only once per year. These students must work with their advisors to develop a semester-by-semester plan that will allow them to graduate in a reasonable time while minimizing the number of courses taken out of the normal sequence. This customized plan is entered on a Long-Range Planning Form (Exhibit 1-4) which is retained in the student's personal file. This plan is reviewed and revised if necessary in all subsequent pre-registration advising sessions.

Other issues related to advising of MSE undergraduate students:

1. All undergraduate records are maintained by the Director of Undergraduate Programs (Dr. C. M. Balik) and the Student Services Assistant (Edna Deas) in the departmental undergraduate programs office (EB1 3078). An academic file is kept for each undergraduate student.
2. All students must meet with their advisor at least once per semester (prior to each pre-registration period). Many also schedule additional meetings with their advisors to discuss curricular and other issues. At a minimum, each pre-registration advising period involves a review of courses in progress, selection of elective courses to meet individual goals, discussion of prerequisites, monitoring of academic progress and a review of academic guidelines and policies. Release of the advising hold, which allows a student to preregister for courses, is done only after the advisor is satisfied that the student is taking the proper courses leading to timely graduation.
3. The MSE department and the COE are sensitive to avoiding last minute problems with regard to academic performance and graduation requirements. All MSE majors falling below a 2.0 GPA are assigned to the Director of Undergraduate Programs for advisement. In some cases, students may be asked to seek counseling, tutoring or consultation with other units on campus. Student records are reviewed at least twice a year. Students in academic difficulty are required to meet with their advisor at the beginning of each semester to discuss their current status and evaluate their progress. These students must complete and submit a form to NCSU Registration and Records confirming that they have fulfilled this timely advising requirement. If this form is not received by Registration and Records, the student is prevented from pre-registering for the following semester.
4. Before graduation, confirmation that all requirements for the MSE degree have been met is first made by the MSE Director of Undergraduate Programs, and then by personnel in the COE Dean's office. This is done at the beginning of the semester for all students slated to graduate at the end of that semester. An Application for Degree (Exhibit 1-5) is filled out by each student which lists courses that must be completed in that final semester to qualify for the B.S. degree. This form is signed by the MSE Director of Undergraduate Programs, the MSE Department Head, and the Dean of the COE. Graduating students must also apply for their degree online, and this electronic application is approved by the COE Dean's office after the paper copy is verified.
5. An "Adviser Toolkit" website is maintained by the NC State Division of Undergraduate Academic Programs which provides useful information relevant to the advising process and university policies. Links to this and other NCSU web pages which contain information relevant to undergraduate advising are listed below.

Adviser Toolkit
http://www.ncsu.edu/oasis/adviserstoolkit/index.php

Handbook for Teaching and Advising
http://www.ncsu.edu/provost/hat/current/index.html

NCSU Course Catalog
http://www2.acs.ncsu.edu/reg_records/crs_cat/directory.html

Counseling Center
http://www.ncsu.edu/stud_affairs/counseling_center/

Course Equivalency (transfer credits)
http://admissions.ncsu.edu/how-apply/admission-profile/course-equiv.php

Co-op Program
http://www.ncsu.edu/co-op_ed/

Study Abroad Program
http://studyabroad.ncsu.edu/

D. Transfer students and transfer courses

Every year more than 25 percent of the students receiving a degree in engineering at NC State University are students who began their education at another institution. Typically, they come from the state of North Carolina community colleges, four-year colleges and universities within North Carolina, as well as throughout the United States, and from institutions in foreign countries. In addition, formalized 2+2 transfer programs in engineering currently exist at Lenoir Community College (Kinston, N.C.), the University of North Carolina at Asheville, and the University of North Carolina at Wilmington. The COE also has 3+2 dual degree programs with Meredith College (Raleigh, N.C.), Elon University (Greensboro, N.C.), St. Andrews Presbyterian College (Laurinburg, N.C.), and St. Augustine's College (Raleigh, N.C.). In these programs students not only receive an NC State University engineering degree upon graduation but additionally a second degree from their home institution.

For the 2008-2009 academic year, 266 external transfer students transferred into the COE at NC State University. These students came from the state of North Carolina community colleges (48%), other four-year colleges and universities within North Carolina (23%), out-of-state schools (14%), and from foreign institutions (3%). Another group of students (12%) transferred from Non-Degree Seeking (NDS) status at NC State University into a COE degree program.
Students who wish to be admitted to the NC State University COE as transfer students must meet the following requirements as shown on the COE transfer web site:

Transfer Student Admission Requirements
The following list contains the admission requirements for engineering transfer students. The NC State University course number is written in parentheses for your reference. A course taken at another institution must be equivalent to the NC State course and completed with a grade of C- or better.

If NC State courses are taken, the overall NC State GPA must be at least 2.0. Core courses, also known as C wall courses, require at least a C-.

1. **30 credit hours or more** of transferable college-level courses
2. **3.0 or higher cumulative GPA** * Depending on your intended major, a cumulative GPA between 2.5 and 2.9 may be considered for transfer admission.
3. **College English composition course** 3 credits (ENG 1**)
4. **Second college English composition course**, 3 credits (ENG 1**) * In lieu of requirements 3 and 4, take NC State (ENG 101), 4 credits
5. **College chemistry course with lab**, 4 credits (CH 101 and 102)
6. **Calculus I**, 4 credits (MA 141)
7. **Calculus II**, 4 credits (MA 241)
8. **Minimum 2.5 math GPA** in last two math courses at MA 141 level or higher
9. **Calculus-based Physics I**, 4 credits (PY 205)

Once you meet the transfer admission requirements or currently have the last requirements in progress, you are ready to apply to NC State's College of Engineering. Please note the following exceptions:

Note 1: If applying for the spring semester, all admission requirements must already be completed. None may be in progress.
Note 2: Depending on your intended major, you may want to take additional courses. To select the appropriate courses, refer to your intended NC State engineering degree requirements.
Note 3: Transfer students are not initially admitted into Biomedical Engineering. For information on matriculating into Biomedical Engineering, contact Dr. Lianne Cartee at 919-515-6726.

The NC State Office of Undergraduate Admissions and the COE publish transfer policies in both print and on the Web. These policies assist in advising prospective students as well as ensuring consistent evaluation and acceptance of transfer courses and advanced placement tests. The COE transfer advisers serve as the primary live resource for questions and advice for transfer students on the campus as well as for prospective transfer students. The transfer advisors also work directly with the University Office of Undergraduate Admissions to ensure that the admissions processes and procedures are applied to all COE transfer applicants. The website at:

www.engr.ncsu.edu/undergrad/transfer/

was built specifically as a resource to provide information for transfer students. At this site, students can find information on "Transfer Admission Requirements," a database entitled "Which Courses Transfer to NC State?", and information regarding "Engineering Degree Requirements," as well as "Transfer Scholarship Application" materials.

Students apply to be admitted as transfer students through the University Office of Undergraduate Admissions. Transfer applications as well as other information are available on the admissions website at http://admissions.ncsu.edu. Students can find requirements and application materials on this admissions website. In addition, transfer applicants can check the status of their application online once they have formally applied.

The COE transfer advisors and Office of Undergraduate Admissions jointly review transfer applications. Based on the information in the student's transfer application, one of three admission decisions is made: (1) admit the student (2) deny admission or (3) mark as pending until the student's current semester's grades are received. The pending state is generally not used for spring transfer applicants because of the short time between fall and spring semesters.

The COE has made continued efforts to matriculate admitted, eligible students directly into an engineering degree-granting program by the start of their first admitted semester at NC State University. The COE's transfer admission requirements parallel the matriculation requirements for engineering freshmen. Freshmen must meet similar requirements plus successful completion of E 101 and E 115 in order to gain formal entrance into their specific engineering degree program. The COE has focused on admitting external transfer students with transfer GPA's comparable to the required departmental matriculation GPA standards for freshmen. In borderline admissions decisions, transfer advisors may request departmental input.

On a limited basis, some transfer students are accepted as exceptions to the general admission requirements. Generally, in such cases there is a shortage or mismatch of transfer credit for a specific admissions course which cannot be easily remedied outside of the institution, but transfer admission is still warranted. A typical example is a student who meets every other transfer admission requirement but has only three of the four credit hours required for English composition. In such cases extra time is given to rectify the shortage of credit at NC State University.

During first-semester advising for a newly admitted transfer student, the previous semester's grades and course work are reviewed by the transfer advisor. At this point in the process, transfer students are appropriately matriculated into their respective engineering degree or notified if there is any requirement still in question. In rare instances, if a student has already been accepted for the upcoming semester and his/her GPA drops below the minimum admission requirement due to the latest semester's grades, admission may be rescinded. Table 1-3 provides new transfer student enrollment data for the past five years in the College of Engineering. Transfer students matriculating into the MSE major number 5 or fewer each year.

TABLE 1-3. New transfer students in COE for past five academic years

Academic Year	Number of new transfer students enrolled
2008-2009	286
2007-2008	221
2006-2007	256
2005-2006	265
2004-2005	265

E. Graduation requirements

At North Carolina State University the Automated Degree Audit (ADA) tool is used for academic advising and graduation certification. The ADA lists all of the required courses that a student must complete for his or her specific major. In addition, the ADA tracks the student's progress toward completing those requirements. The ADA tool is available to students, faculty, advisers, and staff through secure University databases. Each engineering degree program is coded on the ADA through the COE Office of Academic Affairs, and is managed by NC State University Registration and Records. All engineering degree programs have been designed to meet EAC requirements, and thus the ADA graduation checkout tool represents those requirements. Therefore, when students complete the requirements represented on their ADA, they have completed program-specific and EAC requirements.

Students meet with their individual departmental advisers at the beginning of each semester to make sure that they are on track toward graduation and to verify their schedule for the next semester. Students must meet with their advisers to have advising/registration holds lifted. Once the advising/registration hold is lifted, students may register for classes.

Certification of graduation requirements is administered by the Office of Academic Affairs in the COE. Candidates for graduation must apply online through their MyPack Portal student information system. They also notify their departmental coordinator of advising during the first 30 days of the semester in which they expect to graduate. Applications for academic "minors" are also submitted at the same time. Upon certification by the program coordinator of advising, the student's ADA report is sent to the COE Office of Academic Affairs for final certification. Upon review by the Office of the Assistant Dean for Academic Affairs, departmental coordinators of advising are notified if discrepancies exist. This process is ongoing during the last semester of enrollment. When final grades become available at the end of the semester, the Office of the Assistant Dean for Academic Affairs does a final check of graduation requirements. Academic minors are reviewed after the major degree is cleared. Departments are notified of those students with clearance difficulties and of those who will receive their diplomas from the University Office of Registration and Records.

F. Enrollment and graduation trends

Table 1-4a shows the enrollment and graduation numbers for the NCSU College of Engineering for the past five academic years. Full time student enrollment has increased each year, with between 165 and 230 additional students being added in undergraduate engineering programs each year over a five year period. The FTE similarly shows a continual increase each year. Part-time student enrollment has fluctuated between 520 and 580 students over the five years. The number of engineering graduates each year is between 1040 and 1239.

TABLE 1-4a. Enrollment trends in COE for past five academic years

	Four years prior 2005-2006	Three years prior 2006-2007	Two years prior 2007-2008	Year prior 2008-2009	Current year 2009-2010
Full-time Students	5020	5248	5460	5625	5846
Part-time Students	578	575	528	536	524
Student FTE[1]	5238	5462	5648	5819	6051
Graduates	1239	1040	1103	1049	---

[1] FTE = Full-Time Equivalent

Table 1-4b shows the enrollment and graduation numbers for the Department of Materials Science and Engineering for the past five years. Enrollment has decreased from a high of 85 in 2006-07 to 65 in 2007-08, and has since remained close to this level. Graduation rates have also decreased over this time period, and are currently holding at 10-20 graduates per year.

TABLE 1-4b. Department of Materials Science and Engineering
Enrollment trends for past five academic years

	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
Full-time Students	81	85	65	71	68
Part-time Students	6	7	4	3	1
Student FTE[1]	83.25	89.5	66.5	73.25	68.75
Graduates	30	14	12	16	11[2]

[1] FTE = Full-Time Equivalent
[2] Projected number

Table 1-5 shows details for the most recent 27 BS graduates from the MSE program, spanning the spring 2008 through spring 2009 semesters. In this group of graduates, 37% are attending graduate school, 44% are working in an industrial job and the remaining 19% are pursuing other careers or did not provide any information.

TABLE 1-5. Recent MSE program graduates

Numerical identifier	Year entered university	Year matriculated into MSE	Year graduated	Initial or current employment/job Title/Other Placement
1	Aug 2005	Aug 2006	Dec 2009	Cree, RTP, NC
2	Aug 2005	Aug 2006	May 2009	Corning, Wilmington NC
3	Aug 2005	Aug 2006	May 2009	Graduate school NCSU MSE
4	Aug 2006	Jan 2007	May 2009	Graduate school NCSU MSE
5	Aug 1992	Aug 1994	May 2009	Static Control Components, Sanford NC
6	Aug 2005	Jan 2006	May 2009	NCSU 2nd BS Physics & BA English
7	Aug 2005	Jan 2006	May 2009	Graduate school NCSU MSE
8	Aug 2005	Aug 2006	May 2009	Graduate school NCSU MSE
9	Aug 2005	Aug 2006	May 2009	Graduate school Carnegie Mellon
10	Aug 2005	Sum II 2006	May 2009	Graduate school MIT
11	Aug 2005	Sum I 2006	May 2009	Jerry's Artorama
12	Sum II 2001	Aug 2002	May 2009	---
13	Aug 2005	Aug 2006	May 2009	---
14	Aug 2005	Aug 2006	May 2009	---
15	Aug 2003	Jan 2007	May 2009	NCSU MSE Staff
16	Aug 2004	Sum I 2006	Dec 2008	GE Wilmington NC
17	Jan 2006	Jan 2006	Dec 2008	S&ME Raleigh, NC
18	Aug 2004	Fall 2005	May 2008	Navair, China Lake CA
19	Aug 2004	Fall 2006	May 2008	Graduate school NCSU MSE
20	Aug 2004	Jan 2006	May 2008	Graduate school NCSU MSE
21	Aug 2004	Aug 2005	May 2008	Progress Energy Shearon Harris NC
22	Aug 2005	Aug 2006	May 2008	Graduate school UC Santa Barbara
23	Aug 2003	Jan 2005	May 2008	Nucor, Cofield NC
24	Jan 2006	Jan 2006	May 2008	Navair-Maryland
25	Aug 2004	Aug 2005	May 2008	Navair-Maryland
26	Aug 2004	Aug 2005	May 2008	Graduate school NCSU MSE
27	Aug 2004	Jan 2006	May 2008	Navair-Jacksonville, FL

EXHIBIT 1-1

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

ADVISING PLANNING FORM

To be completed by all MSE students before pre-registration advising

Name ________________________________ **Date:** ______________

last first M.I.

Student Identification Number: ________________________________

Graduation Planning Information

☐ B.S. in MSE ☐ Second major in __________ ☐ Minor in __________

☐ None of the above, planning to transfer to ____________________

☐ EU; planning to matriculate into ____________________

Expected graduation: ☐ Fall ☐ Spring ☐ Summer of ____________
year

Schedule Planning Information

Courses for which you plan to register for the __________________ semester.

COURSES	CREDITS
TOTAL	

I have discussed my schedule and progress towards a degree with my advisor. I will register for the courses listed on the left for the next semester. I have also discussed my ADA with my advisor and understand what courses I must take to complete the requirements for a degree.

____
Student's signature Date

____
Advisor's signature Date

If for any reason you do not register for the courses shown on this plan, you are expected to meet with your advisor again and file a revised plan. Blank forms are available on the MSE web site or from Edna Deas in EB1 3078.

EXHIBIT 1-2

NC STATE UNIVERSITY
College of Engineering

HUMANITIES & SOCIAL SCIENCES REQUIREMENTS

A total of ***seven courses (21 credit hours)*** from the ***Approved COE Humanities & Social Sciences*** list is required. These courses may be taken in any order. All of the courses must be completed for a letter grade; none of the seven courses may be taken as pass / fail or credit only grading.

LITERATURE Select one course from the approved list of "Literature."	____________ (3cr.)
HISTORY, PHILOSOPHY, OR RELIGION Select one course from the approved lists: "History," "Philosophy," or "Religion."	____________ (3cr.)
VISUAL & PERFORMING ARTS OR HISTORY Select one course from the approved lists: "Visual & Performing Arts" or "History" *NOTE: CEM, ENE & TE majors must choose GC 120.*	____________ (3cr.)
SOCIAL SCIENCES Select one course from the approved list of "Social Sciences" (anthropology, politics & government, sociology, cultural geography, psychology, or linguistics). *NOTE: ENE majors must choose PS 336 or PS 320.*	____________ (3cr.)
INTRODUCTORY ECONOMICS Select an introductory economics course: EC 205 **(recommended)**, EC 201, or ARE 201. *Transfer or AP credit for EC 202 can count here.*	____________ (3cr.)
SCIENCE, TECHNOLOGY, & SOCIETY Select one course from the approved list of "Science, Technology, and Society." *NOTE: BE majors must choose from IDS 201 or STS 302, 304, 320; PHI 422* *IE & IEF majors must choose from IDS 201, 303 or STS 214, 302, 304, 320, 322, 325*	____________ (3cr.)
OTHER HUMANITIES & SOCIAL SCIENCES Select an additional course from **any** of the *Approved COE Humanities & Social Sciences* to complete the *total of seven courses.* *NOTE: CEM majors choose from EC 301, 304, 336, 348, 372* *AE & ME majors choose from STS 302, 304, 320 (or may be used to fulfill Sci./Tech & Society above); PHI 214, 375 (or may be used to fulfill Hist./Phil/Rel above)* *MSE majors choose from IDS 201, STS 302, 304, 320, 325 (or may be used to fulfill Sci./Tech & Society above); PHI 214, 221, or 375 (or may be used to fulfill Hist./Phil/Rel above)* *ENE majors choose from ARE 309, 336 (may only be used to fulfill this Other Human. & Soc. Sci.); ET 410, IDS 201, 303, or PHI 422 (or may be used to fulfill Sci./Tech & Society above)*	____________ (3cr.)
The following requirement must also be satisfied:	**Total = 21 credit hours**
NON-ENGLISH SPEAKING CULTURE At least one of the seven courses selected above **must** focus on a *non-English speaking culture* **(denoted by an asterisk *; complete list on last page)** *– OR –* Select an additional course to satisfy this requirement.	course from above (3cr.) *– OR –* ____________ (3cr.)

NOTE: Foreign Language Proficiency is also required for graduation from all departmental degree programs.

EXHIBIT 1-3

nc state ENGINEERING

General Education Program (GEP) Requirements in the *Humanities, Social Sciences, Visual & Performing Arts, and Interdisciplinary Perspectives*

A total of ***seven courses (21 credit hours)*** from the appropriate GEP category list is required. These courses may be taken in any order. All of the courses must be completed for a letter grade; none of the seven courses may be taken as pass / fail or credit only grading.

Some courses will have a USD or GK indicator. The USD or GK code identifies courses that will not only fulfill the specific GEP category in which it is listed but will also satisfy either the U.S. Diversity (USD) or Global Knowledge (GK) GEP co-requisites.

Students should consider the GEP web site the authoritative source for approved courses and requirements. This document is provided merely as a planning tool. **http://www.ncsu.edu/uap/academic-standards/gep/index.html**

Category	Course	Double Counting *GK*	*USD*	*Major*
Humanities				
http://www.ncsu.edu/uap/academic-standards/gep/courselists/humanities/humanitiescourses.html				
Two courses from different disciplines:				
Special Major Requirements: ME & AE majors may select PHI 214 or PHI 375 (GK) to fulfill Ethics requirement **OR** see Interdisciplinary Perspectives Requirements MSE majors may select PHI 214, PHI 221, PHI 375 (GK) or PHI/STS 325 (USD) to fulfill Ethics requirement **OR** see Interdisciplinary Perspectives Requirements				
Social Sciences				
http://www.ncsu.edu/uap/academic-standards/gep/courselists/socscience/socscicourses.html				
Introductory Economics	**EC 205/201 or ARE 201**			**YES**
Social Science course from discipline other than Economics				
Special Major Requirements ENE majors select PS 336 (GK) or PS 320.				
Interdisciplinary Perspectives				
http://www.ncsu.edu/uap/academic-standards/gep/courselists/ip/ipcourses.html				
Two courses:				
Special Major Requirements BE majors select IDS 201 (GK) or STS 302 (GK), STS 304, STS 320; PHI 422 (USD) IE & IEF majors select IDS 201 (GK), IDS 303 (GK) or STS 214, STS 302, STS 304, STS 320, STS 322, STS 325 AE & ME majors select STS 302 (GK), STS 304, STS 320 to fulfill Ethics requirement **OR** see Humanities Requirements MSE majors select IDS 201 (GK), STS 302 (GK), STS 304, STS 320, STS/PHI 325 (USD) to fulfill Ethics requirement **OR** see Humanities Requirements				
Additional Breadth				
http://www.ncsu.edu/uap/academic-standards/gep/courselists/humanities/humanitiescourses.html http://www.ncsu.edu/uap/academic-standards/gep/courselists/socscience/socscicourses.html http://www.ncsu.edu/uap/academic-standards/gep/courselists/vpa/vpacourses.html				
One course from either Humanities, Social Sciences or Visual & Performing Arts				**NO**
Co-requisites				
US Diversity (USD)				
http://www.ncsu.edu/uap/academic-standards/gep/courselists/coreq/usdcourses.html				
Global Knowledge (GK)				
http://www.ncsu.edu/uap/academic-standards/gep/courselists/coreq/gkcourses.html				

EXHIBIT 1-4

LONG-RANGE ADVISING PLANNING FORM
Department of Materials Science and Engineering

Name: ________________________ **Reviewed/date:** __________ _______________
__________ _______________
Student ID: ____________________ __________ _______________

FALL 2_____	Cr Hrs		SPRING 2_____	Cr Hrs		SUMMER 2_____	Cr Hrs
Total			**Total**			**Total**	

FALL 2_____	Cr Hrs		SPRING 2_____	Cr Hrs		SUMMER 2_____	Cr Hrs
Total			**Total**			**Total**	

FALL 2_____	Cr Hrs		SPRING 2_____	Cr Hrs		SUMMER 2_____	Cr Hrs
Total			**Total**			**Total**	

FALL 2_____	Cr Hrs		SPRING 2_____	Cr Hrs		SUMMER 2_____	Cr Hrs
Total			**Total**			**Total**	

EXHIBIT 1-5

APPLICATION FOR DEGREE IN THE COLLEGE OF ENGINEERING

Please print in ink.

000_______________ _______________ _______________
Student ID Number Department Curriculum Code

____
Last Name First Name Middle Suffix

____
Student Email Address

University Policy, consistent with the laws of the State of North Carolina, requires that the name on the Diploma be the same as that on the official University records. Titles, nicknames, and initials will NOT be used.

Semester to be awarded: (Insert year) **Date applied for graduation on MyPack** ____________

Spring Semester ________
Summer Session I ________
Summer Session II ________
Fall Semester ________

Are you applying for two degrees awarded on the same date? ______(No)______ (Yes)
If yes, write degree and complete an application for the second degree. ____________________
Are you completing requirements for an academic minor? _____(No) _____(Yes)
Minor application completed? ______(No) ______(Yes)
If so, indicate minor(s): ____
Have you earned another degree at NCSU? _____ (No) ______(Yes)

Course(s) with incomplete grade(s): ____

Courses in progress:

Current Semester ____________ (Date) **Final Semester** ____________ (Date)

____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

____________________ __________
Signature of Applicant Date

APPROVED: ______________________________
Signature of Adviser Date

APPROVED: ______________________________
Signature of Dept. Head Date

Section for use by the Department/College

Overall GPA ________ **Major GPA** ________

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission statements

The mission statement for North Carolina State University can be found on the NCSU website at

http://www2.acs.ncsu.edu/UPA/strategicplan/mission.htm

Mission statement
North Carolina State University

The mission of North Carolina State University is to serve its students and the people of North Carolina as a doctoral/research-extensive, land-grant university. Through the active integration of teaching, research, extension, and engagement, North Carolina State University creates an innovative learning environment that stresses mastery of fundamentals, intellectual discipline, creativity, problem solving, and responsibility. Enhancing its historic strengths in agriculture, science, and engineering with a commitment to excellence in a comprehensive range of academic disciplines, North Carolina State University provides leadership for intellectual, cultural, social, economic, and technological development within the state, the nation, and the world.

The mission statement for the College of Engineering can be found on the COE website at

http://www.engr.ncsu.edu/news/about/mission.html

Mission statement
College of Engineering

The College of Engineering at NC State University leads discovery, learning and innovation by creating and disseminating knowledge, empowering significant advances in technology, and driving economic development for the welfare of the state, the nation and the world.

The mission statement for the Materials Science and Engineering program can be found on the MSE website at

http://www.mse.ncsu.edu/undergrads/about

Mission statement
Materials Science and Engineering Department

The mission of the NCSU Department of Materials Science and Engineering is to provide students with a sound materials engineering education, advance the understanding and application of scientific principles, enhance economic development, and improve the quality of life of our citizens through teaching, research, and outreach programs. In addition to ensuring that our students are exposed to modern materials engineering principles and have access to modern equipment and technology to support their educational experience, the Department seeks to create a team-oriented environment throughout our academic enterprise. Our goal is to produce well-rounded materials engineers who can function effectively in the technical arena as well as possess the skills to assume leadership roles in industry, academia, and government.

B. Program educational objectives

The MSE Faculty, in consultation with its constituencies, have identified four broad Program Educational Objectives (PEOs) as listed below. These are published on the MSE website at

http://www.mse.ncsu.edu/undergrads/program-objectives

They are also published online in the NC State Undergraduate Course Catalog under the Engineering link at

http://www.ncsu.edu/registrar/guides/ugc/index.html.

MSE PROGRAM EDUCATIONAL OBJECTIVES

The MSE program at NCSU prepares their B.S. graduates to achieve the following career and professional goals:

1. Apply their basic MSE knowledge and skills to problems and challenges encountered in their professional careers.

2. Use modern analytical equipment and methods as needed for materials testing, design, processing, development and research.

3. Communicate well orally and in writing, interact professionally and work effectively on multi-disciplinary teams to achieve design and project objectives.

4. Engage in lifelong learning in their profession and practice professional and ethical responsibility.

C. Consistency of the PEOs with the mission of the institution.

In addition to their mission statements, the College of Engineering and NC State University have published additional statements of purpose which are listed below along with the websites where the complete documents can be found. These documents are referenced in this section as the MSE PEOs are compared with the missions of NC State University and the College of Engineering.

NC State University Strategic Plan (2006)
http://www2.acs.ncsu.edu/UPA/strategicplan/index.htm

College of Engineering Long-Term Goals
http://www.engr.ncsu.edu/news/about/future.html

College of Engineering Core Values and Guiding Principles
http://www.engr.ncsu.edu/news/about/mission.html

All of the MSE PEOs enable NC State University to attain its mission, which "…creates an innovative learning environment that stresses mastery of fundamentals, intellectual discipline, creativity, problem solving, and responsibility". The MSE PEOs are also consistent with the

COE mission statement, which "....leads discovery, learning and innovation by creating and disseminating knowledge....", and the MSE departmental mission statement, which seeks to "....provide students with a sound materials engineering education, advance the understanding and application of scientific principles....". Other specific ways in which each MSE PEO relates to the mission of the University, College of Engineering and MSE department are listed below.

1. Apply their basic MSE knowledge and skills to problems and challenges encountered in their professional careers.

From the *NC State University Strategic Plan:* "....NC State needs to build outstanding research, teaching and outreach programs in areas of identified state and national needs.....and reinvigorate the undergraduate experience." "....emphasize science, technology, engineering and mathematics...."

From the *College of Engineering Long Term Goals:* "We will provide relevant, world-class education for students to enable their professional and personal success, ..."

From the *College of Engineering Core Values and Guiding Principles:* "We believe that by empowering students to be independent and to pose, address and find innovative solutions to problems, they have the necessary tools to succeed....."

2. Use modern analytical equipment and methods as needed for materials testing, design, processing, development and research.

From the *University Mission Statement:* "Enhancing its historic strengths in agriculture, science and engineering with a commitment to excellence in a comprehensive range of academic disciplines."

From the *NC State University Strategic Plan:* "....we will offer well-integrated programs....in a technology-rich learning environment."

From the *College of Engineering Long Term Goals:* "We will develop world-class facilities for interdisciplinary research and education."

From the *MSE Mission Statement:* "....ensuring that our students are exposed to modern engineering principles and have access to modern equipment and technology to support their educational experience...."

3. Communicate well orally and in writing, interact professionally and work effectively on multi-disciplinary teams to achieve design and project objectives.

From the *NC State University Strategic Plan* (regarding students): "We will help them develop critical thinking and communication skills...."

From the *MSE Mission Statement:* "....the Department seeks to create a team-oriented environment throughout our academic enterprise."

4. **Engage in lifelong learning in their profession and practice professional and ethical responsibility.**

From the *NC State University Strategic Plan:* "....we seek to give students a....foundation for a lifetime of learning." We will "....conduct ourselves according to the highest ethical principles...."

From the *College of Engineering Long Term Goals:* "....We will....promote social responsibility and promote lifelong involvement...."

From the *College of Engineering Core Values and Guiding Principles:* "We value honesty, integrity and insist on ethical behavior...." "We value discovery and lifetime learning...."

From the *MSE Mission Statement:* "Our goal is to produce well-rounded engineers who can function effectively in the technical arena as well as possess the skills to assume leadership roles in industry, academia, and government."

D. Program constituencies

The constituencies of the Materials Science and Engineering Program at NCSU have been identified as:

- the current MSE graduating senior class
- the MSE alumni
- the MSE faculty
- the MSE Academic Advisory Committee (AAC)

At the time of the previous ABET visit in 2004, the MSE AAC consisted of 13 distinguished materials scientists and engineers from industry, academia and professional societies as listed in Exhibit 2-1. With the arrival of a new MSE department head in 2009, a new MSE AAC committee is being formed. The proposed membership of this committee is listed in Exhibit 2-2 and the first meeting with this committee is being scheduled for September 2010.

E. Process for establishing program educational objectives

The MSE Program Educational Objectives were initially drafted by the MSE ABET Committee in 2001. The MSE ABET committee consists of the following faculty:

MSE ABET Committee

C. Maurice Balik (chair)	Professor and Director of Undergraduate Programs in MSE
J. Michael Rigsbee	Previous MSE Department Head
Carl C. Koch	Previous MSE Associate Department Head and former EAC Team Chair
Keith Dawes	Teaching Professor and MSE Senior Design Course Coordinator

The original set of MSE PEOs consisted of six objectives which were reviewed and approved by the MSE faculty and the MSE AAC. These PEOs were in place for the previous ABET visit to

NCSU in 2004, and are listed below for comparison.

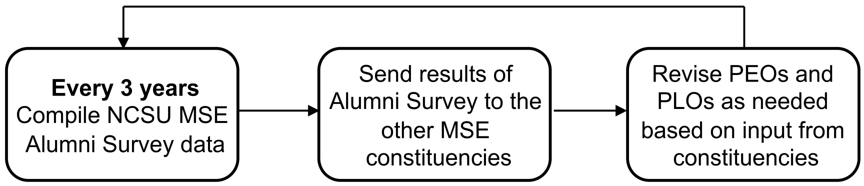
Original MSE Program Educational Objectives

1. To produce graduates who are able to apply the principles of mathematics, science, and engineering, so they are prepared for entry level engineering jobs or graduate school.
2. To produce graduates who are knowledgeable about a variety of engineering materials (including metals, semiconductors, ceramics, polymers, and composites), and the relationships among processing, structure, properties, and performance.
3. To produce graduates who are able to define and solve problems, especially those involving materials selection and design, and are capable of developing, implementing and evaluating solutions via integration of their basic scientific skills and knowledge.
4. To produce graduates who are able to communicate effectively and who demonstrate the ability to function on multi-disciplinary teams.
5. To produce graduates who are skilled at using modern engineering tools for characterization, analysis and design of materials.
6. To produce graduates who are able to understand their responsibility to their profession and society in a global context and who are prepared for and realize the importance of life-long learning.

In 2006, ABET redefined and clarified the nature of PEOs to differentiate them from Program Learning Outcomes. PEOs were defined as broader goals to be achieved by BS graduates several years after receiving their degrees, whereas Program Learning Outcomes are more specific goals to be achieved by graduation. To respond to this clarification from ABET, the engineering programs at NCSU decided to review and revise their PEOs as necessary to ensure they were in compliance with the current interpretation of PEOs. As part of this effort, the MSE department revised their PEOs somewhat and reduced the number from six to four. The revised PEOs are those shown above in Section B. These were reviewed and approved by the MSE ABET committee and the MSE faculty at the spring 2007 faculty retreat.

The assessment (and revision, if necessary) of the MSE PEOs takes place on a three-year cycle and includes all of the constituencies of the MSE program. The three-year cycle was chosen to coincide with the frequency of the NCSU Alumni Survey, from which data for the PEO assessment is taken. The number of MSE graduates in recent years has been small (10-20), thus a three-year cycle also provides a more statistically relevant sample of alumni. Finally, each alumni survey targets alumni who graduated three to six years before the survey date. Thus, these alumni have been in the workforce for several years, which is a sufficient length of time for them to assess their educational preparation for achieving the PEOs. The MSE PEO assessment process is illustrated and described in the flowchart below.

MSE PEO ASSESSMENT FLOWCHART



The MSE PEO assessment process consists of the following steps.

1. Collect NCSU Alumni Survey data from MSE alumni that indicates how they feel their education at NCSU has prepared them for their careers.
2. Map related survey questions to the MSE Program Educational Objectives.
3. Assess the results of this mapping. This constitutes the review of the MSE PEOs by the MSE alumni.
4. Send the results of the assessment in (3) to the other MSE program constituencies and ask for their input and recommendations.
5. Revise the MSE PEOs as needed.

F. Achievement of program educational objectives

The MSE PEOs were reviewed in the 2006-07 and the 2009-10 academic years. The survey instruments used for this purpose were the 2006 and 2009 NCSU Baccalaureate Alumni Survey which consists of three parts. The first part is the main survey containing very general questions meant to address all NCSU graduates. Of more interest to us are the College of Engineering and MSE Inserts. These two parts of the Alumni Survey contain questions specific to engineering majors and to MSE majors, respectively. The MSE Insert directly addresses the MSE Program Learning Outcomes which are related to the MSE Program Educational Objectives (see Exhibit 2-3 and Section 3). The College of Engineering Insert addresses the general ABET Criteria 3 program outcomes *a* through *k,* as well as other outcomes specific to the engineering programs at NCSU.

2006 Alumni survey results
The 2006 NCSU Alumni Survey targeted alumni who received their BS degrees between summer 2000 and spring 2003. A total of 766 engineering alumni responded to this survey, including 21 MSE graduates. The parts of the survey used in the assessment of the MSE PEOs are the College of Engineering Insert and the MSE Insert. The relationship between the MSE PEOs and the COE/MSE Insert questions is shown in Exhibit 2-3.

Alumni rated how well NCSU prepared them for the topics addressed by the survey questions on a scale from 1 (poor) to 5 (excellent). The mean ratings MSE alumni gave for the MSE Insert questions are shown in Figure 2-1. The MSE and COE alumni ratings for the COE Insert questions are compared in Figure 2-2. The survey questions are grouped according to MSE PEO by the dashed lines. In general, our alumni rate their preparation for achieving the MSE PEOs as good to very good. Figure 2-2 shows that MSE alumni also feel they have been prepared as well or better than other COE engineering graduates. The MSE scores are higher than the COE scores for 7 out of the 12 questions. MSE alumni rated their preparation for outcome 4 slightly lower than other COE alumni.

FIGURE 2-1. 2006 NCSU ALUMNI SURVEY
MSE INSERT RESULTS

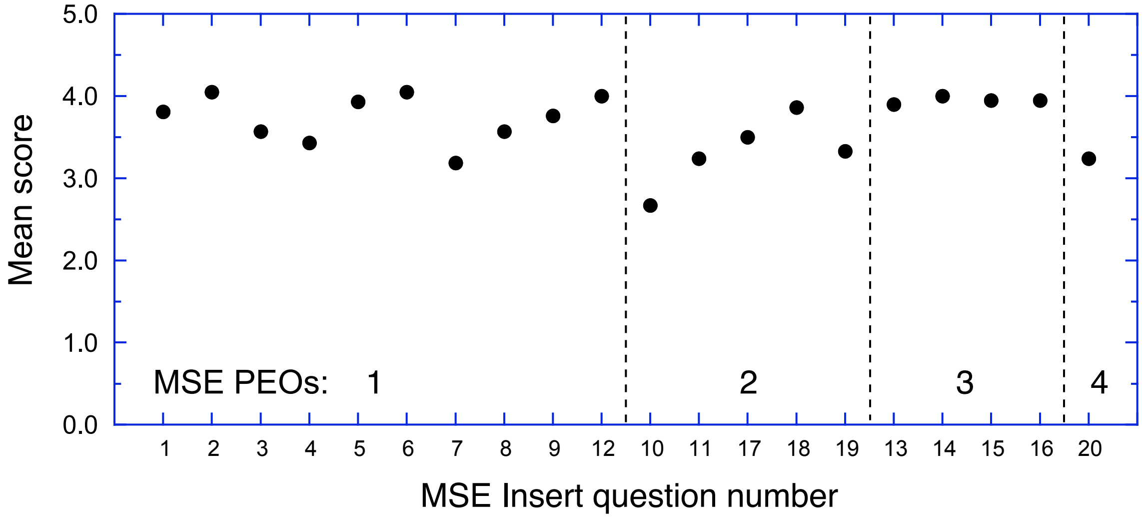


Figure 2-1. Mean scores from 21 MSE alumni responding to the MSE Insert questions on the 2006 NCSU Alumni Survey. Survey questions are grouped according to MSE PEO by the dashed lines. See Exhibit 2-3 for a description of the questions. Scale: 1 = poor, 2 = fair, 3 = good, 4= very good, 5 = excellent preparation.

FIGURE 2-2. 2006 NCSU ALUMNI SURVEY
COE INSERT RESULTS

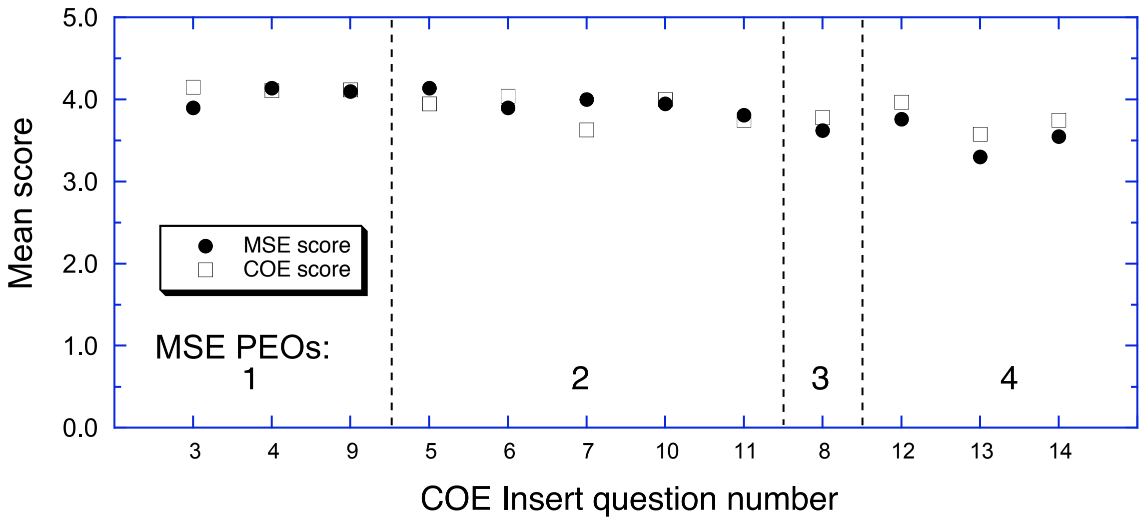


Figure 2. Mean scores from 21 MSE alumni (circles) and 766 COE alumni (squares) responding to the COE Insert questions on the 2006 NCSU Alumni Survey. Survey questions are grouped according to MSE PEO by the dashed lines. See Exhibit 2-3 for a description of the questions. Scale: 1 = poor, 2 = fair, 3 = good, 4= very good, 5 = excellent preparation.

Assessment of MSE PEOs by the other MSE program constituencies (2006-07)
The alumni survey data in Figures 2-1 and 2-2 were sent to the other MSE program constituencies for review and assessment. After reviewing the alumni survey data, these constituents were asked to respond to the three questions listed in the left column of Table 2-1 below. The alumni survey data was also posted on a website and an online response form was created to simplify the process for the MSE AAC members around the country. The number of respondents was 11 faculty (61%), 12 graduating seniors (100%) and 4 MSE AAC members (31%). Representative comments written in response to the questions are compiled below the table.

TABLE 2-1. Response of MSE constituencies to the 2006 alumni survey data

Question	MSE faculty	MSE graduating seniors	MSE AAC committee
1. Based on the Alumni Survey data and any experience you may have with our students and alumni, do you feel that the MSE program is achieving its PEOs? If not, which PEOs are of concern to you?	100% yes	100% yes	100% yes
2. Do you feel that the revisions made to the MSE PEOs are appropriate? If not, what additions, deletions or modifications do you suggest?	100% yes	92% yes	100% yes
3. Please list any other recommendations you have for the MSE program at NCSU.	see comments below	see comments below	see comments below

Comments from question 1: MSE AAC
- The lowest scoring area related to use of computer modeling to solve materials problems. Perception regarding the use of computers to solve problems changes after exiting school- I suspect that lower score is an artifact.
- Overall, the department is performing well in achieving its PEOs. Some additional strengthening of computational modeling instruction and additional emphasis on ceramic materials (including electronic, optical and magnetic properties) would be useful.

Comments from question 2: MSE AAC
- They appear to be just a refinement of the intent and no real significant change.
- The objectives are solid- OK consolidation.

Comments from question 3: MSE AAC
- Keep up the good work
- It is useful, from an industrial perspective, for students to have some formal awareness of the structure of problem solving processes. This is an aspect of the COE questions voiced as “ability to identify, formulate and solve” in COE question 9.
- The alumni responses suggest some strengthening is needed in a few selected areas (those that scored near or below 3.0 on the alumni survey, such as use of computational tools).

Comments from question 3: MSE faculty

- As we go through the next set of curriculum revisions, we will need to pay more attention to the engineer in economic, social and global contexts. There is going to be pressure to include “innovativeness” of our engineers within these contexts.
- The program applies also to global and environmental aspects of the economy.

Comments from question 3: MSE graduating seniors

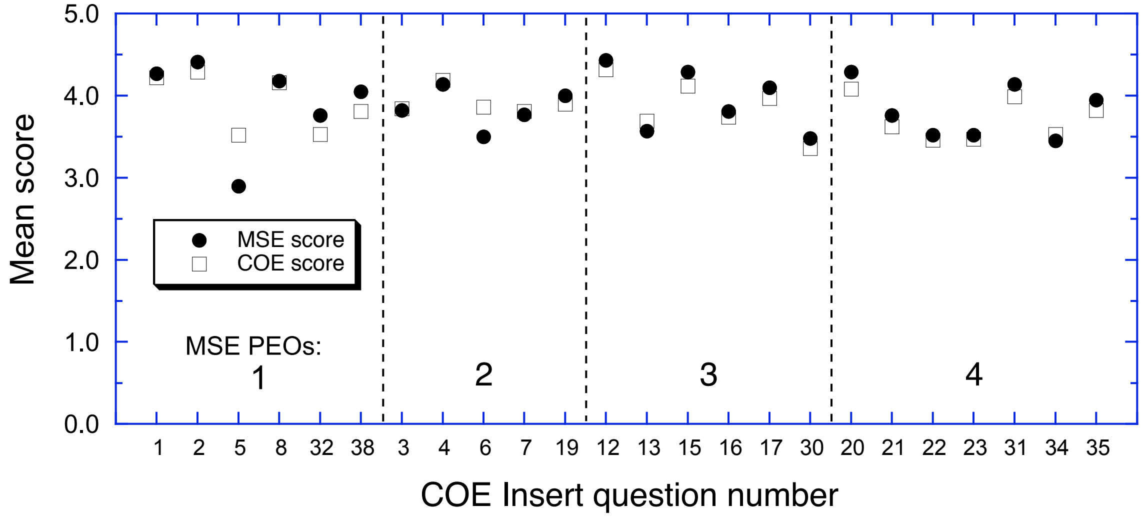
- I feel as if more technical electives should be offered in the MSE program so students can choose a focus between metals, polymers, ceramics or electronics.
- More carefully consider which professors should teach which classes. Some professors focus more on formulas and equations than on concepts.
- Encourage students to take five years to complete their degree. While graduating in four years is possible, it does not allow the student to take any courses beyond those required by the curriculum.
- I think I got an excellent education here, and I am very satisfied with my overall experience. I especially appreciate the undergraduate research opportunities within the department.
- Safety course for lab work; more hands-on examples of materials.
- Focus more on learning the concepts rather than spending a long time on all the math. We took plenty of math courses and shouldn’t be in other courses if we can’t manipulate equations. But do teach where to go to find the equations or other data on the subject.
- Some students including myself would like to design and conduct a senior design project of our own. The senior design class could brainstorm and come up with ideas to be approved by faculty, and then incorporate industrial contacts. This process would most likely take more time, however I believe that the senior design project would be more meaningful in the end. This could allow the student to have a senior design project that would give them experience in the industry that they want to get into.

2009 Alumni survey results

The 2009 NCSU Alumni Survey targeted alumni who received their BS degrees between summer 2003 and spring 2006. A total of 569 engineering alumni responded to this survey, including 23 MSE graduates. The COE Insert questions were revised significantly in the 2009 survey and are now more closely aligned with the MSE program learning outcomes. Therefore, the MSE Insert was not used in this survey. The relationship between the MSE PEOs and the 2009 COE Insert questions is shown in Exhibit 2-4.

Alumni rated how well NCSU prepared them for the topics addressed by the survey questions on a scale from 1 (poor) to 5 (excellent). The mean scores given by MSE and COE alumni are compared in Figure 2-3. The survey questions are grouped according to MSE PEO by the dashed lines. In general, our alumni rate their preparation for achieving the MSE PEOs as good to very good. The MSE alumni also feel they have been prepared as well or better than other COE alumni for each outcome as a whole. MSE scores are higher than the COE scores for 17 out of the 24 questions. The only significantly lower MSE scores are for questions 5 and 6, which deal with use of statistical procedures and design of a system to meet desired needs, respectively.

FIGURE 2-3. 2009 NCSU ALUMNI SURVEY
COE INSERT RESULTS



Mean scores from 23 MSE alumni and 569 COE alumni responding to the COE Insert questions on the 2009 NCSU Alumni Survey. Survey questions are grouped according to MSE PEO by the dashed lines. See Exhibit 2-4 for a description of the questions. Scale: 1 = poor, 2 = fair, 3 = good, 4= very good, 5 = excellent preparation.

Assessment of MSE PEOs by the other MSE program constituencies (2009-10)

A procedure similar to the one used in 2006 was followed with the 2009 alumni survey data. The alumni survey data in Figure 2-3 were sent to the other MSE program constituencies for review and assessment, then they responded to the three questions listed in the left column of Table 2-2 below. The number of respondents was 17 faculty (71%) and 42 graduating seniors (100%), which includes all students from the classes of 2008, 2009 and 2010. The MSE AAC is currently being reconstituted with new members so this group was not contacted. Results are shown in Table 2-2 and comments written in response to the questions are compiled below the table. The responses listed for the graduating seniors are taken from the most recent class of 2010.

TABLE 2-2. Response of MSE constituencies to the 2009 alumni survey data

Question	MSE faculty	MSE graduating seniors
1. Based on the Alumni Survey data and any experience you may have with our students and alumni, do you feel that the MSE program is achieving its PEOs? If not, which PEOs are of concern to you?	100% yes	95% yes
2. Do you feel that the MSE PEOs are appropriate as listed? If not, what additions, deletions or modifications do you suggest?	100% yes	98% yes
3. Please list any other recommendations you have for the MSE program at NCSU.	see comments below	see comments below

Comments from question 1: MSE faculty

- From the survey everything looks alright. I am not sure about PEO #4 and how it is assessed.
- Yes on average. Some basic statistical methods should be stressed/applied in labs.

Comments from question 1: MSE graduating seniors

- I believe we should work more in interdisciplinary teams. By working with other engineering majors, we could better understand other's curriculum and knowledge base.
- Perhaps include more chances for team projects before senior year.
- MSE PEO #2 was a concern for me because I felt that when I was being taught how to use them that some of the instructors and professors had a tendency to assume I knew more information than I actually did. This gave way too much confusion for me and not a good understanding of how to use some of the equipment and tools.
- I feel very prepared for going to graduate school, but very unprepared for an engineering job. I feel like more real-world experience is needed, and more projects with an engineering goal before senior design.
- I feel that groups 2, 3 and 4 are met very nicely. Being a small department, Group 3 is important to get to know your fellow students and this helps one learn to communicate on a scientific level through the undergraduate process. Group 2 was also approached very directly through the many labs, giving us much insight to the machines and testing abilities available.
- I believe my journey through the MSE curriculum has prepared me for any challenge I will face in my professional career. With the myriad of labs and reports, I have developed a thorough, hands-on approach and a refined technical writing style. My interest in the topics in which I have been taught will certainly drive me to learn throughout my life.

Comments from question 2: MSE graduating seniors

- Yes, I feel like these PEOs are very well organized in what we as students should bring out of college in respect to knowledge and social skills.
- I would add in providing resources to struggling students other than a professor's office hours.

Comments from question 3: MSE graduating seniors

- I am afraid that I may not be prepared for an engineering career in the field. We should learn more about materials applications.
- I would like to see more application-oriented teaching so that it is easier to see how what we are learning can be used.
- If possible, add more courses/bigger course selection. Add MSE summer courses.
- It would be nice if composite materials were integrated into some of the sophomore/junior level classes. It would be really neat if students could choose a concentration in a specific material and take classes more targeted towards their concentration.
- Schedule labs after the selected topic has been covered in the lecture class, not before.
- Don't schedule two lab courses in one semester.

- More group projects since most engineers work as a team in their professional jobs. Less emphasis on metal materials and more emphasis (or any emphasis) on nanotechnology and emerging materials. More examples of applications of materials.
- I would like to have seen classes a little more structured. Websites that maybe had an estimated schedule with homeworks and due dates available. Also would have enjoyed more useful homework. Some classes did not have any where I felt it might have been advantageous. While other classes had homework that did not relate to our learnings nor did it prepare or enlighten us to what would be on an exam.
- I somewhat disagree with the change in the number of lab courses in the new curriculum. While I understand that we did similar labs for different classes, it was the experience in the lab and the experience of taking the data and writing a report that I think benefitted me the most. So, the more labs the better.
- More emphasis on composites. The new curriculum's lab requirements are not enough and the physical metallurgy class should have stayed.
- I would create a MSE tutoring center, professors are not always available and sometimes can't answer a question. MSE needs another place where students can go to get help.

Recommendations and revisions
In both the 2006 and 2009 alumni surveys, the MSE alumni rated their preparation for achieving the MSE PEOs as good to very good and on a par with other NCSU engineering alumni. The response of the other MSE constituencies was nearly unanimous in favor of the changes made to the MSE PEOs and they all agreed that the MSE program was achieving its PEOs. Based on the overall positive results from the four MSE constituencies, no changes have been made to our PEOs at this time.

Most of the comments from faculty and students were concerned more with the MSE curricular content rather than the PEOs themselves. Some of these comments have been addressed in our latest curriculum revision, described in Section 4. A summary of the changes which are relevant to the PEO assessment and comments are listed below.

- A 1 credit hour lab safety course (MSE 490 special topics-lab safety) has been added to the undergraduate course offerings. This is an optional course for most students, but it is required for any student who conducts an undergraduate research project or does extensive lab work outside of the normal curriculum requirements. Lab safety instruction is an integral part of all required undergraduate lab courses.
- The new MSE curriculum includes more technical electives (5 instead of 3) and more courses can be chosen to satisfy these electives, including non-MSE courses. This change addresses concerns regarding the flexibility and lack of course choices in the MSE curriculum.
- Required and elective courses covering nanotechnology, biomaterials and other contemporary topics in MSE have been added to the new curriculum.
- To address the lower scores on the statistics questions in Figure 2-3, coverage of design of experiments methods is provided in the first semester of the senior design sequence

(MSE 423). In the new MSE curriculum, students also have the option of taking a statistics elective course (ST 370).

- The laboratory courses in the new curriculum are self-contained and are no longer associated with any particular lecture course. Background material needed to understand the principles of each experiment are covered as part of the lab class.
- The laboratory classes have been reorganized so that one lab (MSE 255) covers methods used to characterize the structure of materials, while the second lab (MSE 335) covers methods that characterize the properties of materials. Since different analytical tools are used for each lab course, overlapping content between lab courses will be eliminated.

EXHIBIT 2-1
FORMER MSE ACADEMIC ADVISORY COMMITTEE

Name	Position	Email address
Professor Reza Abbaschian	Dept. of Materials Science and Eng. University of Florida	rabba@mse.ufl.edu
Mr. John B. Ballance	Executive Director Materials Research Society	ballance@mrs.org
Dr. Everett E. Bloom	Division Director, Metals and Ceramics Oak Ridge National Laboratory	bloomee@ornl.gov
Professor G. S. Cargill (Slade)	Department of Materials Science and Eng. Lehigh University	Gsc3@lehigh.edu
Dr. W. Raymond Cribb (Ray)	Director of Technology Brush Wellman Inc.	rcribb@brushwellman.com
Professor M. C. Flemings (Mert)	Toyota Professor, Dept. of Materials Sci. & Eng. Massachusetts Institute of Technology	flemings@mit.edu
Professor Jeffrey T. Glass	Director, Master of Eng. Management Program Duke School of Engineering, Duke University	jeff.glass@duke.edu
Professor E. J. Kramer (Ed)	Materials Department University of California – Santa Barbara	edkramer@mrl.ucsb.edu
Dr. Walter F. Lange (Walt)	Associate Director Wireless Products IBM Corporation	wlange@us.ibm.com
Professor Harry J. Leamy	Director, Cameron Applied Research Center University of North Carolina at Charlotte	hjleamy@uncc.edu
Professor Linda C. Lucas	Dean, School of Engineering The University of Alabama at Birmingham	llucas@eng.uab.edu
Professor Carolyn W. Meyers	Vice Chancellor for Academic Affairs North Carolina A & T State University	cmeyers@ncat.edu
Dr. John W. Palmour	CREE Incorporated	john_palmour@cree.com

EXHIBIT 2-2
PROPOSED NEW MSE ACADEMIC ADVISORY COMMITTEE

Name	**Affiliation**
Steve Zinkle	Oak Ridge National Lab
Don Gubser	Naval Research Lab
Stephen Streiffer	Argonne National Lab
Barry Farmer	Air Force Research Lab
Kristi Anseth	University of Colorado
Sid Yip	Massachusetts Institute of Technology
Jennifer Lewis	University of Illinois Urbana-Champaign
Julie Trenor	Clemson University
Robert Snyder	Georgia Institute of Technology
Ed Kramer	University of California Santa Barbara
John Edmond	CREE Inc.
John DuPlessis	retired alumnus of MSE
John Fan	Kopin Corp.
INVITED BUT NOT YET ACCEPTED	
Theresa Kotanchek	Dow Chemical
Patrick O’Callaghan	DuPont Microelectronics
Steve Wilcenski	MEMSCAP USA
Robert Shaddock	Tyco Electronics
Chris Story	Commscope
Jacob Hooks	Eaton Corp.

EXHIBIT 2-3
MAPPING OF 2006 MSE INSERT AND COE INSERT QUESTIONS TO MSE PROGRAM EDUCATIONAL OBJECTIVES

MSE PEOs **The MSE program at NCSU prepares their BS graduates to achieve the following career and professional objectives:**	**MSE Insert questions corresponding to MSE program learning outcomes**	**COE Insert questions**
1. Apply their basic MSE knowledge and skills to problems and challenges encountered in engineering jobs or graduate school.	1. The ability to apply the basic mathematical skills needed to solve routine problems within the discipline of MSE. 2. The ability to apply the principles of chemistry and physics that are related to MSE. 3. The ability to apply the principles of engineering thermodynamics that are related to MSE. 4. The ability to apply the principles of statics and solid mechanics that are related to MSE. 5. The background necessary to be accepted into reputable graduate schools in MSE or a related field. 6. The ability to identify the structure-processing-property-performance relationships for metallic materials. 7. The ability to identify the structure-processing-property-performance relationships for ceramic materials. 8. The ability to identify the structure-processing-property-performance relationships for polymeric materials. 9. The ability to identify the structure-processing-property-performance relationships for electronic materials. 12. The ability to articulate the basic processing methods for selected classes of materials that interest you and how processing parameters can affect structure and properties.	3. The ability to apply knowledge from your major in engineering or computer science. 4. The ability to apply knowledge of mathematics and science. 9. The ability to identify, formulate and solve engineering or computer science problems.

EXHIBIT 2-3 (continued)

MSE PEOs **The MSE program at NCSU prepares their BS graduates to achieve the following career and professional objectives:**	**MSE Insert questions**	**COE Insert questions**
2. Use modern analytical equipment and other engineering tools as needed for materials testing, design, development and research.	10. The ability to use computer modeling and other computer-based tools to solve specific materials problems. 11. The ability to select an appropriate material for a given application. 17. The ability to apply basic microscopy and diffraction methods for analysis of the structure of materials at various size scales. 18. The ability to use appropriate methods for analyzing the mechanical and thermal properties of materials. 19. The ability to use appropriate methods for analyzing the electrical, magnetic, and optical properties of materials.	5. The ability to design and conduct experiments. 6. The ability to analyze and interpret data. 7. The ability to design a system, component or process to meet desired needs. 10. The ability to use the techniques and skills necessary of engineering or computer science practice. 11. The ability to use modern tools necessary for engineering or computer science practice.
3. Communicate well orally and in writing, interact professionally and work effectively on multi-disciplinary teams to achieve design and project objectives.	13. The ability to function on multi-disciplinary teams. 14. The ability to communicate orally with others within the discipline of MSE. 15. The ability to communicate through writing with others within the discipline of MSE. 16. The ability to use computers for oral and written communication.	8. The ability to function on multi-disciplinary teams.
4. Engage in lifelong learning in their profession and practice professional and ethical responsibility.	20. The development of an appreciation for contemporary issues.	12. An understanding of professional and ethical responsibility. 13. A broad education necessary to understand the impact of engineering solutions in a global and societal context. 14. A recognition of the need for, and ability to engage in lifelong learning.

EXHIBIT 2-4
MAPPING OF 2009 COE INSERT QUESTIONS
TO MSE PROGRAM EDUCATIONAL OBJECTIVES

MSE PEOs **The MSE program at NCSU prepares their BS graduates to achieve the following career and professional objectives:**	**COE Insert questions**
1. Apply their basic MSE knowledge and skills to problems and challenges encountered in engineering jobs or graduate school.	1. applying knowledge from your major in engineering or computer science 2. applying knowledge of mathematics and science 5. using statistical procedures 8. identifying, formulating and solving engineering or computer science problems 32. considering various career options relevant to the discipline 38. pursuing graduate education or a professional degree
2. Use modern analytical equipment and other engineering tools as needed for materials testing, design, development and research.	3. designing and conducting experiments 4. analyzing and interpreting data 6. designing a system, component or process to meet desired needs 7. testing a system and making improvements 19. using tools and equipment necessary for engineering or computer science practice
3. Communicate well orally and in writing, interact profesionally and work effectively on multi-disciplinary teams to achieve design and project objectives.	12. functioning as a member of a team 13. working on multidisciplinary teams 15. writing reports and other documents 16. making oral presentations 17. listening to and incorporating different perspectives and points of view 30. understanding and adapting to organizational culture(s)
4. Engage in lifelong learning in their profession and practice professional and ethical responsibility.	20. engaging in professional and ethical engineering practice 21. considering the societal impact of engineering solutions 22. considering the global impact of engineering solutions 23. considering the environmental impact of engineering solutions 31. developing a consistent work ethic 34. keeping abreast of developments and advances in the field 35. engaging in lifelong learning, whether formally and informally

CRITERION 3. PROGRAM OUTCOMES

A. Process for establishing and revising program outcomes

A total of 23 MSE Program Learning Outcomes (PLOs) were in place at the time of the 2004 ABET visit to NCSU. The MSE PLOs are reviewed once per year by the MSE ABET Committee and any revisions are presented to the MSE faculty for approval. Revisions to the PLOs since 2004 have attempted to minimize the number of PLOs while ensuring that they adequately address the Criterion 3 *a-k* outcomes and the materials science and engineering program criteria. The number of PLOs has been reduced to twenty through consolidation of the separate structure-property outcomes for polymers, metals, ceramics and electronic materials into a single structure-property outcome. Further revisions to the MSE PLOs are anticipated as a result of the MSE curriculum revision which began in 2009 (see Section 4).

B. MSE program outcomes

The MSE PEOs are shown below in boldface type while the PLOs appear in normal type under the PEO to which they relate. In this document, the MSE PLOs will be referred to with a number and a letter, *e.g.* Outcome 1a, which identifies both the PLO and the PEO to which it relates. The MSE PLOs are listed with the MSE PEOs on the MSE website at

http://www.mse.ncsu.edu/undergrads/program-objectives.

The MSE PLOs and PEOs are also listed in the NCSU online catalog at

http://www.ncsu.edu/registrar/guides/ugc/index.html.

MSE Program Educational Objectives
and
MSE Program Learning Outcomes

The MSE program at NCSU prepares their B.S. graduates to achieve the following career and professional goals:

1. **Apply their basic MSE knowledge and skills to problems and challenges encountered in their professional careers.**

   a. By graduation, students will be able to apply the basic mathematical skills needed to solve routine problems within the discipline of MSE.

   b. By graduation, students will be able to demonstrate knowledge of the principles of chemistry and physics relevant to MSE.

   c. By graduation, students will be able to demonstrate knowledge of engineering thermodynamics relevant to MSE.

   d. By graduation, students will be able to demonstrate knowledge of statics and solid mechanics relevant to MSE.

   e. By graduation, students will be able to identify the structure-property-performance relationships for metallic, ceramic, polymeric and microelectronic materials.

f. By graduation, students who desire to attend graduate school will be accepted into reputable MSE graduate programs.

2. **Use modern analytical equipment and methods as needed for materials testing, design, processing, development and research.**

   a. By graduation, students will be able to apply computer modeling programs and other computer-based tools to solve materials-related problems.

   b. By graduation, students will be able to select an appropriate material for a given application.

   c. By graduation, students will be able to apply basic microscopy and diffraction methods for analysis of the structure of materials at various size scales.

   d. By graduation, students will demonstrate familiarity with methods used to analyze mechanical and thermal properties of materials.

   e. By graduation, students will demonstrate familiarity with methods for characterizing the electrical and magnetic properties of materials.

   f. By graduation, students will be able to articulate the basic processing methods for selected classes of materials that interest them, and explain how processing parameters can affect structure and properties.

3. **Communicate well orally and in writing, interact professionally and work effectively on multi-disciplinary teams to achieve design and project objectives.**

   a. By graduation, students will be able to demonstrate team-oriented skills.

   b. By graduation, students will be able to communicate orally with others within the discipline of MSE.

   c. By graduation, students will be able to communicate through writing with others within the discipline of MSE.

   d. By graduation, students will be able to demonstrate basic computer skills for oral and written communication.

4. **Engage in lifelong learning in their profession and practice professional and ethical responsibility.**

   a. By graduation, students will develop an appreciation for contemporary issues.

   b. By graduation, students will develop an appreciation for professional and ethical responsibility.

   c. By graduation, students will develop an appreciation of the impact of engineering solutions on society and the environment in a global context.

   d. By graduation, students will develop an appreciation for the importance of life-long learning.

C. Relationship of the MSE program outcomes to the MSE program educational objectives

It should be clear after reading the MSE PEOs and PLOs above that the PLOs are directly related to the PEOs. Thus, achievement of the PLOs naturally facilitates achievement of the PEOs.

Relationship of the MSE PLOs to ABET Criterion 3 a-k outcomes
The MSE PLOs have been designed to be specific to the MSE program but still relate in a straightforward way to the ABET outcomes *a-k* listed in Criterion 3. A mapping of the MSE PLOs to the ABET outcomes is shown in Exhibit 3-1. All of the ABET outcomes are related to a minimum of one MSE PLO, and many of the ABET outcomes are related to multiple MSE PLOs. MSE outcome 1f dealing with preparation of students for graduate school does not appear in the ABET outcomes. A significant fraction of MSE BS graduates attend graduate school, so this is an important outcome for the NCSU MSE program. Since Exhibit 3-1 shows that there is a direct mapping of the MSE outcomes to the Criterion 3 outcomes, we consider the Criterion 3 outcomes to be met if the MSE outcomes are met.

Relationship of the MSE PLOs to the MSE program criteria
The MSE program criteria are listed below. A mapping of the MSE PLOs to the program criteria is displayed in Exhibit 3-2, where it can be seen that several MSE PLOs address each of the program criteria. The program criteria are encompassed by MSE PLOs 1a–1e and 2a–2f. MSE PLOs 1a–1e and 2f cover program criteria A and B. MSE PLOs 1a–1e, 2a and 2b cover program criterion C, while MSE PLOs 2a–2e cover program criterion D.

MSE Program Criteria

MSE programs must demonstrate that their graduates have:

A. an ability to apply advanced science and engineering concepts to materials systems,
B. an integrated understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing and performance,
C. an ability to apply and integrate knowledge from the above four elements to solve materials selection and design problems,
D. the ability to utilize experimental, statistical and computational methods consistent with the program educational objectives.

D. Relationship of courses in the curriculum to the program outcomes

The course-based assessment plan in use by the MSE program was developed in 2001 and was designed to create a natural connection between the courses and the MSE PLOs. All courses in the MSE curriculum serve to implement one or more outcomes, and most are also used to assess outcomes. Courses outside of the MSE curriculum (such as chemistry, physics and math) also serve to implement some of the MSE outcomes. Exhibit 3-3 summarizes how all of these courses fit into this scheme using a matrix format with courses across the top and MSE outcomes in the left column. Courses that serve to implement an outcome have an “I” in the corresponding box, while courses used to assess the outcome have an “A” in the corresponding box. The number of courses used to assess each outcome is based on a balance between course content relevant to the outcome and keeping the overall assessment effort manageable.

E. Documentation

The following materials will be available to the ABET evaluators during the visit:

- A notebook containing the PEO assessment data and individual response forms containing comments for the 2006-07 and 2009-10 PEO assessments.
- Notebooks with all of the raw PLO assessment data organized by MSE outcome and by MSE course number. Three separate notebooks will be provided containing assessment data from the 2004-06, 2006-08 and 2008-10 assessment cycles.
- A notebook containing the data, survey forms and interview forms from the annual MSE senior exit surveys for 2005 through 2010.
- Notebooks with examples of student work from each MSE course, organized by MSE outcome and MSE course number. The examples of student work provide verification of the topics covered by each course and the topics related to each MSE outcome.
- Deliverables from senior design projects completed by students in the MSE senior design course from 2005 through 2010. For each project, students provide a preliminary written proposal, a final written report, a final poster presentation and a final oral presentation with PowerPoint slides. The final oral presentation is also videotaped. Representative examples of these student deliverables and videos of the final presentations will be available for review.
- Textbooks or other teaching materials used for each of the MSE courses.

The MSE course-based PLO assessment process is described in detail in Section F below. Each MSE outcome is directly related to and assessed by selected content from one or more MSE courses. Therefore, relating the display materials to the MSE outcomes is a very straightforward process. For each outcome, evaluators can review the raw data used to assess that outcome, which is collected in the notebooks. An example of the raw data is given in Exhibit 3-4, where it can be seen that the homework or exam questions used for assessment are briefly described. This data specifically identifies the course topics used in the assessment process for each outcome. Data such as this is collected once every 2 years for all courses used to assess the MSE PLOs. For more insight into the contents of the MSE courses, the evaluator can review the course syllabi, course textbooks, other teaching materials or the notebooks containing examples of student work from each course.

F. Achievement of the program outcomes

Description of the MSE outcome assessment plan
The MSE PLO assessment plan involves a combination of direct and indirect assessment methods consisting of the following components:

1. **Scoring of specific homework and exam problems which assess the outcomes addressed by lecture-based courses.** An example of the data collected for this assessment method is shown in Exhibit 3-4 for MSE 350 (Mechanical Properties of Materials I). The course instructor selects 5 or more homework and exam problems which directly address the outcome being assessed. For each student in the class, these problems are scored as

"essentially correct" (1 assigned) or "not correct" (0 assigned). No score is entered for students who make no attempt to answer a selected problem. The total percentage of the problems answered correctly by the entire class is used as the metric for assessing these outcomes. The minimum percentage to be achieved is 75%. Data such as this is collected once every 2 years for all lecture courses involved in assessment of the MSE PLOs.

2. **Use of a lab report rubric designed to assess the outcomes addressed by laboratory-based courses.** All MSE laboratory courses require written reports for each experiment. These reports are designed to have a common format which allows the same rubric to be used to assess reports from different courses. The lab report rubric is shown in Exhibit 3-5. A scoring example for one of the experiments conducted in MSE 333 (Electronic Properties Lab) is shown in Exhibit 3-6 and the summary data for all experiments conducted in MSE 333 is shown in Exhibit 3-7. Each section of the lab report is scored from 1 (beginning) to 4 (exemplary). No score is entered for students who do not turn in a lab report. On the summary sheet, the overall percentage of the class scoring 3 or 4 in all sections of the rubric is used as the metric for assessing MSE outcome 3c (written communication). The overall percentage of the class scoring 3 or 4 in the Appearance/Formatting section of the rubric is used as the metric for assessing MSE outcome 3d (basic computer skills). The minimum percentage to be achieved in both cases is 75%. Data such as this is collected once every 2 years for all MSE lab courses.

   The lab report rubric is also used to assess outcomes which address the various materials characterization techniques taught in the laboratory courses (outcomes 2c, 2d and 2e). For this purpose, only the scores from the Abstract, Introduction, Experimental, Results, Discussion and Conclusions sections of the rubric are used. The overall percentage of the class scoring 3 or 4 in these six categories of the rubric is used as the metric for assessing these outcomes. This score is shown in Exhibit 3-6 as the "average for methodology". The minimum percentage to be achieved is 75%. Data such as this is collected once every 2 years for all MSE laboratory courses.

3. **Specialized rubrics and other methods are used to assess outcomes for courses that don't fall into categories 1 and 2 above.** This includes outcome 1f (grad school preparation), outcomes addressed by the senior design courses (MSE 423 and 424), outcomes addressed by the senior seminar course (MSE 491) and the "softer" outcomes 4a–4d. These are described below, and assessment data obtained from each of these rubrics will be available for review during the visit. This assessment data is collected once every 2 years except for the MSE senior exit survey data, which is collected every year.

   Outcome 2b (assessed in MSE 423). The materials selection outcome is assessed by an assignment in MSE 423 in which student teams prepare an oral report describing the process they used to select a material for a given application. Various aspects of the materials selection process are scored from 1 to 4. The overall percentage of teams scoring 3 or 4 on all aspects of the rubric is used as the metric for assessing this outcome. The minimum percentage to be achieved is 75%.

   Outcome 3a (assessed in MSE 424). Team skills are evaluated using a peer review approach near the end of the semester in MSE 424. Team members evaluate each other with a rubric on which attitude, communications, dependability, effort, maturity and response to deadlines are rated from 1 to 4. The percentage of 3 and 4 scores for the entire class is used as the metric for assessing this outcome. The minimum percentage to be achieved is 75%.

Outcome 3b (assessed in MSE 423 and 424). The oral communication outcome is assessed at the end of MSE 423 by the course instructor. A rubric is used which evaluates distracting mannerisms, clarity of speech, voice projection, eye contact and use of notes for each student. Each category is rated from 1 to 4, and the percentage of 3 and 4 scores for the entire class is used as the metric for assessing this outcome. A more extensive rubric is used at the end of MSE 424 to evaluate the final project oral presentations, and this evaluation is completed by a panel of judges which excludes the course instructor. The same 1 to 4 rating scale and metric is used. The minimum percentage to be achieved for both rubrics is 75%.

Outcome 3c (assessed in MSE 423, MSE 424 and MSE 491). The written communication outcome is assessed as described in (2) above using lab reports. In addition, it is also assessed at the end of MSE 423 using the written team proposals, at the end of MSE 424 using the written team project reports and in MSE 491. Rubrics evaluate various aspects of the written documents in MSE 423 and 424, and each aspect is rated from 1 to 4. The instructor of the course completes the rubric for the proposals in MSE 423. The same panel of judges which rates the oral presentations completes the rubric for the written reports in MSE 424. The percentage of 3 and 4 scores for all the teams is used as the metric for assessing this outcome. The minimum percentage to be achieved is 75%.

In MSE 491, students are required to attend 3 departmental seminars where they learn about contemporary issues in MSE. Short reports are submitted for each seminar, and these are evaluated on a scale of 1 to 4, based on the quality and clarity of the writing. The percentage of 3 and 4 scores for the entire class is used as the metric for assessing this outcome. The minimum percentage to be achieved is 75%. These same reports are used to assess outcome 4a (see below).

Outcome 4a (assessed in MSE 491 and the MSE senior exit survey). The contemporary issues outcome is assessed using the MSE 491 seminar reports described in the preceding paragraph. These reports are also evaluated for the level of understanding exhibited by the student for the seminar subject. A rating scale of 1 to 4 is used. The percentage of 3 and 4 scores for the entire class is used as the metric for assessing this outcome. The minimum percentage to be achieved is 75%. Outcome 4a is also assessed in the senior exit survey– see (4) below.

Outcomes 4b, 4c and 4d (assessed in the MSE senior exit survey). See (4) below.

Outcome 1f (assessed in the MSE senior exit survey). Preparation of MSE students for graduate school is assessed in the senior exit survey and by the acceptance of MSE students applying for graduate school into reputable institutions. Details are provided at the end of Section 3.

4. **All outcomes are assessed in the MSE Senior Exit Survey.** All graduating seniors complete this departmental survey which asks students to rate how well the MSE curriculum prepares them to meet each of the 20 MSE PLOs. Students also rate how balanced the MSE program is in terms of its coverage of the various materials classes (metals, ceramics, polymers, composites and electronic materials) and its coverage of the elements of materials science and engineering (structure, properties, processing and applications). Seniors are also individually interviewed and asked to comment about their experience in the MSE program. The survey and interviews provide a perception-based assessment of all the MSE outcomes, especially the "soft" outcomes which are not easily assessed otherwise (outcomes 4a–4d). A copy of the 2009 survey appears in Exhibit 3-8. Surveys from other years are nearly identical. A summary of the survey data obtained from the class of 2009 is shown in Exhibit 3-9. The percentage of graduating seniors who rate their preparation for each of the MSE PLOs as "good" or higher is used as the metric for assessing the outcomes. The minimum percentage to be achieved is 75%. This survey is conducted every year.

Table 3-1 summarizes how the MSE PLOs are grouped into these four assessment categories and the performance criterion for each method.

TABLE 3-1. Grouping of the MSE PLOs into assessment categories

Assessment method	Outcomes assessed this way	Performance criterion
1. Selected homework and exam problems from lecture-based courses	1a, b, c, d, e 2a, f	75% of the selected questions will be answered correctly by the class as a whole
2. Lab report rubric	2c, d, e 3c, d	75% of the class as a whole will score 3 or 4 on the rubric
3. Other rubrics and methods	1f; 2b 3a, b; 4a, b, c, d	75% of the scores on rubrics are 3 or 4. See paragraph (3) above
4. Senior Exit Survey	all	75% of the seniors rate their preparation as good or better

The MSE PLO assessment process

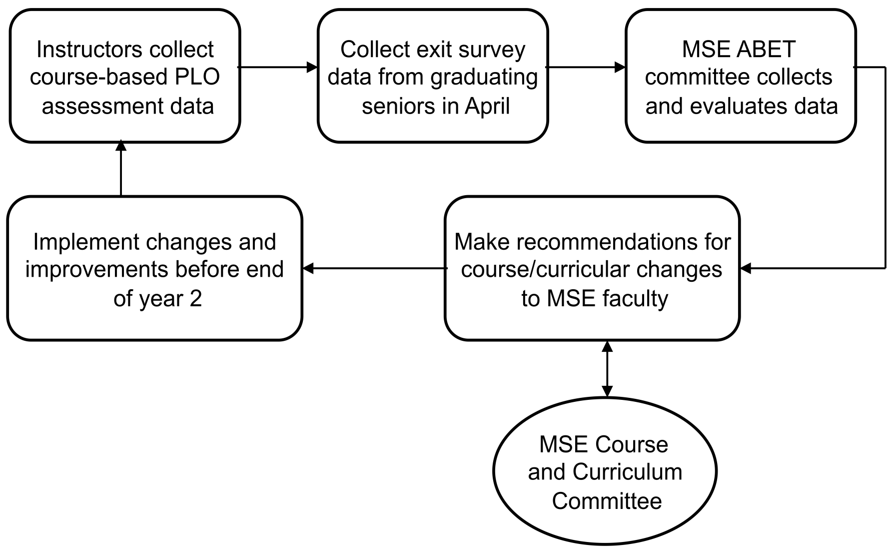
Assessment of the MSE PLOs takes place over a two-year cycle as illustrated schematically in Figure 3-1 below. All of the courses used for PLO assessment in the MSE curriculum are taught only once per year, thus collection of a complete set of assessment data requires one academic year. Evaluation of the assessment data by the MSE ABET Committee and implementation of any changes resulting from the assessment process takes place during the second academic year in each assessment cycle.

The MSE PLO assessment process involves the following steps:

1. In the first year of each assessment cycle, the Director of Undergraduate Programs sends a memo at the beginning of each semester to all faculty reminding them of the need to collect assessment data from their courses. Guidelines for collecting and formatting this data are included, and Excel templates for assessment data are available on the MSE website.

2. Faculty collect assessment data for each outcome addressed by their courses, put it in spreadsheet format and send it to the Director of Undergraduate Programs.
3. In April, the MSE ABET Committee individually interviews each graduating senior and compiles the results from the MSE Senior Exit Survey.
4. The MSE ABET Committee meets to review all the assessment data and identifies any shortcomings.
5. Recommendations for course or curricular changes are presented to the faculty during the next fall semester.
6. Resulting course or curricular changes are implemented during the next academic year.

Figure 3-1. MSE PLO ASSESSMENT FLOWCHART



The MSE ABET Committee also works closely with the MSE Undergraduate Course and Curriculum Committee. This committee occasionally recommends *ad hoc* curricular changes which arise outside of the closed-loop PLO assessment process. Such changes may be prompted by college- or university-initiated revisions in curricular content or hours required for graduation. The MSE ABET Committee ensures that these *ad hoc* changes are consistent with ABET requirements.

Summary of the MSE PLO assessment results

MSE PLO assessment data collected since the 2004 ABET visit includes three two-year assessment cycles. For each cycle, assessment data is collected for all MSE outcomes and the results are summarized a matrix format similar to Exhibit 3-3. The results for the past three assessment cycles are shown in Exhibits 3-10, 3-11 and 3-12. All of the raw data (similar to Exhibits 3-4, 3-6 and 3-7) corresponding to the numbers in these charts is collected in notebooks which will be available to the ABET evaluators during the visit. The gray-shaded boxes in these charts indicate which courses are used to assess each outcome and they correspond to the boxes marked with an "A" in Exhibit 3-3. As assessment data is collected from MSE courses and the senior exit survey, the assessment score is entered into the appropriate shaded box. In cases where the shaded box is empty, assessment data was not provided for that course.

A minimum value of 75% has been established by the MSE ABET committee for all of the assessment scores. This was chosen as a reasonable value, as it corresponds to a mid-level C grade in a typical course grading scale and represents an average level of performance. When the assessment score falls below the target value of 75%, the box is shaded in a "cautionary" yellow color (which appears in this document as a lighter gray). This indicates that this course may not be adequately preparing students to achieve this outcome. A review of the raw data associated with the cautionary scores (from charts similar to Exhibit 3-4) reveals the specific topical areas which need to be strengthened. The instructor of the course then addresses this weakness the next time the course is taught by improving the way these topics are presented, by allocating more time to them or by some other action. This step constitutes "closing the loop" in the assessment process. In some cases, a new instructor is assigned or a new textbook is used. Specific actions that were taken in response to cautionary assessment scores are described in Section 4 of this report.

TABLE 3-2
Number of MSE PLO assessment scores above and below the target values

Assessment cycle	**2004-06**		**2006-08**		**2008-10**		**% scores above**
MSE outcome	**above**	**below**	**above**	**below**	**above**	**below**	
1a. Apply math skills	3	0	3	0	3	0	**100%**
1b. Chemistry and physics	4	1	3	2	4	1	**73.3%**
1c. Thermodynamics of materials	2	2	4	1	2	2	**66.7%**
1d. Statics and solid mechanics	3	0	3	0	3	0	**100%**
1e. Structure-property relationships	3	2	4	2	5	1	**70.6%**
1f. Grad. school preparation	2	0	2	0	2	0	**100%**
2a. Computer-based tools	2	1	2	1	2	1	**66.7%**
2b. Materials selection	3	0	3	0	3	0	**100%**
2c. Microscopy and diffraction	5	0	4	1	5	0	**93.3%**
2d. Mechanical and thermal methods	4	2	4	1	5	0	**84.6%**
2e. Electrical and magnetic methods	3	2	4	0	4	0	**84.6%**
2f. Processing methods, material-specific	5	1	4	1	6	0	**88.2%**
3a. Team skills	3	0	3	0	3	0	**100%**
3b. Oral communication	4	0	4	0	4	0	**100%**
3c. Written communication	7	2	8	1	10	0	**89.3%**
3d. Basic computer skills	7	0	6	0	7	0	**100%**
4a. Contemporary issues	3	0	3	0	3	0	**100%**
4b. Professional and ethical responsibility	3	0	2	0	2	0	**100%**
4c. Global impact of engineering	2	0	2	0	2	0	**100%**
4d. Life-long learning	2	0	2	0	2	0	**100%**
TOTALS	**70**	**13**	**70**	**10**	**77**	**5**	**88.6%**
% scores above for each cycle	**84.3%**		**87.5%**		**93.9%**		**---**

The number of assessment scores above and below the target values for each outcome from Exhibits 3-10, 3-11 and 3-12 is collected in Table 3-2 above. These numbers are the result of compiling the scores across each row of the charts in Exhibits 3-10, 3-11 and 3-12, including the senior exit survey scores. Missing assessment data (blank shaded boxes in Exhibits 3-10, 3-11 and 3-12) were not included in these numbers. The rightmost column of Table 3-2 lists the percentage of the scores in each row that are above the target value. The bottom row of the table shows the percentage of scores above the target value for each assessment cycle. Table 3-2 provides an "at-a-glance" overview of the trends in MSE PLO assessment data over the past six years.

Table 3-2 clearly shows that the number of assessment scores above the target value is higher than the number below for every outcome in each assessment cycle, except for outcome 1c (thermodynamics). For this outcome, two scores above and two below the target value were received for the 2004-06 and the 2008-10 assessment cycles. Better scores were received for outcome 1c in the 2006-08 cycle (four above and one below). This outcome is also missing two assessment scores since the 2004 ABET visit.

The predominance of scores above the target value is also reflected in the percentages in the last row of the table. These percentages also exhibit a positive trend from one assessment cycle to the next. This is evidence that the MSE assessment process is achieving the goals of continuous improvement and ensuring that the MSE PLOs are met.

Level of achievement of the MSE PLOs

For each outcome, the percentage of all the scores which are above the target value is defined as the level of achievement for that outcome. This metric is tabulated in the rightmost column of Table 3-2. Based on this percentage, four levels of achievement are defined:

- Highly achieved: 80% or more of the assessment scores are above the target value.
- Achieved: 60 to 79% of the assessment scores are above the target value.
- Marginally achieved: 50 to 59% of the assessment scores are above the target value.
- Not achieved: less than 50% of the assessment scores are above the target value.

By this or any other measure, it is clear that the majority of the MSE outcomes can be classified as being highly achieved at this time. Sixteen of the twenty outcomes have 80% or more of their assessment scores above the target value, while the remaining four outcomes are classified as being achieved. None of the outcomes are classified as marginally achieved.

Applying the same achievement metric to each individual assessment cycle for the four outcomes that were not highly achieved yields the following results. Outcome 1b (chemistry and physics) was highly achieved in 2004-06, achieved in 2006-08 and highly achieved in 2008-10. However, the student exit survey data (see Exhibits 3-10, 3-11 and 3-12) shows that all graduating classes rated their preparation for this outcome very highly. Outcome 1c (thermodynamics) was marginally achieved in 2004-06 and 2008-10, and was achieved in 2006-08. Consideration of the student survey data for this outcome shows that the classes of 2006, 2009 and 2010 rated their preparation below the target value of 75%, while the classes of 2005, 2007 and 2009 rated their preparation above the target value. Outcome 1e (structure-property relationships) was achieved in 2004-06 and 2006-08, and highly achieved in 2008-10. For this outcome, all graduating classes from 2005–2010 rated their preparation above the target value. Outcome 2a (computer-based tools) had the same level of achievement in all assessment cycles (67%), and was rated below the target value in the senior exit survey by the graduating classes of 2006, 2007 and 2010.

Although the assessment results are mixed for these four outcomes, they are all considered to be achieved at this time. Further discussion of these outcomes and specific actions that have been taken to improve their assessment scores since the 2004 ABET visit is provided in Section 4.

Achievement of Outcome 1f: Graduate school preparation
Although this outcome is not explicitly included in the ABET Criterion 3 *a-k* outcomes, it does relate to preparation of students for a professional career (MSE PEO #1). Table 3-3 lists graduates of the MSE program since 2005 who have been accepted into reputable graduate schools to pursue an MS or PhD degree in materials science or a related field. Results for the class of 2010 are incomplete at the time of this writing, but five students have applied to graduate schools and so far three have been accepted.

Excluding the class of 2010, 34.7% of MSE graduates have applied to and been accepted by an impressive list of graduate schools from 2005–2009. Of these, 54.5% have elected to conduct their graduate studies in the MSE department at NCSU. The rest have attended such prestigious universities such as MIT, University of California-Berkeley, Stanford, Northwestern, University of Illinois at Urbana-Champaign and Carnegie-Mellon University. The materials science graduate programs at these universities are rated in the top 10 nationwide.

This is ample evidence that the MSE program is achieving this outcome. Furthermore, 100% of MSE graduates who plan to attend graduate school rate their preparation for this outcome as good or better, as noted on the 2005-2010 MSE senior surveys (see Exhibits 3-10, 3-11 and 3-12).

TABLE 3-3
MSE graduates accepted into graduate school from 2005-2010

Class of	% of MSE graduates attending grad school	Student	Graduate school attended
2005	43.3%	B. Bass S. Broderick K. Darling W. P. Davis A. Fredenburg J. Gobien D. Gough A. Griffith G. Hogshead L. Jimison J. Semones G. Wheeler B. Williamson	NCSU-MSE Iowa State NCSU-MSE NCSU-MSE Georgia Tech NCSU-MSE U. Illinois- Urbana/Champaign U. Illinois- Urbana/Champaign Penn State Stanford University NCSU-MSE NCSU-MSE NCSU-MSE
2006	29.6%	B. Allen A. Desai Z. Fitzgerald H. McFelea Danielle Proffit Diana Proffit T. Rice P. Stuckey	NCSU-MSE Stanford University NCSU-MSE Arizona State U. of Wisconsin Northwestern NCSU-MSE U. of Hawaii
2007	16.7%	M. Rebovich J. Thornton	Cornell University NCSU-MSE
2008	25.0%	R. Burton C. Holder E. Paisley	NCSU-MSE U. of California, Santa Barbara NCSU-MSE
2009	50.0%	R. Chan R. Clearfield J. Heil D. Hook L. Jackson E. Jones R. McClellan	NCSU-MSE NCSU-MSE NCSU-MSE NCSU-MSE Carnegie Mellon University MIT NCSU-MSE
2010	29.4% (if all are accepted)	M. Avery A. Marlowe J. Railsback M. Shore B. VanLeeuwen	applying to NCSU and Duke accepted at NCSU-MSE applying to NCSU-MSE accepted at U. of Florida accepted at Penn State

EXHIBIT 3-1
MAPPING OF MSE PROGRAM LEARNING OUTCOMES
TO ABET CRITERION 3 OUTCOMES a-k

ABET Outcome	a	b	c	d	e	f	g	h	i	j	k
MSE Outcomes											
1a. Apply math skills	x										
1b. Chemistry and physics	x										
1c. Thermodynamics of materials	x										
1d. Statics and solid mechanics	x										
1e. Structure-property relationships	x		x		x						
1f. Grad. school preparation											
2a. Computer-based tools	x				x						x
2b. Materials selection	x		x		x						
2c. Microscopy and diffraction		x									x
2d. Mechanical and thermal methods		x									x
2e. Electrical and magnetic methods		x									x
2f. Processing methods, matl.-specific			x								x
3a. Team skills				x							
3b. Oral communication							x				
3c. Written communication							x				
3d. Basic computer skills							x				
4a. Contemporary issues										x	
4b. Professional and ethical responsibility						x					
4c. Global impact of engineering								x			
4d. Life-long learning									x		

ABET Criterion 3 outcomes

Engineering programs must demonstrate that their graduates have:

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
d. An ability to function on multi-disciplinary 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 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

EXHIBIT 3-2
MAPPING OF MSE PROGRAM LEARNING OUTCOMES
TO MSE PROGRAM CRITERIA

MSE Program Criteria	A	B	C	D
MSE Outcomes				
1a. Apply math skills	x	x	x	
1b. Chemistry and physics	x	x	x	
1c. Thermodynamics of materials	x	x	x	
1d. Statics and solid mechanics	x	x	x	
1e. Structure-property relationships	x	x	x	
1f. Grad. school preparation				
2a. Computer-based tools			x	x
2b. Materials selection			x	x
2c. Microscopy and diffraction				x
2d. Mechanical and thermal methods				x
2e. Electrical and magnetic methods				x
2f. Processing methods, matl.-specific		x		
3a. Team skills				
3b. Oral communication				
3c. Written communication				
3d. Basic computer skills				
4a. Contemporary issues				
4b. Professional and ethical responsibility				
4c. Global impact of engineering				
4d. Life-long learning				

MSE PROGRAM CRITERIA

MSE programs must demonstrate that their graduates have:

A. an ability to apply advanced science and engineering concepts to materials systems

B. an integrated understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing and performance

C. an ability to apply and integrate knowledge from the above four elements to solve materials selection and design problems

D. the ability to utilize experimental, statistical and computational methods consistent with the program educational objectives

EXHIBIT 3-3

IMPLEMENTATION AND ASSESSMENT OF MSE PROGRAM LEARNING OUTCOUMES BY COURSES IN THE MSE CURRICULUM

I = course used to implement the outcome. A = course used to implement and assess the outcome

	NON-MATERIALS COURSES							MATERIALS SCIENCE & ENGINEERING COURSES																								
PROGRAM OUTCOMES	Chemistry	Physics	Math, CSC	E 101	ECE 331	Eng., H & SS	Tech. Writing	MSE 201	MSE 210 (255)	MSE 301	MSE 310	MSE 321	MSE 324	MSE 330	MSE 331	MSE 333	MSE 350	MSE 423	MSE 424	MSE 425	MSE 430	MSE 431	MSE 434	MSE 435	MSE 440	MSE 445	MSE 450	MSE 455	MSE 460	MSE 491	MSE 556	Sr. Exit Survey
1a. Apply math skills			I		I												A															A
1b. Chemistry and physics	I	I						I						I	A					A							A					A
1c. Thermodynamics of materials	I									A		A		A						I				I								A
1d. Statics and solid mechanics		I															A														I	A
1e. Structure-property relationships								I		I	I	I	I	I	A					A		A		A			I				I	A
1f. Grad. school preparation										I		I			I					I		I		I						I		A
2a. Computer-based tools											A			A			I						A									A
2b. Materials selection															I			A	I	I		I		I				I	I			A
2c. Microscopy and diffraction									A				A								A					I						A
2d. Mechanical and thermal methods								I					A								A		A				I					A
2e. Electrical and magnetic methods					I										I	A							A						I			A
2f. Proc. methods: materials-specific															I										A	A		A	A		A	A
3a. Team skills				I							I							I	A													A
3b. Oral communication				I														A	A											A		A
3c. Written communication				I		I	I		A				A			A		A	A		A		A							A		A
3d. Basic computer skills									A				A			A		A	A		A		A							I		A
4a. Contemporary issues				I		I													I											A		A
4b. Prof. and ethical responsibility				I		I																								I		A
4c. Global impact of engineering				I		I																								I		A
4d. Life-long learning				I		I																								I		A

EXHIBIT 3-4
ASSESSMENT DATA COLLECTED FROM MSE 350 IN THE FALL 2007 SEMESTER TO EVALUATE MSE OUTCOME 1a

MSE 350 ABET DATA: Fall 2007

MSE Outcome 1a. By graduation, students will be able to apply the basic mathematical skills needed to solve routine problems within the discipline of MSE.

	STUDENT	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	
HW/Prob	**HOMEWORK PROBLEMS**																				**% CORRECT**
2-56	2D vectors	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1		1	1	1	**94.4**
3-38	3D vectors	1	0	1	1		1	1	1	1	1	1	0	0	1	1	1	1	1	0	**77.8**
5-60	2D vector moments	1	1	1	1	0	1	1	1	1	1	1			1	1	1	1	1	1	**94.1**
6-49	3D vector moments	1	0	1	1	0	1	1	1	0	1	1	0	1	1	1	0	0	0	0	**57.9**
9-40	singularity function representation	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	**94.7**
9-71	singularity function evaluation	1	1	1	0	1	1	1	1	1	1	1	1	0		0	0	0		0	**64.7**
5-14	vector components	1	0	1	0	1	1	1	1	1	1	1		0	1	1	0	1	1	1	**77.8**
8-67	graphical integration	1	1		1	1	1	1	1	1	1	1		0	1			1	1	0	**86.7**
Exam/Prob	**EXAM PROBLEMS**																				
Quiz 2 #2	linear simultaneous eqs	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	**73.7**
Quiz 3 #4	differential eqs	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	0	**78.9**
	% CORRECT	**100**	**70**	**100**	**80**	**67**	**100**	**90**	**100**	**90**	**100**	**100**	**71**	**33**	**78**	**89**	**50**	**70**	**78**	**40**	**79.9**

EXHIBIT 3-5
LAB REPORT RUBRIC

	1 Beginning or incomplete	2 Developing	3 Accomplished	4 Exemplary	Score
Abstract/Summary	Several major aspects of the experiment are missing, student displays a lack of understanding about how to write an abstact	Abstract misses one or more major aspects of carrying out the experiment or the results	Abstract references most of the major aspects of the experiment, some minor details are missing	Abstract contains reference to all major aspects of carrying out the experiment and the results, well-written	
Introduction	Very little background information provided or information is incorrect	Some introductory information, but still missing some major points	Introduction is nearly complete, missing some minor points	Introduction complete and well-written; provides all necessary background principles for the experiment	
Experimental procedure	Missing several important experimental details or not written in paragraph format	Written in paragraph format, still missing some important experimental details	Written in paragraph format, important experimental details are covered, some minor details missing	Well-written in paragraph format, all experimental details are covered	
Results: data, figures, graphs, tables, etc.	Figures, graphs, tables contain errors or are poorly constructed, have missing titles, captions or numbers, units missing or incorrect, etc.	Most figures, graphs, tables OK, some still missing some important or required features	All figures, graphs, tables are correctly drawn, but some have minor problems or could still be improved	All figures, graphs, tables are correctly drawn, are numbered and contain titles/captions.	
Discussion	Very incomplete or incorrect interpretation of trends and comparison of data indicating a lack of understanding of results	Some of the results have been correctly interpreted and discussed; partial but incomplete understanding of results is still evident	Almost all of the results have been correctly interpreted and discussed, only minor improvements are needed	All important trends and data comparisons have been interpreted correctly and discussed, good understanding of results is conveyed	
Conclusions	Conclusions missing or missing the important points	Conclusions regarding major points are drawn, but many are misstated, indicating a lack of understanding	All important conclusions have been drawn, could be better stated	All important conclusions have been clearly made, student shows good understanding	
Spelling, grammar, sentence structure	Frequent grammar and/or spelling errors, writing style is rough and immature	Occasional grammar/spelling errors, generally readable with some rough spots in writing style	Less than 3 grammar/spelling errors, mature, readable style	All grammar/spelling correct and very well-written	
Appearance and formatting	Sections out of order, too much handwritten copy, sloppy formatting	Sections in order, contains the minimum allowable amount of handwritten copy, formatting is rough but readable	All sections in order, formatting generally good but could still be improved	All sections in order, well-formatted, very readable	

EXHIBIT 3-6
ASSESSMENT DATA COLLECTED FROM MSE 333 IN THE FALL 2007 SEMESTER TO EVALUATE MSE OUTCOME 2e

MSE 333 Experiment 3: Electrical Resistivity of Metals and Semiconductors

MSE Outcome 2e. By graduation, students will demonstrate familiarity with methods for characterizing the electrical and magnetic properties of materials.

Student	Abstract	Introduction	Experimental	Results	Discussion	Conclusions	Spelling, grammar	Appearance, formatting	% 3 and 4
1	3	4	2	1	1	4	4	4	**62.5**
2									
3									
4	4	4	4	4	1	3	4	4	**87.5**
5	1	3	1	1	3	3	4	4	**62.5**
6	4	4	4	4	4	4	4	4	**100.0**
7	3	3	3	2	3	3	4	4	**87.5**
8	4	1	3	2	2	3	4	4	**62.5**
9	3	2	3	3	4	3	4	4	**87.5**
10									
11	4	4	4	4	2	4	4	4	**87.5**
12	3	4	3	3	3	3	4	4	**100.0**
13	4	3	3	3	3	4	4	4	**100.0**
14	4	1	1	3	3	1	4	4	**62.5**
15	4	4	4	4	4	3	4	4	**100.0**
16	3	3	4	3	3	3	4	4	**100.0**
17	4	1	4	3	2	3	4	4	**75.0**
18	4	4	4	4	3	4	4	4	**100.0**
19	4	2	4	3	1	3	4	4	**75.0**
20	3	1	1	3	1	3	4	4	**62.5**
% of students with 3 or 4	**94.1**	**64.7**	**76.5**	**76.5**	**58.8**	**94.1**	**100.0**	**100.0**	**83.1**
					Average for methodology				**77.5**

EXHIBIT 3-7
ASSESSMENT DATA COLLECTED FROM MSE 333 IN THE SPRING 2007 SEMESTER TO EVALUATE MSE OUTCOMES 3c AND 3d

Summary: MSE 333 Spring 2007

MSE outcomes 3c and 3d. By graduation, students will will be able to communicate in writing with others in the discipline of MSE. By graduation, students will be able to demonstrate basic computer skills for oral and written communication.

Percentage of students getting 3 or 4 in each section of lab report

Experiment	Abstract	Introduction	Experimental	Results	Discussion	Conclusions	Spelling/ grammar	Appearance/ formatting	Overall	Reports turned in
1	94.7	94.7	94.7	94.7	68.4	89.5	100.0	100.0	92.1	19
2	33.3	66.7	66.7	72.2	94.4	100.0	100.0	100.0	79.2	18
3	94.1	64.7	76.5	76.5	58.8	94.1	100.0	100.0	83.1	17
4	93.8	87.5	68.8	93.8	68.8	62.5	100.0	100.0	84.4	16
5	70.6	52.9	76.5	82.4	58.8	64.7	100.0	100.0	75.7	17
6	100.0	55.6	94.4	94.4	88.9	94.4	100.0	100.0	91.0	17
Weighted average	**80.8**	**70.6**	**79.9**	**85.6**	**73.2**	**84.7**	**100.0**	**100.0**	**84.3**	**104**

EXHIBIT 3-8
MSE 2009 SENIOR EXIT SURVEY

Please rate the preparation you received as a major in Materials Science and Engineering (MSE) at NCSU for each of the following by placing the appropriate number in the blank. For these questions, consider ALL of the courses you have taken at NCSU, not just MSE courses. Use the following scale:

5: Excellent 4: Very good 3: Good 2: Fair 1: Poor

1. _____ The ability to apply the basic mathematical skills needed to solve routine problems within the discipline of MSE.
2. _____ The ability to apply the principles of chemistry and physics that are related to MSE.
3. _____ The ability to apply the principles of engineering thermodynamics that are related to MSE.
4. _____ The ability to apply the principles of statics and solid mechanics that are related to MSE.
5. _____ The ability to identify the structure-processing-property-performance relationships for metallic materials.
6. _____ The ability to identify the structure-processing-property-performance relationships for ceramic materials.
7. _____ The ability to identify the structure-processing-property-performance relationships for polymeric materials.
8. _____ The ability to identify the structure-processing-property-performance relationships for electronic materials.
9. _____ (Answer only if you plan to attend graduate school). The background necessary to be accepted into reputable graduate schools in MSE or a related field.
10. _____ The ability to use computer modeling and other computer-based tools to solve specific materials problems.
11. _____ The ability to select an appropriate material for a given application.
12. _____ The ability to apply basic microscopy and diffraction methods for analysis of the structure of materials at various size scales.
13. _____ The ability to use appropriate methods for analyzing the mechanical and thermal properties of materials.
14. _____ The ability to use appropriate methods for analyzing the electrical, magnetic, and optical properties of materials.
15. _____ The ability to articulate the basic processing methods for selected classes of materials that interest you and how processing parameters can affect structure and properties.
16. _____ The ability to function on multi-disciplinary teams.
17. _____ The ability to communicate orally with others within the discipline of MSE.
18. _____ The ability to communicate through writing with others within the discipline of MSE.
19. _____ The ability to use computers for oral and written communication.
20. _____ The development of an appreciation for the importance of life-long learning.
21. _____ The development of an appreciation for professional and ethical responsibility.
22. _____ The development of an appreciation for the impact of engineering solutions on society and the environment in a global context.
23. _____ The development of an appreciation for contemporary issues.

EXHIBIT 3-8
MSE 2009 SENIOR EXIT SURVEY (continued)

Please rate the degree to which the MSE courses at NCSU have enabled you to address the following elements of the field of materials science and engineering. Use the same scale as in questions 1–23.

24. _____ Structure
25. _____ Properties
26. _____ Processing
27. _____ Applications

Please rate the *amount* of coverage you received in MSE for the following major classes of materials. Use the following scale:

5: Excessive 4: More than enough 3: Just right 2: Not quite enough 1: Far too little

28. _____ Metals
29. _____ Ceramics
30. _____ Polymers
31. _____ Electronic materials
32. _____ Composites

33. What technical electives did you take? Check all that apply.

- ❑ MSE/NE 409 Nuclear Materials
- ❑ MSE 440 Processing of Metallic Materials
- ❑ MSE 445 Ceramic Processing
- ❑ MSE 455 Polymer Technology and Engineering
- ❑ MSE 460 Microelectronic Materials
- ❑ MSE 490B Biomaterials Science
- ❑ MSE 490C Introduction to Nanomaterials
- ❑ MSE 556 Composite Materials

34. For your career in materials science and engineering, which materials classes are of primary interest to you? Check all that apply.

- ❑ Metals
- ❑ Ceramics
- ❑ Polymers
- ❑ Electronic materials
- ❑ Composites
- ❑ I plan to pursue a different career field. Please specify:________________________________

35. Provide any additional comments you may have about your experience with the Materials Science and Engineering Department at NCSU.

EXHIBIT 3-9
MSE SENIOR EXIT SURVEY RESULTS: CLASS OF 2009
number of students completing this survey = 14

		% 1's	% 2's	% 3's	% 4's	% 5's	AVERAGE	% Good or higher
	PROGRAM OUTCOMES							
1	1a. Apply math skills	0.0	0.0	7.1	57.1	35.7	4.29	100.0
2	1b. Chemistry and physics	0.0	0.0	14.3	42.9	42.9	4.29	100.0
3	1c. Thermodynamics of materials	0.0	42.9	28.6	28.6	0.0	2.86	57.1
4	1d. Statics and solid mechanics	0.0	7.1	21.4	64.3	7.1	3.71	92.9
5	1e. Structure-property metals	0.0	0.0	14.3	57.1	28.6	4.14	100.0
6	1e. Structure-property ceramics	0.0	0.0	14.3	57.1	28.6	4.14	100.0
7	1e. Structure-property polymers	0.0	0.0	14.3	64.3	21.4	4.07	100.0
8	1e. Structure-property electr. mat.	0.0	14.3	21.4	57.1	7.1	3.57	85.7
--	1e. Structure-property overall							96.4
9	1f. Grad. school preparation	0.0	0.0	0.0	37.5	62.5	4.63	100.0
10	2a. Computer-based tools	0.0	21.4	42.9	28.6	7.1	3.21	78.6
11	2b. Materials selection	0.0	7.1	35.7	42.9	14.3	3.64	92.9
12	2c. Microscopy and diffraction	0.0	7.1	28.6	28.6	35.7	3.93	92.9
13	2d. Mechanical and thermal methods	0.0	7.1	21.4	57.1	14.3	3.79	92.9
14	2e. Electrical and magnetic methods	0.0	7.1	42.9	42.9	7.1	3.50	92.9
15	2f. Processing methods, matl.-specific	0.0	0.0	21.4	50.0	28.6	4.07	100.0
16	3a. Team skills	7.1	7.1	21.4	21.4	42.9	3.86	85.7
17	3b. Oral communication	0.0	0.0	7.1	71.4	21.4	4.14	100.0
18	3c. Written communication	0.0	7.1	21.4	50.0	21.4	3.86	92.9
19	3d. Basic computer skills	0.0	0.0	7.1	35.7	57.1	4.50	100.0
20	4a. Contemporary issues	0.0	14.3	0.0	35.7	50.0	4.21	85.7
21	4b. Prof. and ethical responsibility	7.1	7.1	0.0	28.6	57.1	4.21	85.7
22	4c. Global impact of engineering	0.0	7.1	14.3	35.7	42.9	4.14	92.9
23	4d. Life-long learning	7.1	7.1	21.4	64.3	0.0	3.43	85.7
	ELEMENTS OF MATERIALS SCIENCE							
24	Structure of materials	0.0	0.0	14.3	42.9	42.9	4.29	100.0
25	Properties of materials	0.0	0.0	0.0	28.6	71.4	4.71	100.0
26	Processing of materials	0.0	0.0	35.7	42.9	21.4	3.86	100.0
27	Applications of materials	0.0	7.1	42.9	28.6	21.4	3.64	92.9
	AMOUNT OF COVERAGE: 1 = far too little, 3 = just right, 5 = excessive						**AVERAGE**	**% 3's**
		1	**2**	**3**	**4**	**5**		
28	Coverage of metals	0.0	0.0	14.3	71.4	14.3	4.00	14.3
29	Coverage of ceramics	0.0	14.3	71.4	14.3	0.0	3.00	71.4
30	Coverage of polymers	0.0	21.4	78.6	0.0	0.0	2.79	78.6
31	Coverage of electronic materials	0.0	42.9	42.9	14.3	0.0	2.71	42.9
32	Coverage of composites	28.6	71.4	0.0	0.0	0.0	1.71	0.0
	ELECTIVES						**TOTAL**	**% of CHOICES**
33	MSE/NE 409 Nuclear Materials						0	0.0
33	MSE 440 Metals Processing						10	25.0
33	MSE 445 Ceramics Processing						8	20.0
33	MSE 455 Polymer Technology & Eng.						8	20.0
33	MSE 460 Electronic Materials Proc.						5	12.5
33	MSE 490B Biomaterials Science						6	15.0
34	MSE 490C Introduction to Nanomaterials						2	5.0
35	MSE 490Y Bio-nanomaterials						1	2.5
33	MSE 556 Composite Materials						0	0.0
	CAREER CHOICE						**TOTAL**	**% of CHOICES**
34	Metals						7	20.6
34	Ceramics						9	26.5
34	Polymers						6	17.6
34	Electronic Materials						8	23.5
34	Composites						4	11.8
34	Other						0	0.0

EXHIBIT 3-10

MSE OUTCOMES ASSESSMENT SUMMARY FOR THE 2004-06 CYCLE

(yellow or light gray shading indicates cautionary scores below 75%)

PROGRAM LEARNING OUTCOMES	MSE 210	MSE 301	MSE 310	MSE 321	MSE 324	MSE 330	MSE 331	MSE 333	MSE 350	MSE 423	MSE 424	MSE 425	MSE 430	MSE 431	MSE 434	MSE 435	MSE 440	MSE 445	MSE 450	MSE 455	MSE 460	MSE 491	MSE 556	2005 exit survey	2006 exit survey
1a. Apply math skills									77.9															100	88.9
1b. Chemistry and physics							91.6					60.4							88.8					93.3	100
1c. Thermodynamics of materials		72.3		79.8																				76.7	66.7
1d. Statics and solid mechanics									76.8															93.3	100
1e. Structure-property relationships							50.2					56.9				78.1								84.2	85.2
1f. Grad. school preparation																								100	100
2a. Computer-based tools			93.8																					86.7	66.7
2b. Materials selection										91.7														90.0	88.9
2c. Microscopy and diffraction	91.7				86.4								81.6											93.3	92.6
2d. Mechanical and thermal methods	78.9				50.8								56.7		95.2									100	96.3
2e. Electrical and magnetic methods	93.0							97.2							87.4									73.3	66.7
2f. Processing methods, matl.-specific																	91.5	86.7		87.1			65.9	100	88.9
3a. Team skills											94.6													86.7	88.9
3b. Oral communication										76.3	85.7													96.7	96.3
3c. Written communication	85.6				71.4			97.9		94.6	78.3		74.0		92.3									100	96.3
3d. Basic computer skills	91.2				89.7			100					97.3		97.3									100	100
4a. Contemporary issues																						76.4		90.0	96.3
4b. Professional and ethical responsibility										93.0														90.0	96.3
4c. Global impact of engineering																								86.7	96.3
4d. Life-long learning																								80.0	96.3

EXHIBIT 3-11
MSE OUTCOMES ASSESSMENT SUMMARY FOR THE 2006-08 CYCLE
(yellow or light gray shading indicates cautionary scores below 75%)

PROGRAM LEARNING OUTCOMES	MSE 210	MSE 301	MSE 310	MSE 321	MSE 324	MSE 330	MSE 331	MSE 333	MSE 350	MSE 423	MSE 424	MSE 425	MSE 430	MSE 431	MSE 434	MSE 435	MSE 440	MSE 445	MSE 450	MSE 455	MSE 460	MSE 491	MSE 556	2007 exit survey	2008 exit survey
1a. Apply math skills									79.9															100	100
1b. Chemistry and physics							73.2					63.6							76.8					100	100
1c. Thermodynamics of materials		63.3		87.2		75.2																		83.3	100
1d. Statics and solid mechanics									83.1															75.0	91.7
1e. Structure-property relationships							65.2					69.8		76.7		76.5								85.4	95.8
1f. Grad. school preparation																								100	100
2a. Computer-based tools			85.0																					66.7	83.3
2b. Materials selection										90.6														100	91.7
2c. Microscopy and diffraction	74.8				92.8								64.2											100	91.7
2d. Mechanical and thermal methods	80.1				88.6								58.4											100	100
2e. Electrical and magnetic methods	87.7							79.0																100	75.0
2f. Processing methods, matl.-specific																	78.9			78.1			71.3	100	91.7
3a. Team skills											96.1													91.7	91.7
3b. Oral communication										89.2	78.3													100	100
3c. Written communication	75.2				90.3			84.3		81.9	95.8		71.9									87.2		100	100
3d. Basic computer skills	100				98.4			100					100											100	100
4a. Contemporary issues																						82.1		91.7	100
4b. Professional and ethical responsibility																								100	83.3
4c. Global impact of engineering																								100	75.0
4d. Life-long learning																								100	83.3

EXHIBIT 3-12
MSE OUTCOMES ASSESSMENT SUMMARY FOR THE 2008-10 CYCLE
(yellow or light gray shading indicates cautionary scores below 75%)

PROGRAM LEARNING OUTCOMES	MSE 255 (210)	MSE 301	MSE 310	MSE 321	MSE 324	MSE 330	MSE 331	MSE 333	MSE 350	MSE 423	MSE 424	MSE 425	MSE 430	MSE 431	MSE 434	MSE 435	MSE 440	MSE 445	MSE 450	MSE 455	MSE 460	MSE 491	MSE 556	2009 exit survey	2010 exit survey
1a. Apply math skills									87.5															100	100
1b. Chemistry and physics							72.2					74.4							80.5					100	94.1
1c. Thermodynamics of materials		76.5				75.7																		57.1	64.7
1d. Statics and solid mechanics									82.5															92.9	82.4
1e. Structure-property relationships							69.6					78.3		75.2		76.9								96.4	86.8
1f. Grad. school preparation																								100	100
2a. Computer-based tools			85.0																					78.6	70.6
2b. Materials selection										96.9														92.9	88.2
2c. Microscopy and diffraction	87.6				88.2								91.6											92.9	94.1
2d. Mechanical and thermal methods					90.6								92.4		85.6									92.9	94.1
2e. Electrical and magnetic methods								81.9							83.5									92.9	94.1
2f. Processing methods, matl.-specific																	78.2	87.9		88.2			80.8	100	88.2
3a. Team skills											96.7													85.7	76.5
3b. Oral communication										88.8	84.7													100	94.1
3c. Written communication	86.1				91.7			86.4		82.5	88.0		91.4		86.9							86.1		92.9	100
3d. Basic computer skills	76.0				100			100					86.2		94.4									100	100
4a. Contemporary issues																						85.4		85.7	94.1
4b. Professional and ethical responsibility																								85.7	100
4c. Global impact of engineering																								92.9	94.1
4d. Life-long learning																								95.7	94.1

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Information used for program improvement

A variety of sources provide input and inducements that can result in changes and improvements to the MSE undergraduate program. These include:

1. *Course-based assessment results from the MSE program learning outcomes.* By design, the MSE assessment plan requires changes to be made to the MSE courses and/or curriculum in order to correct deficiencies noted in the assessment data.
2. *Annual MSE senior exit survey data and exit interviews with MSE graduating seniors.* The data from the MSE senior exit survey and interviews complement the course-based assessment data and are part of the MSE PLO assessment process. These data provide the students' perception of how well the MSE program is achieving its PLOs. Students often voice important concerns during exit interviews that do not show up on survey forms.
3. *Assessment results from the MSE program educational objectives.* The MSE PLOs are directly linked to the MSE PEOs (see Sections 2 and 3). Changes to the MSE PEOs usually require changes to be made to the PLOs, which in turn may necessitate course or curricular changes. Input obtained from the MSE constituencies as part of the PEO assessment process may also induce course and/or curricular changes.
4. *Suggestions from the MSE undergraduate course and curriculum committee.* This is a departmental standing committee which has oversight of the MSE undergraduate program. This group responds to undergraduate program issues which arise on a shorter time scale than the two-year cycle for assessment of the MSE PLOs. This committee was responsible for development and implementation of the new MSE curriculum in 2009.
5. *Suggestions from the MSE faculty as a whole.* Input from MSE faculty who are not serving on the undergraduate course and curriculum committee is always encouraged. An MSE faculty consensus is required before changes are made to the MSE curriculum, so all faculty are given an opportunity to make suggestions at that time.
6. *Curricular mandates and constraints from the university administration.* All undergraduate curricula at NCSU must met specific general education requirements and are constrained to a maximum of 128 credit hours. The MSE program must comply when changes are made to these university-wide requirements.
7. *Changes to the accreditation process mandated by ABET.* Changes in the way program learning outcomes or program educational objectives are interpreted by ABET can induce modifications in courses and curricula to ensure that PLOs and PEOs continue to be met.

B. Actions taken to improve the MSE program

Actions taken to improve the MSE program since the 2004 ABET visit fall into two main categories: (i) actions taken in response to cautionary PLO assessment scores and (ii) actions resulting from a major revision of the MSE undergraduate curriculum which began in the spring semester of 2009. In the first case, the actions were motivated primarily by items 1 and 2 from section A above. In the second case, the actions were motivated by input from items 2, 3, 4, 5, 6 and 7 above. Most of this section is devoted to a description of these two categories of actions. Other changes have been made which don't fall into the two categories just described. These are also considered continuous improvement and they include:

- Modification of the MSE program educational objectives as described in Section 2.
- Modification of the MSE program learning outcomes as described in Section 3A.
- Restructuring of the MSE AAC as described in Section 2.
- Formation of separate MSE undergraduate and graduate course and curriculum committees. This change was instituted by the new MSE department head in the fall 2009 semester to better address the individual needs of the MSE undergraduate and graduate programs. The undergraduate course and curriculum committee will work closely with the MSE ABET committee to evaluate and improve the MSE undergraduate program.

Finally, the MSE department moved into a new building on Centennial Campus in December 2004 (shortly after the 2004 ABET visit). This move is part of a long-range plan at NCSU to move the entire College of Engineering to the Centennial Campus. It provided the MSE undergraduate program with much improved lab space and classroom facilities. Additional discussion of the impact the relocation of the MSE department has had on the MSE program is provided in Section 6 of this report.

Actions taken in response to cautionary PLO assessment scores
Table 3-2 shows that 9 of the 20 MSE PLOs had at least one assessment score below the target value over the past three assessment cycles. For 5 of these 9 outcomes (2c, 2d, 2e, 2f, 3c), Table 3-2 shows that the percentage of non-cautionary scores is 80% or higher, therefore these outcomes are classified as highly achieved in spite of the cautionary scores. The percentage of non-cautionary scores is 60-79% for the other 4 outcomes (1b, 1c, 1e, 2a), thus these are considered to be achieved. The actions taken in response to all of the cautionary scores is described below as evidence of continuous improvement. These actions also constitute the "loop-closing" step in the assessment process. The raw data on which these and all other scores are based are documented in notebooks which will be available to the evaluators during the visit. Refer to Exhibits 3-10, 3-11 and 3-12 for a complete summary of the assessment scores that are discussed in the following sections.

To improve cautionary scores from the MSE senior exit survey, it is necessary to change the students' perception of how well they have been prepared for the outcomes that produce cautionary scores. This can only be done by changing and improving the courses associated with the outcomes in question. Cautionary scores from the senior exit survey are included in the discussion below, but corrective actions for these scores are relegated to the associated courses.

1. Outcome 1b: Chemistry and physics.

Assessment cycle	Course	Cautionary score	Action taken
2004-06	MSE 425	60.4	More emphasis given to the kinetics and statistics of polymerization reactions and their relationship to polymer molecular weight.
2006-08	MSE 425	63.6	More emphasis given to the kinetics and statistics of polymerization reactions and their relationship to polymer molecular weight.
2006-08	MSE 331	73.2	More emphasis given to free electron concentrations in materials.
2008-10	MSE 331	72.2	More emphasis given to dielectrics, polarization and transmission/reflection of light.

The chemistry component of this outcome is assessed in MSE 425 and the physics component is assessed in MSE 331 and MSE 450. In MSE 425, students struggled with the mathematical relationships between polymerization kinetics and polymer molecular weight. This was corrected by increasing the lecture time devoted to this topic, which produced a more acceptable score of 74.4 in the 2008-10 assessment cycle. In MSE 331, the assessment scores were not far below the target value of 75%. This course was revised in spring 2009 as part of the MSE curriculum revision, and a new textbook and instructor were assigned to it. The assessment score (from spring 2009) did not change much as a result of these actions. Students did not perform well in the areas of dielectrics, polarization and the behavior of light in materials. An increased emphasis in these areas is recommended for the next offering of this course.

2. Outcome 1c: Thermodynamics.

Assessment cycle	Course	Cautionary score	Action taken
2004-06	MSE 301	72.3	More emphasis given to polymer solutions, equilibrium constants and pressure dependence of melting point. New instructor assigned.
2004-06	Exit survey ‘06	66.7	Actions taken in MSE 301 are intended to address this.
2006-08	MSE 301	63.3	More emphasis given to concepts of entropy, free energy, intensive properties and reversible reactions. New instructor assigned.
2008-10	Exit survey ‘09 Exit survey ‘10	57.1 64.7	Actions taken in MSE 301 are intended to address this.

Thermodynamics concepts are assessed in MSE 301 (thermodynamics), MSE 321 (phase transformations and kinetics) and MSE 330 (crystal chemistry). Over the past three assessment cycles, cautionary scores have been restricted to MSE 301 assessment data and the MSE senior exit survey, although assessment scores from MSE 330 are marginally above the target value. Students in the MSE program have historically struggled with thermodynamics and the course-based assessment scores often reflect this. Students’ perception of their preparation for thermodynamics is also often low, as reflected in the 2006, 2009 and 2010 exit surveys. The assessment score in MSE 301 is below the target value for the 2004-06 and 2006-08 assessment cycles, but improves to 76.5 in the 2008-10 cycle. Some areas of concern in MSE 301 over the past three assessment cycles are polymer-solvent interactions, swelling, solubility parameters, equilibrium constants for chemical reactions, intensive thermodynamic properties, nonideal solutions and free energy expressions.

A different instructor has taught MSE 301 in each of the three assessment cycles. The current instructor for the course has now taught it two consecutive times, and a higher assessment score was obtained (76.5) for the fall 2009 offering. The current instructor has incorporated the following changes and improvements to MSE 301:

- An in-class tutorial on how to use Mathematica was given during the second lecture.
- Additional content from sources other than the main textbook was introduced for lectures about the Second and Third Laws, and for calculations on gas compression/expansion cycles and reacting systems.
- Material on kinetics and rate constants was replaced with a thermodynamic treatment of reacting systems.
- A list of typographical errors in the textbook was generated, and the instructor alerted students to the errors and how to correct them during his lectures.

The 2010 senior exit survey score for Outcome 1c shows some improvement over the 2009 score, but is still below the target value. If assessment scores in MSE 301 continue to improve as they did in 2008-10, the exit survey scores should eventually improve as well. Finally, MSE 301 has been moved from the spring semester of the sophomore year to the fall semester of the junior year in the new MSE curriculum. As juniors, students may be better prepared to absorb the principles of thermodynamics, which should positively affect the exit survey scores. No additional changes are planned for MSE 301 at this time.

3. Outcome 1e. Structure-property relationships.

Assessment cycle	Course	Cautionary score	Action taken
2004-06	MSE 331	50.2	New instructor was assigned. Extensive set of lecture slides was developed showing applications of the topics covered and solutions to example problems.
2004-06	MSE 425	56.9	More emphasis needed on crosslinking of rubber, time-dependence of polymer mechanical properties, copolymer composition and molecular weight distributions for step-growth polymers.
2006-08	MSE 331	65.2	More emphasis needed on semiconductor doping and principles of Schottky and p-n junction diodes. New instructor was assigned and new textbook was adopted.
2006-08	MSE 425	69.8	More emphasis given to effects of polymer branching and factors affecting Tg and Tm of polymers. An extensive set of PowerPoint notes were developed and placed online for students to use during the class.
2008-10	MSE 331	69.6	More emphasis needed on magnetic moments, photoelectric effect and force constants associated with atomic bonds.

This outcome includes structure-property relationships for metallic (MSE 431), ceramic (MSE 435), polymeric (MSE 425) and microelectronic materials (MSE 331). Cautionary assessment scores were received only from MSE 331 and MSE 425, while scores from MSE 435 are only slightly above the target value. The raw assessment data from MSE 331 show low scores in nearly all course topics for the 2004-06 assessment cycle. A major change was needed in the way this course was taught, and in the next assessment cycle a new instructor was assigned. This raised the assessment score significantly to 65.2% but it still remained below the target value of

75%. In 2009, the content of the course was revised and a new textbook was adopted as a result of the MSE curriculum revision. The assessment score increased slightly again, but still remains below the target value.

In MSE 425, students showed weaknesses in the general area of polymer structure-property relationships for the first two assessment cycles. The assessment score increased significantly in the second cycle but remained below the target value. After the fall 2006 offering of this course, the instructor created an extensive set of PowerPoint notes which were placed online as a learning aid for the students. The latest assessment score rose above the target value to 78.3.

4. Outcome 2a: Computer-based tools.

Assessment cycle	Course	Cautionary score	Action taken
2004-06	Exit survey '06	66.7	No action taken
2006-08	Exit survey '07	66.7	MSE 310 course revised and expanded to 3 credit hours (now MSE 260)
2008-10	Exit survey '10	70.6	No action taken

This outcome deals with use of computers for data analysis and atomistic modeling of materials. Cautionary scores were received on 3 of the 6 senior surveys completed since the 2004 ABET visit. Furthermore, the assessment scores from the primary course devoted to this outcome (MSE 310: Computer Applications for Materials Engineering) have consistently been above the target value. No action was taken on this outcome after the 2006 exit survey. However, in 2008 this course was revised and expanded from two to three credit hours in spring 2009 as part of the MSE curriculum revision. The new course number is MSE 260. The syllabi for MSE 310 and MSE 260 can be reviewed and compared in Appendices A1 and A2. The 2009 exit survey score improved to 78.6 after these changes, but the 2010 exit survey score was below the target value. At this time, no additional action is planned for MSE 260.

5. Outcome 2c: Microscopy and diffraction.

Assessment cycle	Course	Cautionary score	Action taken
2006-08	MSE 430	64.2	A lab manual was written for this class which included a detailed explanation of the principles behind each experiment and outlined the experimental objectives and how they were to be addressed.

A review of the raw assessment data for MSE 430 for the 2006-08 assessment cycle reveals that students had a poor understanding of how to write several sections of the lab reports associated with microscopy and diffraction techniques. This was also evident in lab reports written for the mechanical property experiments in MSE 430 (see Outcome 2d below). To address this shortcoming, the instructor wrote a lab manual for this course which students purchased at the university bookstore. The manual included a detailed explanation of the principles behind each experiment, the experimental objectives and the specific lab report requirements. The assessment score for this outcome improved to 91.6 in the 2008-10 cycle.

6. Outcome 2d: Mechanical and thermal methods.

Assessment cycle	Course	Cautionary score	Action taken
2004-06	MSE 324	50.8	More emphasis given to the principles of the rate dependence of polymer mechanical properties. More emphasis given on how to write an effective lab report.
2004-06	MSE 430	56.7	New instructor was assigned to this course.
2006-08	MSE 430	58.4	More emphasis needed on the proper way to write a lab report. A detailed lab manual was produced (see discussion associated with MSE 430 in Outcome 2c above)

A review of the raw assessment data from MSE 324 in the 2004-06 cycle shows that students had a poor understanding of the rate dependence of polymer mechanical properties as demonstrated by low assessment scores on the Abstract, Introduction, Results and Discussion sections of the lab report associated with this outcome. During the next assessment cycle, more time was devoted to this topic during the background lecture for this experiment, and additional lecture time was devoted to a description of how to write an effective lab report at the beginning of the course. The assessment scores for this outcome improved to 88.6 and 90.6 over the next two assessment cycles.

After the low assessment score received in the 2004-06 assessment cycle for MSE 430, a new instructor was assigned. A similar low score was received in the 2006-08 cycle. The new instructor developed a lab manual for this course as discussed in Outcome 2c above. In the 2008-10 assessment cycle, this score improved to 92.4.

7. Outcome 2e: Electrical and magnetic methods.

Assessment cycle	Course	Cautionary score	Action taken
2004-06	Exit survey ‘05	73.3	None. Course-based assessment scores were high
2004-06	Exit survey ‘06	66.7	None. Course-based assessment scores were high

In addition to the senior exit survey, this outcome is also assessed in the lab courses MSE 210, MSE 333 and MSE 434. The course-based assessment scores were all well above the target value in 2004-06 (see Exhibit 3-10), but the exit survey scores do not reflect this. Since the course-based assessment scores were high, no action was taken. In the subsequent assessment cycles, all assessment scores, including exit survey scores, were above the target value.

8. Outcome 2f: Processing methods

Assessment cycle	Course	Cautionary score	Action taken
2004-06	MSE 556	65.9	More emphasis given to boron fiber composites and interface engineering of composites.
2006-08	MSE 556	71.3	More emphasis given to processing methods

The assessment scores in MSE 556 have steadily improved with each assessment cycle, and have risen to 80.8 in the 2008-10 assessment cycle. This improvement has resulted from the following changes made to this course:

- More time is spent on processing of fibers and composite materials
- More time is spent on applications of composite materials
- Participants are asked to prepare a term paper on composite materials of their interest. The term paper can be used to replace one of the three tests.
- Extensive mathematical analysis of laminates is reduced.

MSE 556 is one of five MSE processing courses used to assess this outcome and it is a graduate-level course. This is not consistent with the other MSE processing courses which are all taught at the senior undergraduate level. This discrepancy has been addressed in the new MSE curriculum by revising the content of MSE 556 and offering it as an undergraduate course (MSE 456), piggy-backed with a graduate course (MSE 556). The coverage of advanced topics such as laminate theory and micromechanics is significantly reduced in MSE 456, while coverage of composite processing and applications is increased. These changes are documented in the syllabi for these two courses, which appear in Appendices A1 and A2.

9. Outcome 3c: Written communication.

Assessment cycle	Course	Cautionary score	Action taken
2004-06	MSE 324	71.4	See actions taken for Outcomes 2c and 2d above.
2004-06	MSE 430	74.0	See actions taken for Outcomes 2c and 2d above.
2006-08	MSE 430	71.9	See actions taken for Outcomes 2c and 2d above.

This outcome is assessed extensively with input from eight different MSE courses (five lab courses, the two senior design courses and the MSE seminar course) as well as the senior exit survey. Out of 26 assessment scores collected over the past three assessment cycles, only the three above fell slightly below the target value of 75%. This is a direct result of the low scores received in Outcomes 2c and 2d for MSE 324 and MSE 430, since the assessment scores for these outcomes are based on the same lab report elements. This correlation is clearly shown in Exhibits 3-10 and 3-11 for MSE 324 and MSE 430. Actions taken in response to low assessment scores in Outcomes 2c and 2d have produced much higher assessment scores for Outcome 3c in the latest assessment cycle, as shown in Exhibit 3-12.

Other issues evaluated in the MSE senior exit survey

In addition to assessment of the MSE PLOs, the senior exit survey also polled the seniors about their preparation in the elements of materials science and engineering (structure, properties, processing and applications) and the balance in coverage of metals, ceramics, polymers, electronic materials and composites across the curriculum. Results are shown in Table 4-1. The assessment score for the elements of materials science and engineering is the percentage of students rating their preparation as good or higher. The scores are uniformly high in all areas for all graduating classes since 2005, except for the class of 2010 which rated their preparation in the area of applications somewhat lower. Overall, MSE students feel well-prepared in the elements of materials science and engineering.

The assessment score for the coverage of the various classes of materials is based on a scale from 1 to 5 in which 1 represents far too little coverage, 5 represents excessive coverage and 3 represents just the right amount of coverage. The score shown is the average rating given by the graduating seniors. The data generally show that too much coverage given to metals and not enough coverage is given to composite materials. The results for the other classes of materials vary about the ideal score of 3, but tend to be on the low side as well. The low score for coverage of composites is not surprising since the only course devoted entirely to composite materials is a technical elective (MSE 556). Some coverage of composites is provided in MSE 201 and MSE 450. MSE 556 has not been a popular elective choice, with only 15% of MSE students selecting it from 2005-2010. Changes that have been made to address this shortcoming are addressed in the discussion associated with MSE 556 and Outcome 2f above.

TABLE 4-1. Other issues evaluated in the MSE senior exit survey

TOPIC	2005	2006	2007	2008	2009	2010
Elements of MSE[1]						
Structure	93.3	96.2	100	100	100	100
Properties	100	100	100	100	100	100
Processing	83.3	96.2	100	100	100	88.2
Applications	96.7	88.5	100	83.3	92.9	64.7
Amount of coverage[2]						
Metals	3.37	3.42	3.08	3.42	4.00	4.18
Ceramics	2.80	2.92	2.50	2.92	3.00	2.82
Polymers	2.73	2.85	3.00	2.83	2.79	2.82
Electronic materials	2.83	2.73	2.58	3.33	2.71	2.29
Composites	1.53	1.80	1.53	1.42	1.71	1.47

[1]The score is the percentage of students rating their preparation as good or higher.
[2]The rating scale is 1 = far too little, 3 = just right, 5 = excessive.

MSE undergraduate curriculum revision

The discussion below refers to the older MSE curriculum (14MSE056) which was in effect since the 2004 ABET visit and the new MSE curriculum (14MSE097), for which implementation began in the spring 2009 semester and will finish in the spring 2011 semester. The eight-semester layouts for these two curricula are presented for comparison in Exhibits 4-1 and 4-2. The course-based assessment data discussed in this report came almost exclusively from curriculum 14MSE056, however most current MSE students are enrolled in curriculum 14MSE097. Thus, both curricula are presented and discussed in Section 5 of this report.

As noted in section A above, the motivation for a major revision in the MSE undergraduate curriculum came from several sources, including the MSE PLO assessment process. In the senior exit interviews, students often complained about the rigidity of the MSE curriculum. Although it included three technical electives, these had to be chosen from a list of only five MSE courses (a sixth elective course in Biomaterials Science was added in 2008). More flexibility in the choice of technical electives was desired so that students could “customize” their undergraduate curriculum for attending graduate school, entering industry or simply to take other engineering, basic science or math courses of interest to them. The basic framework on which curriculum 14MSE056 is based was developed in 1983. The field of materials science and engineering has changed significantly since then, with important new developments in the areas of nanomaterials, biomaterials, computer modeling and others. MSE faculty and the MSE course and curriculum committee felt it was time to modernize the undergraduate curriculum and include some of these topics. Finally, the university administration was contemplating a change in the General Education Program (GEP) requirements at the same time the new MSE curriculum was being developed. Changes to the university GEP necessitate a change in all NCSU curricula, so this was further motivation to make a change at this time. The new NCSU GEP went into effect in the fall 2009 semester.

The new MSE curriculum is being phased in on a semester-by-semester basis starting with the spring semester of the sophomore year. During each semester of the implementation process, the old curriculum courses are replaced by the new curriculum courses. This process began in the spring semester of 2009 and will end in the spring semester of 2011. The last class to graduate under the 14MSE056 curriculum is the class of 2010, and the first class to graduate under the 14MSE097 curriculum is the class of 2011.

The new MSE curriculum 14MSE097 incorporates the following changes and improvements:

- *Integration of concepts that are common to all classes of materials: metals, ceramics, polymers, semiconductors and composites into each course as much as possible.* This is a significantly different approach from all prior MSE curricula (at NCSU and many other universities) in which separate courses are taught for each different type of material. This curricular approach may become a national trend as the field of materials science and engineering becomes more interdisciplinary, necessitating a broader educational perspective. At least one prestigious university (MIT) has already adopted a similar integrated approach in their undergraduate MSE curriculum; more may follow.

  The integrated approach is exemplified by the course sequence MSE 300 (Structure of Materials at the Nanoscale), MSE 370 (Microstructure of Inorganic Materials) and MSE 380 (Microstructure of Organic Materials). In these courses, the traditional structure-property description of polymers, metals and ceramics is organized by size scale, rather than by material class. Metals and ceramics are combined in MSE 370, while MSE 380 includes polymers, biomaterials and other soft materials.
- *Modernization of the curricular content.* In the new curriculum, content has been added in the cutting-edge areas of nanotechnology (MSE 300), soft materials and biomaterials (MSE 380), computer modeling (MSE 260) and materials forensics including corrosion, degradation, failure analysis, etc. (MSE 480).
- *Revision of the technical elective requirements to provide more flexibility.* The 14MSE056 curriculum contains three technical electives that are restricted to a list of five or six MSE courses. The 14MSE097 curriculum increases the total number of technical electives to five. This number includes three general technical electives, one engineering elective and only one restricted MSE processing elective. To provide additional flexibility, engineering electives can also count as technical electives and MSE processing electives can count as engineering or technical electives. The non-MSE electives may be chosen from a long list of departmental-approved courses (see Exhibit 4-2).

The flexibility afforded by these electives allows students to customize their education to prepare them for careers in industry or for graduate school. Since non-MSE elective courses can now be used to partially satisfy the MSE degree requirements, it is easier for MSE students to pursue a minor or a double major. This also facilitates transfer of students into MSE from another curriculum or university.

- *Reduction and integration of the laboratory courses.* The 14MSE056 curriculum contains five laboratory courses totaling 6 credit hours. Separate labs are dedicated to metals, ceramics, polymers and semiconductors. This has led to overlapping content in different lab courses, a fact which was often pointed out by students during the senior exit interviews. In the proposed curriculum, these labs have been integrated into two 2-credit hour lab courses. The first lab course (MSE 255) covers methods for structural characterization of materials and the second (MSE 335) covers methods for measuring material properties. The analytical equipment used in these two courses is different, thus avoiding the possibility of redundant content. The final semester of the senior design sequence (MSE 470) also involves laboratory work and is retained in the new curriculum.
- *Improved accommodation of students transferring from other curricula or universities into the MSE program in the sophomore year.* This was accomplished by moving MSE 301 from the spring semester of the sophomore year (curriculum 14MSE056) into the fall semester of the junior year (curriculum 14MSE097). MSE 301 (thermodynamics) is a key pre-requisite course in the MSE curriculum, and students who miss this course cannot take many of the junior-level MSE courses. As a consequence, their graduation is delayed by a year. Moving MSE 301 one semester later in the curriculum may also improve the exit survey scores for the thermodynamics Outcome 1c, as discussed earlier in this section.

  In addition, the spring semester sophomore courses (MSE 255 and 260) are set up with the introductory course MSE 201 as a co-requisite instead of a pre-requisite. This allows students who do not take MSE 201 in the fall semester of the sophomore year to take it concurrently with the spring semester sophomore MSE courses. With these changes, students who have completed most of the freshman and sophomore chemistry, physics and math courses can transfer into MSE in the second semester of their sophomore year without losing any time toward graduation.
- *Moving the undergraduate seminar course from the senior year to the sophomore year.* This change also entails a change in the course number from MSE 491 to MSE 270. This course exposes students to contemporary topics in materials science and engineering and informs them of career options in the field. Taking this course early in the curriculum rather than at the end allows students to customize their curriculum to fit with their career plans and goals.
- *Reduction in the number of credit hours required in the major.* Curriculum 14MSE056 requires more hours in the major (54) than any other engineering department at NCSU. This number is reduced to 45 in the proposed curriculum, which is more in line with the average number of credit hours (41) required by other NCSU engineering departments. The reduction in MSE credit hours is accompanied by a reduction in the number of required MSE courses from 22 to 17.
- *Provision of a systematic numbering scheme for the required courses in the curriculum.* The course numbers in 14MSE056 do not consistently reflect the year or semester in which the

course is taken by students. The courses in the proposed curriculum are numbered 2xx, 3xx and 4xx for sophomore-, junior- and senior-level courses, respectively. Furthermore, fall semester courses are numbered from x00 – x49 and spring semester courses are numbered from x50 – x99.

The specific actions taken in the MSE curriculum revision and their effect on credit hours are summarized in Table 4-2 below. The net change in credit hours required for graduation did not change and remains at 127. Although Exhibit 4-2 shows that the *minimum* number of hours required to graduate under 14MSE097 is 126, this would require the availability of 2-credit hour humanities courses. The new NCSU GEP requirements were designed to allow for such courses. At this time, only 3-credit hour humanities courses are available, so the *actual* number of hours remains at 127.

TABLE 4-2. Specific actions taken in the MSE curriculum revision

ACTION	Credits removed	Credits added
A. Add new MSE courses which integrate concepts across all classes of materials. New courses added include MSE 300, 320, 335, 370, 380 and 480.	0	17
B. Revise some existing MSE courses to integrate coverage across all classes of materials and make other changes as needed. Some of these courses have also been renumbered. Existing courses that have been revised but retained in the new curriculum include (new number in parentheses): MSE 210(255), 301, 310(260), 321(360), 331(355), 423, 424(470), 450(420) and 491(270). Changes in credit hours for some of these courses results in a net reduction of 1 credit hour.	2	1
C. Remove MSE courses no longer required. The following courses do not appear in the new curriculum and will be deleted when all students in the 14MSE056 curriculum have completed them: MSE 324, 330, 333, 425, 430, 431, 434 and 435.	19	0
D. Change the technical elective requirements. The number of required MSE electives has been reduced from 3 courses to 1 course. Three technical electives and 1 engineering elective have been added, which may be chosen from a long list of courses approved by the MSE department.	6	12
E. Remove ECE 331 as a required course. This course remains on the list of approved technical electives so interested students may still take it as part of their degree requirements.	3	0
Totals	30	30
Net change in hours required for graduation	0	

To integrate the concepts common to all classes of materials, the content of many the courses in the 14MSE056 curriculum was dispersed and reorganized into new or revised courses in the 14MSE097 curriculum. Table 4-3 shows which courses from the 14MSE056 curriculum provided content for the courses in the 14MSE097 curriculum. An asterisk denotes courses which are new or have been significantly revised compared to the 14MSE056 curriculum.

TABLE 4-3

Relationship between courses in the 14MSE097 and 14MSE056 curricula

Curriculum 14MSE097		**Content taken from these courses in curriculum 14MSE056**	
Course	**Credit hrs**	**Course**	**Credit hrs**
MSE 201	3	MSE 201	3
MSE 255*	2	MSE 210 MSE 324 MSE 430	2 1 1
MSE 260*	3	MSE 310	2
MSE 270	1	MSE 491	1
MSE 300*	3	MSE 330 MSE 425	3 3
MSE 301	3	MSE 301	3
MSE 320*	3	MSE 450	3
MSE 335*	2	MSE 324 MSE 434 MSE 333 MSE 430	1 1 1 1
MSE 355	3	MSE 331	3
MSE 360	3	MSE 321	3
MSE 370*	3	MSE 431 MSE 435	3 3
MSE 380*	3	MSE 425	3
MSE 420*	3	MSE 450 MSE 425	3 3
MSE 423*	1	MSE 423	3
MSE 470	3	MSE 424	3
MSE 480*	3	---	---
MSE 440	3	MSE 440	3
MSE 445	3	MSE 445	3
MSE 455	3	MSE 455	3
MSE 456*	3	MSE 556	3
MSE 490* Biomaterials	3	---	---
MSE 490* Nanomaterials	3	---	---
MSE 490* Bio-nanomaterials	3	---	----

*New or significantly revised course

EXHIBIT 4-1
MATERIALS SCIENCE AND ENGINEERING CURRICULUM 14MSE056

FRESHMAN YEAR

Fall Semester			Cr.	Spring Semester			Cr.
CH	101	Chemistry, A Molecular Science	3	CH	201	Chemistry, A Quantitative Science	3
CH	102	General Chemistry Lab.	1	CH	202	Quantitative Chemistry Lab.	1
E	101	Intro. to Engr. & Prob. Solving	1	MA	241	Calculus II	4
E	115	Intro. to Computing Environment	1	PY	205	Physics for Engr. & Scientists I	4
ENG	101	Academic Writing and Research	4	PE	10x	Fitness and Wellness	1
MA	141	Calculus I	4	***	***	Humanities & Soc. Sci. Elective[1]	3
***	***	Humanities & Soc. Sci. Elective[1]	3				
			17				16

SOPHOMORE YEAR

Fall Semester			Cr.	Spring Semester			Cr.
MSE	201	Struct. & Prop. of Engr. Materials	3	MSE	210	Materials Characterization Lab.	2
CSC	11x	Introduction to Computing[2]	3	MSE	301	Equilibrium & Rate Processes	3
MA	242	Calculus III	4	CH	220	Introductory Organic Chemistry	4
PY	208	Physics for Engr. & Scientists II	4	MA	341	Appl. Differential Eqns. I	3
PE	***	Physical Education Elective	1	***	***	Humanities & Soc. Sci. Elective[1]	3
			15				15

JUNIOR YEAR

Fall Semester			Cr.	Spring Semester			Cr.
MSE	310	Computer Appl. for Materials Eng.	2	MSE	321	Phase Transformations & Diffusion	3
MSE	324	Polymer Characterization Lab.	1	MSE	331	Electronic Properties of Materials	3
MSE	330	Crystal Chemistry & Phase Equil.	3	MSE	333	Electronic Properties Laboratory	1
MSE	350	Mechanical Prop. of Materials I	3	MSE	434	Ceramic Engineering Lab.	1
MSE	425	Intro. to Polymeric Materials	3	MSE	435	Physical Ceramics	3
***	***	Humanities & Soc. Sci. Elective[1]	3	MSE	450	Mechanical Prop. of Materials II	3
				ENG	33x	Technical Writing Elective[3]	3
			15				17

SENIOR YEAR

Fall Semester			Cr.	Spring Semester			Cr.
MSE	423	Intro. to Materials Engr. Design	3	MSE	424	Senior Design Project	3
MSE	430	Physical Metallurgy Lab	1	MSE	***	MSE Technical Elective[4]	3
MSE	431	Physical Metallurgy	3	ECE	331	Principles of Electrical Engr. I	3
MSE	491	Materials Engineering Seminar	1	***	***	Humanities & Soc. Sci. Elective[1]	3
MSE	***	MSE Technical Elective[4]	3	***	***	Humanities & Soc. Sci. Elective[1]	3
MSE	***	MSE Technical Elective[4]	3				
***	***	Humanities & Soc. Sci. Elective[1]	3				
			17				15

Minimum Total Credit Hours Required for Graduation = 127

[1] Humanities and Social Science courses are to be selected from the appropriate list approved by the College of Engineering. One of these courses must be an Ethics course chosen from the following list: IDS 201, STS 302, STS 304, STS 320, STS 325, PHI 375, PHI 214 or PHI 221.
[2] Either CSC 112 (Fortran) or CSC 116 (Java).
[3] Either ENG 331 or ENG 333.
[4] Choose any three courses from the following list: MSE 440, MSE 445, MSE 455, MSE 460 or MSE 556. These electives may be taken in any combination either semester of the senior year by swapping MSE electives with HSS electives.

EXHIBIT 4-2
MATERIALS SCIENCE AND ENGINEERING CURRICULUM 14MSE097

FRESHMAN YEAR

Fall Semester		Cr.	Spring Semester		Cr.
CH 101	Chemistry, A Molecular Science[1]	3	CH 201	Chemistry, A Quantitative Science	3
CH 102	General Chemistry Lab.[1]	1	CH 202	Quantitative Chemistry Lab.	1
E 101	Intro. to Engr. & Problem Solving[1]	1	MA 241	Calculus II[1]	4
E 115	Intro. to Computing Environment[1]	1	PY 205	Physics for Engineers & Scientists I[1]	4
ENG 101	Academic Writing and Research[1]	4	PE 10x	Fitness and Wellness Course*	1
MA 141	Calculus I[1]	4	*** ***	GEP Requirement*	3
EC 205	Economics (or EC 201 or ARE 201)*	3			16
		17			

SOPHOMORE YEAR

Fall Semester		Cr.	Spring Semester		Cr.
MSE 201	Structure & Prop. of Engr. Materials[1]	3	MSE 255	Exp. Meth. Struct. Analysis of Matls.	2
CSC 11x	Introduction to Computing	3	MSE 260	Math. Methods for Materials Engrs.	3
MA 242	Calculus III	4	MSE 270	MSE Seminar	1
PY 208	Physics for Engineers & Scientists II	4	CH 220	Introductory Organic Chemistry	4
PE ***	Physical Ed./Healthy Living Elective*	1	MA 341	Applied Differential Equations I	3
		15	*** ***	GEP Requirement*	3
					16

JUNIOR YEAR

Fall Semester		Cr.	Spring Semester		Cr.
MSE 300	Structure of Materials at Nanoscale	3	MSE 355	Elect., Mag. & Opt. Prop. of Materials	3
MSE 301	Intro. to Thermodynamics of Matls.	3	MSE 360	Kinetic Processes in Materials	3
MSE 320	Intro. to Defects in Solids	3	MSE 370	Microstructure of Inorganic Materials	3
MSE 335	Exp. Meth. Analysis of Matls. Prop.	2	MSE 380	Microstructure of Organic Materials	3
*** ***	GEP Requirement*	3	*** ***	Engineering Elective[2]	3
*** ***	GEP Requirement*	3			15
		17			

SENIOR YEAR

Fall Semester		Cr.	Spring Semester		Cr.
MSE 420	Mechanical Properties of Materials	3	MSE 470	Mat. Sci. & Eng. Design Project	3
MSE 423	Intro. to Materials Eng. Design	1	MSE 480	Materials Forensics	3
ENG 331	Technical Writing (or ENG 333)	3	*** ***	MSE processing elective[3]	3
*** ***	Technical Elective[2]	3	*** ***	Technical Elective[2]	3
*** ***	Technical Elective[2]	3	*** ***	Ethics Elective (GEP Requirement*)[4]	2-3
*** ***	GEP Requirement*	3			14-15
		16			

Minimum total credit hours required for graduation: 126[I,J,K]

EXHIBIT 4-2 (continued)
MATERIALS SCIENCE AND ENGINEERING CURRICULUM 14MSE097

Major/Program requirements and footnotes:
1. Matriculation course. Minimum grade of C-.
2. Choose from departmental approved list.
3. Choose any course from the following list: MSE 440, MSE 445, MSE 455, MSE 456, or MSE 460.
4. Ethics course must be chosen from the following list: IDS 201, STS 302, STS 304, STS 320, STS/PHI 325, PHI 214, PHI 221, or PHI 375

***General Education Program (GEP) requirements and GEP Footnotes:**
To complete the requirements for graduation and the General Education Program, the following category credit hours and co-requisites must be satisfied. University approved GEP course lists for each of the following categories can be found at

http://www.ncsu.edu/uap/academic-standards/gep/courselists/index.html.

A. Mathematical Sciences (6 credit hours – one course with MA or ST prefix)
Fulfilled as part of the Major requirements.

B. Natural Sciences (7 credit hours – include one laboratory course or course with a lab)
Fulfilled as part of the Major requirements.

C. Humanities (6 credit hours selected from two different disciplines/course prefixes)
Choose from the University approved GEP Humanities course list .

D. Social Sciences (6 credit hours selected from two different disciplines/course prefixes)
Choose 3 credits from the University approved GEP Social Sciences course list in a discipline other than Economics. Economics 205 (or EC 201 or ARE 201), taken as part of the Major requirements, satisfies 3 credit hours needed to fulfill the GEP Social Sciences requirement.

E. Physical Education/Healthy Living (2 credit hours – at least one 100-level Fitness and Wellness Course). *Choose from the University approved GEP Physical Education/Healthy Living course list.*

F. Additional Breadth - (3 credit hours to be selected from the following checked University approved GEP course lists)
_**x**_ *Humanities/Social Sciences/Visual and Performing Arts*
or ____*Mathematical Sciences/Natural Sciences/Engineering*

G. Interdisciplinary Perspectives (5-6 credit hours)
Choose from the University approved GEP Interdisciplinary Perspectives course list.

H. Introduction to Writing (4 credit hours satisfied by completing ENG 101 with a C- or better)

The following **Co-Requisites** must be satisfied to complete the General Education Program requirements:

I. U.S. Diversity (USD)
Choose from the University approved GEP U.S. Diversity course list or choose a course identified on the approved GEP course lists as meeting the U.S. Diversity (USD) co-requisite.

J. Global Knowledge (GK)
Choose from the University approved GEP Global Knowledge course list or choose a course identified on the approved GEP course lists as meeting the Global Knowledge (GK) co-requisite.

K. Foreign Language proficiency: Proficiency at the FL_102 level is required for graduation.

EXHIBIT 4-2 (continued)
MATERIALS SCIENCE AND ENGINEERING CURRICULUM 14MSE097

APPROVED ELECTIVES

MSE Processing Electives	Engineering Electives	Technical Electives
MSE 440 Proc. of Metallic Materials MSE 445 Ceramics Processing MSE 455 Polymer Tech. and Eng. MSE 456 Composite Materials MSE 460 Microelectronic Materials	All MSE Processing Electives MSE 350 Mech. Prop. of Materials I MSE/NE 409 Nuclear Materials MSE 490: Special topics: Biomaterials CE 214 or MAE 206 Statics CE 215 or MAE 208 Engrg. Dynamics CE 313 or MAE 314 Solid Mechanics CSC 200 Intro to Computers and Uses ECE 331 Intro to Circuits ISE/GC 210 Intro Engineering Graphics ISE 311 Engineering Economic Analysis NE 202 Radiation Sources Lab (4 hrs) TE 205 Analog & Digital Circuits (4 hrs)	All MSE Processing Electives All Engineering Electives BCH 451 Principles of Biochem. (4 hrs. prereq. CH 223) CH 221/223 Organic Chemistry (8 hrs., one semester substitutes for CH 220) CH 315 Quantitative Analysis CH 437 Physical Chem. for Engr. CH 401 Inorganic Chemistry MA 305 Elementary Linear Algebra MA 351 Intro. to Discrete Math. Models MA 401 Applied Differential Eqs. II MA 402 Comp. Math: Models, Methods and Analysis MA 405 Intro. to Lin. Alg. & Matrices PY 328 Astrophysics PY 407 Modern Physics PY 411/412 Mechanics I & II PY 414/415 Electromagnetism I & II MEA/PY 463 Fluid Physics ST 370 Prob. and Statistics for Engrs.

CRITERION 5. CURRICULUM

A. Program curriculum

As described in Section 4, a major revision of the MSE undergraduate curriculum took place in 2009. Curriculum 14MSE056 (Exhibit 4-1), which was in place at the time of the 2004 ABET visit, was replaced by curriculum 14MSE097 (Exhibit 4-2) in the spring semester of 2009. The 14MSE097 curriculum is being phased in one semester at a time and this transition will be complete at the end of the spring 2011 semester. Nearly all of the assessment data in this report was obtained under the 14MSE056 curriculum, and all MSE students graduating through the spring 2010 semester will complete the requirements of this curriculum. For these reasons, most of the discussion in this section will refer to curriculum 14MSE056. Parallel discussion of the 14MSE097 curriculum is provided when appropriate.

1. Preparation of students for a professional career

Students are exposed to engineering concepts and design beginning with the general freshman engineering course, E 101. Students work in interdisciplinary teams and learn how to solve problems from a general engineering perspective. First-semester sophomores get an overview of the field of materials science and engineering in the survey course, MSE 201. In the 14MSE056 curriculum, this is followed in the second semester by a laboratory course (MSE 210) which introduces students to statistical treatment of experimental data, design of experiments and a variety of analytical techniques commonly used to characterize the properties of materials. In the same semester, students take a thermodynamics course (MSE 301) which provides them with the fundamental principles and applications of thermodynamics, including phase diagrams, solution behavior and chemical reactions. The junior year consists primarily of MSE courses which include three of the four materials-specific courses with associated labs (polymers, ceramics, electronic materials), as well as generic MSE courses covering computer applications, mechanical properties, phase transformations, crystallography and phase diagrams. The junior-year courses provide a mix of engineering science and design topics that familiarize students with underlying principles that apply to all classes of materials and structure-property relationships for each specific class of materials. The final materials-specific course and lab (MSE 431/430- metallurgy) is taken during the first semester of the senior year, concurrently with the first semester of the senior design sequence. The senior year contains the capstone senior design sequence (MSE 423/424) which gives students hands-on experience in solving a real-world materials problem and bridges the gap between the classroom and an industrial setting. During the senior year, students also select three MSE technical electives which focus on processing and applications of materials.

As noted in Section 4, the 14MSE097 curriculum integrates concepts from the different classes of materials into each course as much as possible. The freshman year in the 14MSE097 curriculum is unchanged from the 14MSE056 curriculum. The sophomore year in the 14MSE097 curriculum also contains the survey course MSE 201 in the fall semester. The spring semester contains an integrated structure characterization laboratory course (MSE 255), an expanded course in mathematical methods and computer applications (MSE 260), and a seminar course (MSE 270) which exposes students to career options in materials science and engineering, graduate school, contemporary topics in the field and other subjects. The junior year contains an integrated properties-characterization lab course (MSE 335), and courses which cover defects, thermodynamics, kinetics and structure-property relationships for all classes of materials. The junior courses cover engineering science and design topics, and prepare the student for the senior design sequence (MSE 423/470) in the senior year. The senior year also contains an integrated course in mechanical properties (MSE 420), a new course in materials forensics (MSE 480) and a materials-specific processing elective (chosen from MSE 440, 445, 455, 456 or 460). The processing electives are applications-based and provide processing and design concepts for specific classes of materials. With the exception of MSE 456, these electives are essentially unchanged from curriculum 14MSE056. Three technical electives and one engineering elective are taken in the junior and senior years. These are chosen from a long list of departmental-approved math, basic science and engineering courses (see Exhibit 4-2), and allow students to customize their curriculum for entering industry, graduate school or another career path. Students may elect to take additional MSE processing electives to fulfill the technical or engineering electives.

Consistency of the MSE curriculum with the PEOs and PLOs
The relationship between the MSE PLOs and the courses in the MSE curriculum was discussed in Sections 3B and 3C and can readily be seen in Exhibit 3-3, which identifies the courses having significant content relating to each MSE outcome. By design, the MSE PLO assessment plan is course-based, so there is a direct relationship between the PLOs and the courses in the MSE curriculum. In turn, the MSE PLOs are directly aligned with the MSE PEOs as described in Sections 3B and 3C. MSE courses used to assess each outcome are shown in Exhibits 3-10, 3-11 and 3-12. MSE outcomes 4a, 4b, 4c and 4d, along with the associated MSE PEO #4, are covered primarily by courses outside of MSE (*e.g.* NCSU GEP courses and E 101), and are assessed via the MSE senior exit survey. To help address outcome 4b (professional and ethical responsibility), MSE majors must take an ethics-related course as one of the required GEP courses (see footnotes in Exhibits 4-1 and 4-2).

2. Minimum credit hours and credit hour distribution
Both MSE curricula 14MSE056 and 14MSE097 exceed the minimum credit hours required for each curricular component. Refer to Tables 5-1a and 5-1b. A minimum of 35 hours of math and basic science courses are included in both curricula (excluding the computer science course CSC 11x), which exceeds the minimum requirement of 32 hours. The basic science courses also include a significant amount of laboratory experience, as each of the five required chemistry and physics courses has an associated laboratory. A total of 58 hours of engineering courses is included in curriculum 14MSE056, which greatly exceeds the minimum of 48 hours. Fifty percent of these courses also have significant design content. Curriculum 14MSE097 has anywhere from 49-58 hours of engineering courses, depending on which technical electives are selected. A feature of the new 14MSE097 curriculum is that it meets the minimum ABET credit hour requirements for each curricular component excluding the three technical electives. The courses chosen to fulfill these electives will put additional credit hours into the math/basic science and engineering categories.

The general education courses complement the engineering component and help to address the softer ABET outcomes relating to ethics, global impact of engineering, contemporary issues and life-long learning. These courses comprise a significant fraction (22.8%) of the undergraduate curriculum.

Tables 5-2a and 5-2b list the courses taught in the most recent semesters for the 14MSE056 and 14MSE097 curricula, respectively. Fall 2008 was the last semester in which only 14MSE056 courses were offered. The spring 2009 semester marked the beginning of the transition to the new curriculum 14MSE097, and each semester since then has a mix of courses from each curriculum. The last semester in which courses from the 14MSE056 curriculum were taught was the spring 2010 semester.

3. The MSE capstone senior design course

The MSE senior design course sequence (MSE 423/424) has been very successful and has continued to evolve and improve in fruitful ways for 22 years. From 1988 to 2010, 479 students have worked on 136 different industrial projects with three to five students per team. A listing of the senior design projects, industrial sponsors and composition of the teams from 2005–2010 is provided in Table 5-3. Example project summaries from the 2009 senior design teams are provided in Table 5-4. Additional materials from the 2005-2010 senior design projects will be available to the evaluator during the 2010 visit.

The success of the MSE senior design course is attributed to (a) the proximity of a large and diverse industrial community which provides opportunities for interaction with research, development, engineering and manufacturing activities in both high-tech and traditional product lines which cut across the fields of ceramics, metals, polymers, microelectronics and composites, (b) the technical expertise, extensive industrial experience and marketing abilities of the past and present program coordinators, (c) the considerable time commitments made by faculty advisors, drawing upon their academic and industrial experience and (d) the high quality of research and development work produced by the senior design teams.

In the first semester of the sequence, MSE 423 provides a strong preparatory base for engineering design. It includes open-ended classroom exercises and student involvement in group dynamics, teamwork, visual and spatial perception, creative synthesis, the interdependence of design with analysis and evaluation and other “tools of the trade”. Recently even more emphasis has been placed on (a) rekindling the creativity of the seniors, (b) improving further oral and written communication skills, (c) materials selection exercises and (d) greater use of cooperative and problem-based learning techniques. In the second half of the semester, real-world problems are introduced, carefully selected from and supported by local industries. The problems range widely in subject matter but all draw on the knowledge and skills learned from MSE courses earlier in the curriculum. They are drawn from pressing materials problems currently being experienced by the sponsoring company and there may already be some company effort being directed toward their solutions. Thus, the problems selected have both technical and economic significance and they carry a sense of urgency. Teams comprised of three or four students, an industrial liaison and a MSE faculty advisor are assigned to each project. By the end of the semester, the team has developed, refined and presented a written proposal for a solution to the problem acceptable to the sponsor.

At the outset of the second semester (MSE 424, number changed to MSE 470 in the 14MSE097 curriculum), the teams, working independently, meet with their respective liaisons and set their own schedules of action. Often, special production sequences are called for and the industrial liaison (a working engineer) must approve and schedule fabrication or testing. The bulk of the semester is spent working on the problem with few class meetings, but a firm timetable for completion is enforced. The student teams are strongly encouraged to meet with their faculty advisor at least once a week to review their progress, plan the following week's activities, and assign tasks among themselves. In keeping with the real world nature of the program, quarterly and mid-term project reviews are held by the program coordinator (currently Keith Dawes). These are formal presentations (accompanied by written reports) designed to convey the progress the teams have made and to assess how closely the accomplishments agree with the timelines given in their project proposals developed at the end of MSE 423. Roadblocks and means of overcoming them are discussed as well as a work plan for the following 30 days. The students also submit peer evaluation forms which are a good indicator of individual contributions to the team effort. The course grade is based on the quarterly and mid-term reviews, peer evaluations, the final written team report and the final oral presentation. The latter is a formal event/competition which is videotaped with an audience and is judged by a panel of three or four distinguished materials scientists (academic and industrial). Prizes are awarded for the best oral presentation and the best written report. Design teams also prepare a research poster which is presented at the annual NC State Undergraduate Research symposium held near the end of the spring semester.

The senior design course requires students to draw upon the knowledge and skills learned from many MSE and non-MSE courses leading up to the final senior semester. Senior design projects cover a wide range of materials and processes which require application of the fundamental principles of materials science, structure-property relationships, experimental and computer methods of analysis, processing and fabrication. Students work in teams and therefore must also have an appreciation for ethical principles and professional responsibility. The principal courses in the MSE curricula which prepare students for each of these senior design components are listed in the table below. Nearly all of these courses are completed by the time students enroll in the project phase (final semester) of the senior design sequence, thus students are well-prepared to address their design project.

Courses in the MSE curricula which prepare students for the senior design project

Senior design component	Courses in 14MSE056	Courses in 14MSE097
Fundamental principles	Basic chemistry, physics, and math courses MSE 301, 330, 350, 450	Basic chemistry, physics, and math courses MSE 301, 320, 360, 420
Structure-property relationships for all classes of materials	MSE 201, 425, 434, 331, 431	MSE 201, 300, 370, 380, 480
Experimental methods	MSE 210, 324, 434, 333, 430	MSE 255, 335
Computer methods and data analysis	CSC 11x, MSE 310	CSC 11x, MSE 260
Fabrication and processing	MSE 440, 445, 455, 460, 556	MSE 440, 445, 455, 456, 460
Ethical behavior and professional responsibility	Required ethics elective	Required ethics elective

Incorporation of standards and constraints into the senior design experience
The MSE senior design projects have historically incorporated the use of engineering standards and realistic constraints. In general, standard ASTM testing procedures are used for measurement of properties whenever possible. Any work carried out at the sponsoring company's facility must adhere to that company's policies regarding use of such standards, proper safety procedures and environmentally-conscious disposal of wastes. Similar standards are in place for work carried out in NCSU labs. Each team is provided with a budget, which imposes an economic constraint. Each senior design project incorporates many of these constraints, ensuring that all students are exposed to the need for including these concerns in any engineering design process.

4. Coverage allocated to each curricular component
Coverage of the curricular components identified as Basic Math and Science, Engineering Topics, General Education and Other is shown in Tables 5-1a and 5-1b for MSE curricula 14SMSE056 and 14MSE097, respectively. As noted in section A-2 above, both MSE curricula provide adequate coverage of each curricular component and they exceed the minimum requirements for Math, Basic Science and Engineering Topics.

A more program-specific evaluation of curricular coverage can be made by using the ABET program criteria for MSE programs to define the curricular components. The MSE program criteria specify that MSE graduates must have:

A. the ability to apply advanced science and engineering principles to materials systems;
B. an integrated understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing and performance;
C. the ability to apply and integrate knowledge from each of the above four elements to solve materials selection and design problems;
D. the ability to utilize experimental, statistical and computational methods consistent with the program educational objectives.

These criteria are directly aligned with the MSE PLOs as shown in Exhibit 3-2 and discussed in Section 3. In that section it was shown that the MSE program is achieving all of its outcomes and meeting the MSE program criteria. This is evidence that adequate coverage is being given to each curricular component. To identify which courses in the MSE curricula provide coverage of each numbered curricular component above, refer to the table below. The detailed contents of each course can be found in the syllabi in Appendices A1 and A2. This table shows that both curricula allocate an adequate amount of coverage to each curricular component as specified in the ABET MSE program criteria.

Courses related to the MSE curricular components

Curricular component	MSE Courses in 14MSE056	MSE Courses in 14MSE097
A	MSE 201, 301, 321, 330, 331, 350, 450	MSE 201, 301, 355, 360, 420
B	MSE 331, 425, 431, 435	MSE 300, 320, 370, 380, 480
C	MSE 423, 424, 440, 445, 455, 460, 556	MSE 423, 470, 440, 445, 455, 456, 460
D	MSE 210, 310, 324, 333, 430, 434	MSE 255, 260, 335

5. Cooperative education requirements

The MSE program does not require a cooperative education experience as part of its degree requirements. Nevertheless, a few MSE students have successfully completed a co-op experience. This requires three co-op sessions, usually two semesters and a summer, and necessarily extends the time required to complete the BS degree by one year. In other engineering curricula, students can usually alternate co-op semesters with semesters on campus without losing more than a year toward graduation. This is harder to do in the MSE curriculum, since all required MSE courses are taught only once per year (except MSE 201). Students who take a semester off to work on a co-op miss the pre-requisites for MSE courses in the following semester. This can delay graduation by more than one year. The best way for MSE students to complete a co-op is to schedule their work experience in consecutive fall, spring and summer sessions (if permitted by the co-op company). Classes are then resumed at the same point where they left off a year later, and only one year is lost toward graduation.

6. Additional materials that will be available for review during the visit (per section II.E.3.c of the 2010-11 APPT manual)

- Examples of student work for each assignment from all MSE courses taught in the fall 2009 and spring 2010 semesters, including high, average and low grades.
- Examples of lab reports
- Senior design final written reports
- Senior design team final presentations (PowerPoint slides)
- Senior design team final presentations (videotapes)

B. Pre-requisite tables

A flow-chart representation of the pre-requisite structure in the MSE curriculum would be too convoluted, especially for curriculum 14MSE056, thus a tabular format was chosen. Pre-requisites and co-requisites for curriculum 14MSE056 are shown in Table 5-5a, and those for curriculum 14MSE097 are shown in Table 5-5b. The pre-requisite structure was simplified considerably in the new curriculum 14MSE097.

C. Course syllabi

Course syllabi from MSE curriculum 14MSE056 are presented in Appendix A1. Course syllabi from curriculum 14MSE097 are presented in Appendix A2. All non-engineering syllabi are presented in the Institutional Summary (Appendix D).

TABLE 5-1a. MATERIALS SCIENCE AND ENGINEERING CURRICULUM 14MSE056

Semester	Course	Math & Basic Science	Engineering Topics (D = Design)	General Ed.	Other
Freshman Fall	CH 101: Chemistry, A Molecular Science	3			
	CH 102: General Chemistry Lab	1			
	E 101: Intro. to Engr. & Problem Solving		1 (D)		
	E 115: Intro. to Computing Environment			1	
	ENG 101: Academic Writing and Research			4	
	MA 141: Calculus I	4			
	Humanities and Social Science Elect.			3	
Freshman Spring	CH 201: Chemistry, A Quantitative Science	3			
	CH 202: Quantitative Chemistry Lab	1			
	MA 241: Calculus II	4			
	PY 205: Physics for Engrs. and Scientists I	4			
	PE 10x: Fitness and Wellness Elective				1
	Humanities and Social Science Elect.			3	
Sophomore Fall	MSE 201: Struct. & Prop. of Engr. Materials		3		
	CSC 11x: Introduction to Computing				3
	MA 242: Calculus III	4			
	PY 208: Physics for Engrs. & Scientists II	4			
	PE xxx: Physical Education Elective				1
Sophomore Spring	MSE 210: Materials Characterization Lab.		2		
	MSE 301: Equilibrium and Rate Processes		3		
	CH 220: Introductory Organic Chemistry	4			
	MA 341: Applied Differential Equations I	3			
	Humanities and Social Science Elect.			3	
Junior Fall	MSE 310: Computer Appl. for Mat. Eng.		2		
	MSE 324: Polymer Characterization Lab.		1		
	MSE 330: Crystal Chemistry & Phase Equil.		3		
	MSE 350: Mechanical Prop. of Materials I		3		
	MSE 425: Intro. to Polymeric Materials		3 (D)		
	Humanities and Social Science Elect.			3	
Junior Spring	MSE 321: Phase Transf. & Diffusion		3		
	MSE 331: Electronic Prop. of Materials		3 (D)		
	MSE 333: Electronic Properties Lab.		1 (D)		
	MSE 434: Ceramic Engineering Lab.		1		
	MSE 435: Physical Ceramics		3 (D)		
	MSE 450: Mechanical Prop. of Materials II		3 (D)		
	ENG 33x: Technical Writing Elective			3	
Senior Fall	MSE 423: Intro. to Materials Engr. Design		3 (D)		
	MSE 430: Physical Metallurgy Lab.		1		
	MSE 431: Physical Metallurgy		3 (D)		
	MSE 491: Materials Engineering Seminar		1		
	MSE xxx: MSE Technical Elective		3 (D)		
	MSE xxx: MSE Technical Elective		3 (D)		
	Humanities and Social Science Elect.			3	
Senior Spring	MSE 424: Mat. Sci. & Eng. Design Project		3 (D)		
	MSE xxx: MSE Technical Elective		3 (D)		
	ECE 331: Principles of Electrical Engr. I		3		
	Humanities and Social Science Elect.			3	
	Humanities and Social Science Elect.			3	
TOTALS– ABET Basic Level Requirements		**35**	**58**	**29**	**5**
OVERALL TOTAL FOR DEGREE	**127**				
PERCENT OF TOTAL		**27.6%**	**45.7%**		
Totals must satisfy one set of requirements:					
MINIMUM SEMESTER CREDIT HOURS		**32 hrs**	**48 hrs**		
MINIMUM PERCENTAGE		**25%**	**37.5%**		

TABLE 5-1b. MATERIALS SCIENCE AND ENGINEERING CURRICULUM 14MSE097

Semester	Course	Math & Basic Science	Engineering Topics (D = Design)	General Ed.	Other
Freshman Fall	CH 101: Chemistry, A Molecular Science	3			
	CH 102: General Chemistry Lab	1			
	E 101: Intro. to Engr. & Problem Solving		1 (D)		
	E 115: Intro. to Computing Environment			1	
	ENG 101: Academic Writing and Research			4	
	MA 141: Calculus I	4			
	EC 201 (or ARE 201): Economics			3	
Freshman Spring	CH 201: Chemistry, A Quantitative Science	3			
	CH 202: Quantitative Chemistry Lab	1			
	MA 241: Calculus II	4			
	PY 205: Physics for Engrs. and Scientists I	4			
	PE 10x: Fitness and Wellness Elective				1
	GEP Requirement			3	
Sophomore Fall	MSE 201: Struct. & Prop. of Engr. Materials		3		
	CSC 11x: Introduction to Computing				3
	MA 242: Calculus III	4			
	PY 208: Physics for Engrs. & Scientists II	4			
	PE xxx: Phys. Ed./Healthy Living Elective				1
Sophomore Spring	MSE 255: Materials Structure Analysis Lab		2		
	MSE 260: Math. Methods. Mat. Engineers		3		
	MSE 270: MSE Seminar		1		
	CH 220: Introductory Organic Chemistry	4			
	MA 341: Applied Differential Equations I	3			
	GEP Requirement			3	
Junior Fall	MSE 300: Structure of Matls. at Nanoscale		3		
	MSE 301: Intro. to Thermo. of Materials		3		
	MSE 320: Intro. to Defects in Solids		3		
	MSE 335: Materials Property Analysis Lab		2		
	GEP Requirement			3	
	GEP Requirement			3	
Junior Spring	MSE 355: Elec., Mag., Opt. Prop of Matls.		3 (D)		
	MSE 360: Kinetic Processes in Materials		3		
	MSE 370: Microstructure Inorg. Materials		3 (D)		
	MSE 380: Microstructure Organ. Materials		3 (D)		
	Engineering Elective		3		
Senior Fall	MSE 420: Mechanical Properties of Matls.		3 (D)		
	MSE 423: Intro. to Materials Engr. Design		1 (D)		
	ENG 331: Technical Writing			3	
	Technical Elective*	(3)*	(3)*		
	Technical Elective*	(3)*	(3)*		
	GEP Requirement			3	
Senior Spring	MSE 470: Mat. Sci. & Eng. Design Project		3 (D)		
	MSE 480: Materials Forensics		3 (D)		
	MSE xxx: MSE Processing Elective		3 (D)		
	Technical Elective*	(3)*	(3)*		
	Ethics Elective			3	
TOTALS– ABET Basic Level Requirements		**35–43**	**49–58**	**29**	**5**
OVERALL TOTAL FOR DEGREE	**126**				
PERCENT OF TOTAL		**27.8–34.1%**	**38.9–46.0%**		
Totals must satisfy one set of requirements:					
MINIMUM SEMESTER CREDIT HOURS		**32 hrs**	**48 hrs**		
MINIMUM PERCENTAGE		**25%**	**37.5%**		

*Technical electives may be engineering, math or basic science courses

TABLE 5-2a. COURSE AND SECTION SIZE SUMMARY: 14MSE056 CURRICULUM
Courses taught in the Spring 2008 and Fall 2008 semesters

COURSE	TITLE	Responsible faculty member	Sections offered in current year	Avg. section enrollment	Course content (%)		
					Lecture	Laboratory	Other
MSE 200	Mechanical Prop. of Structural Materials	Kasichainula, Zhu, El-Masry, Rigsbee	6	99.7	100%		
MSE 201	Structure & Prop. of Engr. Materials	Irving, Tracy, Brenner, Yingling	4	70.0	100%		
MSE/BME 203	Intro. to Mat. Science of Biomaterials	Luo	1	64.0	100%		
MSE 210	Materials Characterization Lab.	Reynolds	1	28.0	50%	50%	
MSE 301	Equilibrium and Rate Processes	Tracy	1	30.0	100%		
MSE 310	Computer Applications for Mat. Eng.	Brenner	1	21.0	100%		
MSE 321	Phase Transf. & Diffusion	Johnson	1	18.0	100%		
MSE 324	Polymer Characterization Lab.	Balik	2	9.5	50%	50%	
MSE 330	Crystal Chemistry & Phase Equilibria	Maria	1	26.0	100%		
MSE 331	Electronic Prop. of Materials	Reynolds	1	21.0	100%		
MSE 333	Electronic Properties Lab.	Reynolds	3	6.7	50%	50%	
MSE 350	Mechanical Prop. of Materials I	Scattergood	1	23.0	100%		
MSE/NE 409	Nuclear Materials	Murty	1	3.0	100%		
MSE 423	Intro. to Materials Engr. Design	Dawes	1	17.0	50%		50%
MSE 424	Materials Sci. & Eng. Design Project	Dawes	1	13.0			100%
MSE 425	Intro. to Polymeric Materials	Balik	1	22.0	100%		
MSE 430	Physical Metallurgy Lab.	Reynolds	2	8.5	50%	50%	
MSE 431	Physical Metallurgy	Reynolds	1	14.0	100%		
MSE 434	Ceramic Engineering Lab.	Maria	2	8.5	50%	50%	
MSE 435	Physical Ceramics	Maria	1	19.0	100%		
MSE 440	Processing of Metallic Materials	Koch	1	13.0	100%		
MSE 445	Ceramic Processing	Zhu	1	7.0	100%		
MSE 450	Mechanical Prop. of Materials II	Murty	1	20.0	100%		
MSE 455	Polymer Technology and Engineering	Dawes	1	9.0	100%		
MSE 460	Microelectronic Materials	Rozgonyi	2	5.0	100%		
MSE 490B	Special topics: Biomaterials Science	Luo	1	7.0	100%		
MSE 490Y	Special topics: Nano-biotechnology	Yingling	1	4.0	100%		
MSE 491	Materials Engineering Seminar	Cuomo	1	13.0	100%		
MSE 556	Composite Materials	Kasichainula	1	2.0	100%		

TABLE 5-2b. COURSE AND SECTION SIZE SUMMARY: 14MSE097 CURRICULUM
Courses taught in the Fall 2009 and Spring 2010 semesters

COURSE	TITLE	Responsible faculty member	Sections offered in current year	Avg. section enrollment	Course content (%)		
					Lecture	Laboratory	Other
MSE 200	Mechanical Prop. of Structural Materials	Rigsbee, Reynolds, Zhu, Kasichainula, Scattergood	6	95.3	100%		
MSE 201	Structure & Prop. of Engr. Materials	Melechko, Balik, Irving, Yingling	4	95.8	100%		
MSE/BME 203	Intro. to Mat. Science of Biomaterials	Luo	1	68.0	100%		
MSE 255	Exp. Meth. Struct. Analysis of Materials	Reynolds	1	27.0	50%	50%	
MSE 260	Math. Methods for Materials Engineers	Brenner	1	29.0	100%		
MSE 270	Mat. Science & Engineering Seminar	Rozgonyi	1	28.0	100%		
MSE 300	Structure of Materials at the Nanoscale	Irving	1	25.0	100%		
MSE 301	Equilibrium and Rate Processes	Tracy	1	29.0	100%		
MSE 320	Introduction to Defects in Solids	Scattergood	1	23.0	100%		
MSE 335	Exp. Meth. for Analysis of Mat. Props.	Reynolds	1	24.0	50%	50%	
MSE 355	Elec., Mag. and Opt. Prop. of Materials	Melechko	1	18.0	100%		
MSE 360	Kinetic Processes in Materials	Lichtenwalner	1	19.0	100%		
MSE 370	Microstructure of Inorganic Materials	Rigsbee	1	20.0	100%		
MSE 380	Microstructure of Organic Materials	Balik	1	19.0	50%	50%	
MSE/NE 409	Nuclear Materials	Murty	1	3.0	100%		
MSE 423	Intro. to Materials Engr. Design	Dawes	1	16.0	100%		
MSE 430	Physical Metallurgy Laboratory	Reynolds	2	10.5	50%	50%	
MSE 431	Physical Metallurgy I	Reynolds	1	18.0	100%		
MSE 440	Processing of Metallic Materials	Koch	1	11.0	100%		
MSE 445	Ceramic Processing	Zhu	1	13.0	100%		
MSE 455	Polymer Technology and Engineering	Dawes	1	20.0	100%		
MSE 456	Composite Materials	Kasichainula	1	3.0	100%		
MSE 460	Microelectronic Materials	Rozgonyi	1	4.0	100%		
MSE 470	Mat. Sci. & Eng. Senior Design Project	Dawes	1	15.0			100%
MSE 490	Sp top: Adv Mat Renew Sustain Energy	Maria	1	5.0	100%		
MSE 490	Special topics: Biomaterials Science	Luo	1	2.0	100%		
MSE 490	Special topics: Intro. to Nanomaterials	Narayan, Tracy	1	4.0	100%		
MSE 490	Sp top: Adv Exp. MSE Lab Course	Maria	1	1.0	100%		
MSE 491	Materials Engineering Seminar	Cuomo	1	17.0	100%		

TABLE 5-3

SENIOR DESIGN PROJECTS

YEAR	TITLE OF PROJECT	STUDENTS	FACULTY MENTOR	COMPANY SPONSOR
2005	Nonisothermal 7085 Heat Treatment	Eric Austin, Brett Godin, Darryl Glanton, Ginger Wheeler	M. Rigsbee	Alcoa
	Improving the Mechanical Properties of Semi-Austenitic Stainless Steels	Rachel Doss, Sarah Bolls, Adam Pearce	R. Scattergood	Allvac
	*Process Development of Titanium Aluminide using the Arcam S12 Electron Beam Melting Machine	Abby Griffith, Jon Semones, Jason Van Duyn, Jess Bardin (IE), Laural Flythe (IE)	M. Rigsbee D. Cormier (IE)	Boeing
	Improving the Barrier Performance of Multilayer Print Blankets	Kelly Ervin, Greg Hogshead, Brandon Williamson	R. Spontak	Day Int'l.
	Etching Techniques for Copper Compatible Barium Titanate Thin Films for Embedded Passives	Scott Abernathy, Trinity Biggerstaff, Myles Connor, Kris Darling	J.P. Maria	DuPont Electronics
	Process Improvement to Eliminate Surface Defects on Keys through Examination of 353 Brass Material and Punch Press Operation	Melissa Day, Heather Baird, Jeremy Gobien, Anthony Fredenburg	C. Koch	Kaba Ilco
	Evaluation of PROTEK Coating as a Feasible Component for MEMS Fabrication	Ivy Littman, Courtney Floyd, Brandon Davis, Andrew Stuart	M. Johnson	MEMSCAP
	Alternative Supports for Propane Tanks	Brandy Dixon, Leslie O'Laughlin, Carole Mertes	K. Dawes	National Gas Dist.
	Dependence of Adhesion Characteristics on the Surface Preparation of Steel	Leslie Jimison, Dara Gough, Patrick Davis, Brendon Bass	J. Cuomo	Northrop Grumman
	High Voltage AC Corrosion in Underground Cables	Scott Broderick, Ryan Mayer, John Waldrep	H. Lewerenz	Tyco Electronics
2006	*CoCrMo Alloys in Hip Joint Replacements	Cris Cruz, Charita McClees, David Tucker, Erica Wilson, Karl Angermeier, Jessica Beasley	M. Luo	Allvac
	Mechanical Failure in Printing Sleeves and Blankets	Matthew Hawn, Joshua Law, Matthew McCaskill, Adam McCauliffe	R. Sanwald	Day Int'l.
	Yield Analysis of Thin Film Capacitors on Copper Foil for Embedded Passive Applications	Jason Brethauer, Patrick Daniels, Amit Desai	J.P. Maria	DuPont Electronics
	Silane Crosslinking of Polyethylene	Zach Fitzgerald, Catherine Heath, Sev Johansson, Philip Stuckey	M. Balik	Nomaco
	Fabrication of $CaCu_3Ti_4O_{12}$ with Electrical and Microstructural Characterization	Andrew Kubik, Heather McFelea, Tony Rice, Marianne Trexler	Z. Sitar	Northrup Grumman
	Transverse Edge Cracking in Continuously Cast Low-Carbon Steel Slabs	Darren Cutler, Tanner Dahlke, Colin Fletcher, James Oxendine, Diana Proffit	M. Rigsbee	Nucor Steel
	Improving the Lubricity of the Tyco GelWrap Product	Danielle Proffit, Sarah Mullins, Brian Allen, Adam Helsel	R. Spontak	Tyco Electronics

*Indicates a multi-disciplinary project with students from other engineering departments

TABLE 5-3 (continued)

SENIOR DESIGN PROJECTS

YEAR	TITLE OF PROJECT	STUDENTS	FACULTY MENTOR	COMPANY SPONSOR
2007	Designing a Multilayer Steel Armor Utilizing ATI Allvac's 13-8 Mo supertough and a High Hardness Steel	Lindsey Berk, Leslie Coleman, Jeremy Woock	C. Koch	Allvac
	Development of Bonding and Matching Layers for Acousto-Optic Device Applications	Angela Felker, Kristina Marshall, Mary Rebovich	R. Spontak	Northrup Grumman
	Failure Analysis of Crane Wire Rope	William Goodwin, Kevin Lazar, Matthew Ross	M. Rigsbee	Nucor Steel
	Increasing the Radiation Resistance of Cold Applied Gel Sealing Technology	Jackson Thornton, Justin Gotchy, Paul Fox	M. Balik	Tyco Electronics
2008	Evaluation of High-Speed Steels for Wood Machining: The Role of Microstructure in Wear	Marshall Jones, Stephen Starnes, Matt Rothwell, William Milan	H. Conrad	Crucible Materials
	Characterization of Electro-Deposited Ni-Co Alloys for MEMS Applications	Dan Barnhardt, Mike Hallock, Eric Abernethy	C. Koch	MEMSCAP
	Chemical Routes for Deposition of CaCu3Ti4O12 Thin Films	Elizabeth Paisley, Ronald Burton Jr., Steven Wuester	J.P. Maria	Northrup Grumman
	Inclusion Analysis of Calcium Treated Grades of Steel	Casey Holder, Lee Jackson, Joseph Shepherd	M. Rigsbee	Nucor Steel
2009	Microstructural Control of 7085-T7452 Forgings	Raphael Clearfield, Katrina Zmithrovitch, Ryan McClellan	H. Conrad	Alcoa
	Etch Optimization for Polysilicon on MEMS Devices	Brian Bender, Toby Tung, Lauren Jackson	G. Rozgonyi	MEMSCAP
	High Temperature Thin Film Thermocouples	Ryan Chan, David Hook, Javon Powell, Patrick Wong	J.P. Maria	Northrup Grumman
	Inclusion Analysis of Calcium Treated Grades of Steel	Roger Daniel, Eric Jones, Jessica Sievers	M. Rigsbee	Nucor Steel
	Improving Tracking and Erosion Resistance of Raysulate Formula T277	Joshua Harris, Carissa Lada, Jonathan Pierce	M. Balik	Tyco Electronics
2010	Omega Phase in Cold-Rolled ATI425 Alloy	Justin Greene, Joshua Nunn, Jeanelle Todd, Kevin Aycock	C. Koch	Allvac
	718+ Delta Phase Characterization	Justin Railsback, Matt Shore, Brian Van Leeuwen, Michael Hall	C. Koch	Allvac
	Structure and Properties of Corrosion-Resistant Steel	Thomas Greenhalgh, Marc Moore, Sharon Licata, Teddy Franklin	M. Rigsbee	Nucor Steel
	Poisoning of Silicone-Based Splice-Sealing Gels	Zach Howard, Ashley Marlowe, Brad Mooring	M. Balik	Tyco Electronics

TABLE 5-4

2009 SENIOR DESIGN PROJECT SUMMARIES

Microstructural Control of 7085-T7452 Forgings

Previous work has shown that when aluminum alloy 7085 (AA7085) is forged at 730ºF – 830ºF voids often form leading to the rejection of the material, and when AA7085 is forged below 730ºF the alloy partially recrystallizes during solution heat treatment. This leads to unacceptably low fracture toughness due to failure by intergranular fracture. The objective of this project was to develop a thermal practice that would inhibit recrystallization of forged AA7085. A heat treatment was developed and used in conjunction with Alcoa's existing processing techniques. The heat treatment primarily focused on minimizing large particles that accumulate dislocations during deformation and maximizing fine particles that inhibit recrystallization during Alcoa's solution heat treatment. Our practice modifies Alcoa's existing processing techniques by inserting an intermediate solution heat treatment (SHT), which follows Alcoa's existing procedure for a SHT, and a precipitation heat treatment (PHT), which was developed by experimental analysis. The PHT consists of a heating schedule that varies PHT time at 450ºF. The effects of the PHT on recrystallization were analyzed using optical microscopy.

Etch Optimization for Polysilicon on MEMS Devices

The primary objective of this project is to develop an etching and cleaning process that can be used to reduce the occurrence of etch-related defects in polysilicon microelectromechanical (MEMS) devices. MEMS combine electrical and mechanical components with a length scale between 1 μm and 1 mm on an integrated circuit platform. MEMS are incorporated into numerous applications including biomedical sensors, microphones in mobile technology, and actuators for energy harvesting.

The industry standard for producing MEMS includes Reactive Ion Ethcing (RIE), which is the selective vertical removal of material. The primary goals of processing MEMS device trenches are achieving vertical sidewalls and minimizing micromasking during etching. Non-vertical sidewalls can inhibit the ability of subsequent layers to adhere and limit the mechanical functionality of a MEMS device. Micromasking from redeposition of etched material can result in post-etching debris that can short out MEMS devices and inhibit mechanical motion[1]. MEMSCAP has presented the problem of non-vertical sidewalls and micromasking defects to NCSU. MEMSCAP provided pattered silicon wafers and a photoresist mask.

Optimization of the Bosch RIE process for polysilicon substrates was expected to increase the quality of sidewalls, minimize effects of micromasking, and achieve a desirable surface smoothness[2]. The Bosch RIE process for etching polysilicon has been optimized by varying the ratio of C_4F_8 to SF_6, source power, and bias power. The combination of parameters was determined using a Box-Behnkin DOE. The Alcatel DRIE in the NCSU Nanofabrication Facility was used to perform the etching. Each sample in the DOE was analyzed with SEM imaging, specifically looking for vertical sidewalls and surface defects.

The run that produced the most vertical sidewalls, 90°, was the baseline run and run 7 of the DOE. The etching parameters included 150 sccm of C_4F_8 cycled for 3 seconds, 150 sccm of CF_6 cycled for 2 seconds, 50 sccm of cycled O_2 for 1 second, 1500 W source power, and 100 W bias power. Other parameters, such as pressure and temperature were kept constant, at 18 mTorr and 0 ºC, respectively. This recipe consistently creates vertical sidewalls and no micromasking with an etch rate of 1 μm/min. The DOE yielded etch rates of varying between 0.9 μm/min and 1.5 μm/min with non-vertical and rough sidewalls. Sidewall angles decreased as the etch rate increased because an increased isotropic etch rate caused etching past the polysilicon layer and into the silicon oxide layer. This released further O_2 into the etch plasma and caused chemical etching of the polymeric passivation layer on the polysilicon sidewalls.

The MEMSCAP requirements for vertical sidewalls without micromasking defects has been achieved through the parameters established in run 7 of the Box-Behnkin DOE. The etch parameters used in this experiment are operational on MEMSCAP equipment. Therefore, a processing change to more closely match these etch parameters could potentially produce a more defect-free etch while saving on operational costs. MEMSCAP is planning to use this experimental recipe in evaluation.

TABLE 5-4 (continued)

2009 SENIOR DESIGN PROJECT SUMMARIES

High Temperature Thin Film Thermocouples

The purpose of this document is to outline some of the major goals, strategies, and results of the Northrop Grumman Senior Design Team of 2008-2009. We have been tasked by the company, as well as our faculty advisor Dr. Jon-Paul Maria, to research and attempt to produce a robust thin-film thermocouple able to function at up to 1400ºC. This group proposes that Indium Tin Oxide (ITO) be the operative material in this endeavor.

ITO is known for its excellent optical, electrical and thermal properties; it is the material of choice in anode contacts for high-definition (HD) liquid-crystal display (LCD) technology as well as use in strain gauges in jet and rocket engines. By distinctly varying the ratio of indium to tin between two ITO thin-films in contact, it is believed that a temperature dependent, measurable voltage will be produced at the interface. In order to perform these experiments with the greatest precision and with the least cost, sol-gel processing methods will be used to produce the films.

Various characterization methods will be used to analyze the ITO thin-films including: x-ray diffraction (XRD), four point probe, scanning electron microscopy (SEM) and profilometry. It is vital that they are characterized so that the underlying principle of any working thermocouple's function can be completely understood. Thermo-electrical measurements, operation temperature range, and materials’ properties will be used to compare the quality of thermocouple materials.

Much of the testing was conducted in the laboratories in Engineering Building I (EBI), the instrument rooms in the Analytical Instrumentation Facility (AIF), as well as the laboratories in RB1 (Dr. Maria's lab). With the proper experimental procedures and testing matrix, an attempt will be made to produce a new and useful technology with a range of potential applications.

Inclusion Analysis of Calcium Treated Grades of Steel

This project continues the work done by last year’s team to characterize clogging at the caster and inclusion formation yet will focus on processes such as desulfurization that occur at the ladle metallurgical furnace (LMF) designed to reduce solid inclusion formation. The project is sponsored by Nucor Steel Hertford County.

First, the project will seek to establish where in the process inclusions originate. Secondly, a process will be designed to optimize desulfurization based on inclusion chemistry and location, time, and temperature. Finally, the project will provide suggestions to alleviate clogging and reduce solid inclusions.

Improving Tracking and Erosion Resistance of Raysulate Formula T277

The objective of this project was to improve the performance of a Tyco Electronics polymer formulation in the ASTM D2303 regulated Tracking and Erosion Resistance Test (TERT), a high voltage failure test. Variations of this polymer formulation are used as insulating covers for switchgears, busbars, overhead lines, substations, etc. The predominant failure mechanism for these products in the field is tracking due to dry band arcing. The principal factors affecting TERT performance are thermal conductivity and hydrophobicity. Tracking failure occurs when current flow due to dry band arcing through the polymer heats the polymer and causes it to degrade along the conductive path; thus, increasing thermal conductivity allows heat to diffuse away from the site more quickly, increasing the time it takes for the polymer to degrade. Dry band arcing is itself the result of contaminant deposition via water; therefore, increasing hydrophobicity can prevent contaminant deposition in the first place. Thermal conductivity and hydrophobicity were enhanced by changing the additive composition; the effects of particular additives were studied using Tyco’s current formulation as well as virgin base resins (linear low density polyethylene and EPDM rubber). Several additives were identified which affect TERT performance, including aluminum trihydrate, alumina, and silicone oil. It was shown that adding 2% alumina to the current formulation improved TERT performance, and decreasing the current composition of aluminum trihydrate from 42% to 25% improved TERT performance in samples of the LLDPE and EPDM rubber resin. Due to the nature of the test, the results for silicone oil were not considered conclusive.

TABLE 5-5a PRE-REQUISITES AND CO-REQUISITES FOR MSE CURRICULUM 14MSE056

COURSE	PRE-REQUISITES	CO-REQUISITES
CH 101	1 yr high school chemistry, eligible for MA 107	CH 102
CH 201	CH 101 with C- or higher, eligible for MA 121	CH 202
CH 220	CH 101 with C- or higher	
PY 205	MA 141 with C- or higher	
PY 208	PY 205 with C or higher; MA 241 with C or higher	
MA 141	MA 111 with C- or higher or placement via math level II achievement test	
MA 241	MA 141 with C- or higher	
MA 242	MA 241 (C- or higher)	
MA 341	MA 242	
CSC 112	E 115, MA 141	
CSC 116	E 115	MA 121, 131 or 141
MSE 201	CH 101	
MSE 210	MSE 201	MSE 201
MSE 301	MA 241	MSE 201
MSE 310	none	
MSE 321	MSE 330	
MSE 324		MSE 425
MSE 330	MSE 301	
MSE 331	MSE 330	MSE 333
MSE 333	MSE 330	MSE 331
MSE 350	MSE 201, MA 341	
MSE 423	MSE 434, 435, 450, senior standing in MSE	MSE 430, 431
MSE 424	MSE 423, 430, 431, 434, 435, 450, senior standing in MSE	
MSE 425	CH 220, MSE 301	MSE 324
MSE 430		MSE 431
MSE 431	MSE 321, 450	MSE 430
MSE 434		MSE 435
MSE 435	MSE 201, 210	MSE 321, 434
MSE 440	MSE 321, 450	MSE 431
MSE 445	MSE 434, 435	
MSE 450	MSE 350	
MSE 455	MSE 425	
MSE 460	MSE 331	
MSE 490: Biomat.	permission of the instructor	
MSE 490: Nanomat.	permission of the instructor	
MSE 490: Bio-nanmat.	permission of the instructor	
MSE 490: Cmpt. mod.	permission of the instructor	
MSE 491	Junior or senior standing in MSE	
MSE 556	MSE 450	

TABLE 5-5b PRE-REQUISITES AND CO-REQUISITES FOR MSE CURRICULUM 14MSE097

COURSE	PRE-REQUISITES	CO-REQUISITES
CH 101	1 yr high school chemistry, eligible for MA 107	CH 102
CH 201	CH 101 with C- or higher, eligible for MA 121	CH 202
CH 220	CH 101 with C- or higher	
PY 205	MA 141 with C- or higher	
PY 208	PY 205 with C or higher; MA 241 with C or higher	
MA 141	MA 111 with C- or higher or placement via math level II achievement test	
MA 241	MA 141 with C- or higher	
MA 242	MA 241 (C- or higher)	
MA 341	MA 242	
CSC 112	E 115, MA 141	
CSC 116	E 115	MA 121, 131 or 141
MSE 201	CH 101	
MSE 255		MSE 201
MSE 260	E 115, MA 141	
MSE 270		MSE 201
MSE 300	C- or better in MSE 201	
MSE 301	C- or better in MSE 201	
MSE 320	C- or better in MSE 201	
MSE 335	C- or better in MSE 201	
MSE 355	PY 208, MA 341	
MSE 360	MA 341, MSE 301	
MSE 370	MSE 300, 301, 320	
MSE 380	CH 220, MSE 300	
MSE 420	MSE 370, 380	
MSE 423	Senior standing in MSE	
MSE 440	MSE 360, 370	MSE 420
MSE 445	MSE 370	
MSE 455	MSE 380	
MSE 456	MSE 420	
MSE 460	MSE 355	
MSE 470	MSE 423	
MSE 480	MSE 370, 380	
MSE 490: Biomat.	permission of the instructor	
MSE 490: Nanomat.	permission of the instructor	
MSE 490: Bio-nanomat.	permission of the instructor	
MSE 490: Comp. mod.	permission of the instructor	

CRITERION 6. FACULTY

A. Leadership responsibilities

Although final responsibility for the program rests with the Department Head (J. M. Rigsbee through the 2008-09 academic year, J. Schwartz since August 2009), significant programmatic leadership and day-to-day management of the MSE undergraduate program is handled by the Director of Undergraduate Programs (DUP), Professor C. M. Balik. In the MSE department, this position has traditionally been held by a tenured faculty member and it entails the following major responsibilities:

- administrative oversight of the MSE courses and curriculum, including service on the College of Engineering Course and Curriculum Committee,
- acting as Coordinator of Advising for MSE undergraduates, including service on the College of Engineering Coordinators of Advising Committee,
- acting as Coordinator of ABET assessment activities, including service on the College of Engineering ABET Committee,
- checking transcripts to ensure that all seniors have met all degree requirements before graduation.

In addition, Dr. Balik ensures that courses are offered during the appropriate semesters, advises the Department Head on faculty teaching assignments, nominates qualified students for scholarships and awards, advises incoming freshman engineers during summer orientation sessions, and interfaces with the College of Engineering and the University on matters related to the undergraduate program. He is the first point of contact for students in academic difficulty or encountering abnormal circumstances that affect their coursework. He also often meets with prospective students who are simply interested in learning more about the MSE program. As a tenured faculty member, Dr. Balik also maintains an average teaching load, a research program and is active in several professional societies.

B. Authority and responsibility of faculty

Faculty involvement in course and curriculum development
The MSE faculty are encouraged to become directly involved in the creation, modification and evaluation of courses and curriculum. Minor revisions to existing courses come about naturally through the MSE ABET assessment process, but revisions are also occasionally suggested by the faculty member teaching the course, independent of the assessment process. A faculty member may also propose a new elective course, which is offered as a special topics course at least two times or until its sustainability can be ascertained. All of these actions are reviewed and modified if necessary by the MSE Course and Curriculum Committee (CCC), and are then presented to the entire faculty for discussion and final approval.

Through the 2008-09 academic year, the MSE CCC had the responsibility for both the undergraduate and graduate programs. The MSE CCC was chaired by Dr. Carl Koch, who was Associate Head at that time. This committee played a central role in developing the MSE curriculum revision which was initiated in the Spring 2009 semester (see Sections 4 and 5 of this report). Beginning with the Fall 2009 semester, the MSE CCC was replaced by two separate committees, one with oversight of the undergraduate program and one with oversight of the graduate program. This change allows for more focused attention on the two programs. The Undergraduate Program Committee (UPC) is currently chaired by Dr. A. Melechko, and membership includes Dr. Balik, Dr. Rigsbee, Dr. Tracy and Dr. Kasichainula, and this committee is responsible for "big picture" oversight of the program. New proposed courses are discussed with the DUP, the UPC and the Department Head before being offered on a trial basis. In certain circumstances where faculty who are not members of the UPC are needed to assess a particular aspect of the undergraduate program, the Department Head pulls together the individual faculty so they can focus on a particular task or topic. One example of this is the evaluation of the undergraduate lab courses and the equipment supporting them. In Spring 2010, additional resources became available from the College of Engineering, so Professors Maria, Melechko, Luo, Reynolds, Balik, Brenner and Schwartz, with input from Roger Russell, re-evaluated the lab course content and made appropriate revisions to incorporate the new equipment and modernize the content. Rearrangement of undergraduate lab space is also being carried out as part of this change.

Involvement of other campus units in course and curriculum development
Two additional course and curriculum committees at NC State must review and approve all course and curriculum actions. One operates at the College level and one at the University level. Changes are initiated at the departmental level by completing a course or curriculum action form, which must include a new course syllabus and other information. The syllabus must conform to standardized guidelines set by the Provost's office for all courses at NC State. After approval by the department head, the action is sent to the College of Engineering CCC. This committee reviews the content and format of the action to make sure it is consistent with the Provost's guidelines, and that the other engineering departments approve of the change. If the change impacts other departments on campus, documentation must be provided which shows that the affected departments have been consulted and that they approve of the change. If corrections or additions to the form are required, it is sent back to the department. Upon approval by the COE CCC, the form is sent to the University CCC (UCCC), where the impact of the change (if any) on the entire university is considered. This committee also makes an effort to minimize duplication and proliferation of courses on campus. If corrections are required, the action is sent back to the department and re-routed through the system. Upon approval by the UCCC, the form is sent to Registration and Records, where the change is officially entered into the University's online catalog and registration system.

Broad oversight of all undergraduate programs at NC State is provided by the Provost, who is the chief academic officer of the university. Within the Provost's office, the Council on Undergraduate Education (CUE) develops, evaluates and revises the General Education Program (GEP) requirements for the entire university. The GEP stipulates the minimum number of math, science and liberal arts credit hours which all departments at NC State must incorporate into their degree programs. CUE also stipulates which courses can be used to satisfy GEP requirements. Any changes made to the GEP requirements affect all undergraduate curricula at NC State.

Although not directly involved in course and curriculum evaluation, the Division of Undergraduate Academic Programs at NC State provides enrichment programs, initiatives and services that help undergraduates across the campus to succeed. This office is headed by the Dean for Undergraduate Programs at NCSU.

Process used to ensure consistency and quality of courses taught
In the MSE department, several recurring processes are in place to ensure the consistency and quality of course offerings. The MSE ABET assessment plan for Program Learning Outcomes is course-based and recurs on a two-year cycle (see Section 3). Shortcomings noted in the outcome assessment process usually require improvements to the course(s) associated with the outcome in question, as noted in Section 4. This ensures that all courses cover the topics needed to adequately meet the MSE PLOs.

Students directly assess all of their courses and instructors at the end of each semester via the online course evaluation system. This evaluation is conducted by the Office of University Planning and Analysis (UPA) at NCSU. A copy of the online evaluation form is displayed in Exhibit 6-1, which shows the standardized form designed for use by any department on campus. It is also possible for departments to customize this form by adding their own questions. The MSE department uses the standardized form. For each course, student responses are collected and compiled by UPA and sent to the instructor at the end of each semester. This feedback gives the instructor a basis for making improvements to the course the next time it is taught. In addition, summary data for all courses in each department is sent to the department heads. This allows the department head to compare evaluation scores for all courses and instructors in the department. During the annual faculty reviews, the department head discusses these results with individual instructors and notes areas where improvement is needed.

Additional direct feedback regarding MSE courses is obtained during the senior exit interviews which take place annually. Students are generally eager to point out shortcomings in course content or teaching methods during these interviews. As noted in Sections 4 and 5, student comments obtained during exit interviews helped to mold the courses and content of the revised MSE curriculum.

C. Faculty

The MSE faculty teaching load is typically 2-3 courses per year, with non-tenure-track teaching faculty sometimes carrying a larger load (see Table 6-1). Most faculty members tend to focus their teaching and research efforts on one or two specific classes of materials, and each has some expertise in structure, properties, processing and performance for those classes.

The composition, size and credentials of the faculty is diverse and includes faculty with PhDs from a number of engineering and science disciplines (see Table 6-2). This provides an educational atmosphere with a diverse spectrum of perspectives of materials science and engineering for our students, and thus an educational experience that prepares them to pursue a variety of paths after graduation. All tenured/tenure-track faculty are actively engaged in research programs.

D. Faculty competencies

The breadth of competencies of the MSE faculty is summarized in the table below, for which the faculty have self-identified their areas of expertise. The breadth of expertise of the faculty is more than adequate to deliver high-quality undergraduate and graduate programs in Materials Science and Engineering. The expertise of the MSE faculty covers all of the traditional classes of materials (metals, ceramics, polymers, electronic materials and composites) as well as the elements of structure, properties, processing and performance, and new topics including biomaterials, nanomaterials and computational materials science.

MSE faculty areas of expertise

Faculty member	Position	Areas of expertise
Maury Balik	Professor and Director of Undergraduate Programs	Polymer structure and properties, small molecule diffusion in polymers, polymer/cyclodextrin inclusion compounds
Don Brenner	Distinguished Professor and Associate Department Head	Multiscale materials design, tribology, nano-featured materials
Jerry Cuomo	Distinguished Professor	Plasma deposition, coatings
Keith Dawes	Teaching Professor	Polymers, design, materials selection, processing
Nadia El-Masry	Professor	Photovoltaics, magnetic properties, thin films
Doug Irving	Assistant Professor	Ab-initio, atomistic and multi-scale simulations
Mark Johnson	Associate Professor	Compound semiconductors, electronic and photonic applications
Jag Kasichainula	Associate Professor	Metals, composites, mechanical properties and defects, thin films, transport properties and modeling
Carl Koch	Distinguished Professor	Nonequilibrium processing, nanostructured materials, intermetallics
Mark Luo	Assistant Professor	Biomaterials, nanocomposites, bio-nanomaterials
Jon-Paul Maria	Associate Professor	Oxides, thin film synthesis, electronic materials
Anatoli Melechko	Associate Professor	Thin films, synthesis of nanomaterials, nanobiotechnology
K.L. Murty	Professor (split with NE)	Deformation and fracture of materials, irradiation effects
Jay Narayan	Distinguished Professor	Semiconducting materials, thin films, defects and interfaces
Lew Reynolds	Teaching Professor	Compound semiconductor materials and devices, thin film epitaxy, interfaces
J. Michael Rigsbee	Professor	Metals, surface engineering, TEM
George Rozgonyi	Professor	Semiconducting materials, defect engineering
Ron Scattergood	Professor and Director of Graduate Programs	Mechanical properties of metals and ceramics, dislocation theory, precision engineering, nanostructured materials
Justin Schwartz	Distinguished Professor and Department Head	Superconducting and multiferroic materials, magnetic field processing, materials failure/forensics, fiber optic sensors for extreme environments.
Zlatko Sitar	Distinguished Professor	CVD, crystal growth, wide bandgap semiconductors
Rich Spontak	Professor (split with CHE)	TEM, block copolymers, polymer morphology
Joe Tracy	Assistant Professor	magnetic and metallic nanoparticle synthesis, properties, and surface chemistry
Yara Yingling	Assistant Professor	Multiscale modeling of biological and soft materials
Yuntian Zhu	Professor	Synthesis of carbon nanotubes, carbon nanotube composites, nanostructured metals and alloys

Much of the faculty expertise is brought to the classroom for the benefit of both undergraduate and graduate students. In addition, many faculty hire undergraduate students on a part-time basis to work in their labs and on their research projects. Funding comes from individual research grants or as a $1000 annual stipend from the MSE department and College of Engineering when funds are available. This provides undergraduates with valuable experience and helps them to prepare for graduate school or jobs in industry. Current MSE faculty who often involve undergraduates in their research activities include Profs. Balik, Cuomo, Irving, Johnson, Koch, Luo, Maria, Rigsbee, Scattergood, Schwartz, Sitar, Spontak, Tracy and Yingling.

E. Faculty size

The MSE faculty includes twenty full-time tenured/tenure-track MSE faculty members, two with joint appointments with other engineering departments, and two teaching faculty who are active in the undergraduate program. As a result, the MSE undergraduate student-to-faculty ratio is very low and facilitates significant, one-on-one student/faculty interactions. The breadth of expertise created by the size of the faculty also enhances the spectrum of research opportunities for students.

During the senior exit interviews, all of the students cite the relatively small size of the MSE department as an advantage. They feel they get more individual attention in and out of the classroom as a result. At present, the typical MSE class size is 30 or less. The current enrollment also facilitates significant hands-on experience in the MSE lab courses. The MSE faculty are dedicated, enthusiastic teachers and four are members of the NCSU Academy of Outstanding Teachers (Balik, Brenner, Scattergood, and Spontak).

Students also comment positively about the quality of the advising they receive in MSE (Section 1-C). The small size of the department allows individual advising sessions. In contrast, large departments often are forced to use a group advising approach. Eight MSE faculty participate in undergraduate advising. Most of these faculty typically advise 5-10 students, while the Director of Undergraduate Programs typically advises 30-40 students. Advisors post sign-up schedules outside their offices and are available to students for three weeks each semester during the pre-registration advising period. MSE faculty also participate regularly in the summer advising/orientation sessions for incoming freshmen at NCSU.

F. Faculty resumes

Faculty resumes appear in Appendix B.

G. Faculty professional development

Service and professional development
Every MSE faculty member belongs to at least one professional society; most are members of three or more societies (see Appendix B). This membership spans many societies as listed below.

AAAS: American Association for the Advancement of Science
AACG: American Association for Crystal Growth

ACerS:	American Ceramic Society
ACS:	American Chemical Society
APS:	American Physical Society
ASEE:	American Society of Engineering Education
ASM:	American Society for Metals
AVS:	American Vacuum Society
ECS:	Electrochemical Society
EMSA:	Electron Microscopy Society of America
IEEE:	Institute for Electrical and Electronics Engineers
MAS:	Microbeam Analysis Society
MRS:	Materials Research Society
Σ Ξ:	Sigma Xi
SPE:	Society of Plastics Engineers
SVC:	Society of Vacuum Coaters
TMS:	The Minerals, Metals and Materials Society

Eight of the faculty have been elected as fellows of these societies, and some faculty are fellows in multiple societies. One (Cuomo) is a member of the National Academy of Engineering and has also won the National Medal of Technology. Many faculty have served as officers of these societies at the local and national levels.

Faculty participate in research-related professional development by publishing papers in scholarly journals, reviewing papers and proposals, giving presentations at scientific conferences, participating in sabbatical leave assignments, and attending workshops that focus on new scientific concepts, instrumentation and methods of analysis. All new faculty in the College of Engineering are now required to participate in a teaching effectiveness workshop, and most MSE faculty have received this training. Many have also organized conferences, workshops and focused sessions within large conferences. Some of the professional development activities of MSE faculty are listed in Table 6-3. The College of Engineering also provides numerous professional development opportunities for faculty on campus, as shown in Exhibit 6-2 for calendar year 2009.

Several faculty serve as advisors to student chapters of professional societies such as the ASM (Rigsbee), SPE (Balik) and MRS (Yingling). Each of these organizations has a North Carolina local chapter which hosts monthly meetings that are attended by several faculty and students. Faculty strongly encourage students to participate in these professional societies. Because the field of materials science and engineering is served by many different professional societies and the MSE enrollment is relatively small, there are not enough interested students to maintain active student chapters for each society. Therefore, interested MSE students have created an umbrella organization, the Materials Technical Society (MTS), which groups all interested students together in one organization. The MTS has functioned very well in this format over the years. MTS members elect officers and schedule several meetings each year with an invited speaker. MTS members also help to organize departmental social events, open houses and MSE participation in Engineer's Week activities.

Consulting and involvement with industry
Another important aspect of ongoing faculty professional development is interactions with industry, and a significant number of MSE faculty maintain close ties with industry and industrial concerns through various research and consulting relationships. Faculty currently involved in consulting include Balik, Cuomo, Murty, Narayan, Rozgonyi, Sitar and Spontak. About 30% of the research contracts and grants received by MSE come from industrial sources and these account for about 20% of MSE research expenditures. These interactions range from active participation with small businesses on SBIR and STTR proposal activities to collaborative proposals with large corporations such as GE and Boeing. The insights and experience faculty gain from these relationships are often carried into the classroom for the benefit of the students. Many undergraduate students are directly involved in research projects with industrial partners.

An important connection between MSE faculty and industry occurs through the senior design course (see Section 5). Each design project brings together an industrial liaison and a faculty advisor which fosters further faculty-industry interactions. Many industrial sponsors clearly view this experience as beneficial and consequently sponsor projects for multiple years. Thirteen different local and regional industries sponsored MSE senior design projects over the past six years (Exhibit 5-3). Eight of these are multiple-year sponsors. These companies get an in-depth look at the graduating seniors as potential employees and the students similarly evaluate the industrial sponsors as potential employers. Companies that hire MSE students also become potential future industrial sponsors. Since 2001, new senior design projects were secured through the efforts of MSE alumni who work for the sponsoring companies Allvac, Ilco Unicam, Northrup Grumman, Nucor and MEMSCAP.

TABLE 6-1. FACULTY WORKLOAD SUMMARY
Materials Science and Engineering: Academic Year 2009-10

Faculty member	Full or Part-time	Classes taught (course number, credit hours)		Total activity distribution (% effort) 2009-10 academic year		
		Fall 2009	Spring 2010	Teaching	Research	Other
Balik	FT	MSE 201-002, 3 credits E 101-015, 1 credit	MSE 380, 3 credits Senior design team	30	30	40
Batchelor/Russell	FT	MSE 712, 3 credits		20	10	70
Brenner	FT	MSE 791, 3 credits	MSE 260, 3 credits	33	34	33
Cuomo	FT	MSE 491, 1 credits		5	90	5
Dawes	PT	MSE 423, 3 credits	MSE 455, 3 credits MSE 470, 3 credits	50	45	5
Hren	emer.	MSE 771, 3 credits		0	0	100
El-Masry	FT			0	0	100
Irving	FT	MSE 300, 3 credits	MSE 201-001, 3 credits	25	70	5
Johnson	FT	MSE 576, 3 credits MSE 708, 3 credits		20	15	65
Kasichainula	FT	MSE 200-002, 3 credits MSE 200-003, 3 credits	MSE 456, 3 credits MSE 702, 3 credits	75	20	5
Koch	FT	MSE 440/540, 3 credits	2 senior design teams MSE 706-001, 3 credits	40	45	15
Lichtenwalner	PT		MSE 360-001, 3 credits	25	75	0
Luo	FT	MSE 203, 3 credits	MSE 490/791, 3 credits	35	60	5
Maria	FT	MSE 490/791 3 credits MSE 601/801, 1 credit	MSE 490-004, 3 credits	30	60	10
Melechko	FT	MSE 201-001, 3 credits	MSE 355, 3 credits	30	60	10
Murty	FT	MSE 757, 3 credits	NE/MSE 409, 3 credits	35	30	35
Narayan, J.	FT	MSE 760, 3 credits	MSE 490/791, 3 credits MSE 770, 3 credits	40	60	0
Rawdanowicz	FT	MSE 710, 3 credits	MSE 715, 4 credits	50	10	40
Reynolds	FT	MSE 335, 2 credits MSE 430, 1 credit MSE 431/531, 3 credits MSE 771, 3 credits	MSE 200-002, 3 credits MSE 255-003, 2 credits	75	15	10
Rigsbee	FT	MSE 200, 3 credits MSE 500, 3 credits	MSE 370, 3 credits Senior design team	65	30	5
Rozgonyi	FT	MSE 460/560, 3 credits	MSE 270, 1 credit	30	50	20
Scattergood	FT	MSE 320, 3 credits	MSE 200-003, 3 credits MSE 705, 3 credits	35	30	35
Schwartz	FT			5	40	55
Sitar	FT	MSE 704, 3 credits	MSE 751-001, 3 credits	30	60	10
Spontak	FT	MSE/CBE 761, 3 credits		35	40	25
Tracy	FT	MSE 301, 3 credits	MSE 490/791, 3 credits	35	60	5
Yingling	FT	MSE 791, 3 credits	MSE 201-002, 3 credits	35	60	5
Zhu	FT	MSE 445/545, 3 credits	MSE 200-001, 3 credits	30	60	10

TABLE 6-2. FACULTY ANALYSIS

Name	Rank	Type of appointment (T, TT, NTT)	Full time/Part time (FT/PT)	Institution from which highest degree earned and year	Years of experience			Professional registration/certification	Level of activity* (H, M, L, none)		
					Government or Industry practice	Total faculty	This institution		Professional society	Research	Consulting or summer work in industry
Balik, C. Maurice	Professor	T	FT	Case Western Reserve University 1981	0	28	28	n/a	H	M	L
Brenner, Donald	Dist. Research Professor	T	FT	Pennsylvania State University 2002	7	16	16	n/a	M	H	L
Cuomo, Jerome	Dist. Research Professor	T	FT	Odense Universitet, Denmark 1979	30	17	17	n/a	L	H	M
Dawes, Keith	Teaching Professor	NTT	PT	University of Manchester 1969	30	10	10	n/a	M	M	N
El-Masry, Nadia	Professor	T	FT	NC State University 1980	0	26	25	n/a	M	H	L
Irving, Doug	Assistant Prof.	TT	FT	University of Florida 2004	0	2	2	n/a	H	H	N
Johnson, Mark	Associate Prof.	T	FT	NC State University 1999	7	8	8	n/a	L	M	M
Kasichainula, Jag	Associate Prof.	T	FT	India Institute of Technology 1973	0	25	25	n/a	L	H	L
Koch, Carl	Dist. Research Professor	T	FT	Case Institute of Technology 1964	18	27	27	n/a	M	H	L
Luo, Mark	Assistant Prof.	TT	FT	Brown University 2003	0	5	5	n/a	M	H	L
Maria, Jon-Paul	Associate Prof.	T	FT	Pennsylvania State University 2002	0	8	8	n/a	M	H	N
Melechko, Anatoli	Associate Prof.	TT	FT	University of Tennessee 2001	3	2	2	n/a	M	H	N

*Averaged over the past three years

TABLE 6-2. FACULTY ANALYSIS (continued)

Name	Rank	Type of appointment (T, TT, NTT)	Full time/Part time (FT/PT)	Institution from which highest degree earned & year	Years of experience			Professional registration/certification	Level of activity* (H, M, L, none)		
					Government or Industry practice	Total faculty	This institution		Professional society	Research	Consulting or summer work in industry
Murty, Korukonda	Professor	T	FT	Cornell University 1970	7	29	29	n/a	M	H	L
Narayan, Jay	Dist. Research Professor	T	FT	University of California-Berkeley 1971	13	26	26	n/a	H	H	L
Reynolds, C. Lewis	Teaching Asst. Professor	NTT	FT	University of Virginia 1974	23	7	7	n/a	M	M	L
Rigsbee, J. Michael	Professor	T	FT	NC State University 1974	4	31	12	n/a	M	M	L
Rozgonyi, George	Professor	T	FT	University of Arizona 1963	19	28	28	n/a	M	H	L
Scattergood, Ronald	Professor	T	FT	Massachusetts Institute of Technology 1968	13	29	29	n/a	L	M	L
Schwartz, Justin	Dist. Research Professor	T	FT	Massachusetts Institute of Technology 1990	0	20	1	n/a	H	H	L
Sitar, Zlatko	Dist. Research Professor	T	FT	NC State University 1990	10	15	15	n/a	H	H	H
Spontak, Richard	Professor	T	FT	University of California-Berkeley 1988	0	18	18	n/a	H	H	H
Tracy, Joseph	Assistant Prof.	TT	FT	Massachusetts Institute of Technology 2005	0	3	3	n/a	H	H	L
Yingling, Yaroslava	Assistant Prof.	TT	FT	Pennsylvania State University 2002	3	3	3	n/a	H	H	L
Zhu, Yuntian	Professor	T	FT	University of Texas-Austin 1994	13	3	3	n/a	H	H	L

*Averaged over the past three years

TABLE 6-3. MSE FACULTY PROFESSIONAL DEVELOPMENT ACTIVITIES

Faculty member	Activities
C. M. Balik	Visiting scientist at the Institute for Science and Technology of Polymers, Madrid, Spain (2005). Editorial board for Materials Science & Engineering A: Structure and Properties Reviewer for many journals
J. Kasichainula	Reviewer to Journal of Applied Physics, Materials Science and Engineering, Diamond and Related materials, and European Journal of Applied Physics, Journal of Vacuum Science and Technology, Journal of Crystal Growth Reviewer for National Science Foundation
C. C. Koch	Invited lectures :Keynote talk at Plasticity January,2005, Kauai, Hawaii Lecture on nanomaterials at the Research and Development Caucus of the US House of Representatives, May 12, 2005 Seminar at Georgia Tech, April 3, 2007 Seminar at Pennsylvania State University, April 10, 2007 Keynote talk, RQ13, Dresden, Germany, August, 2008 Keynote talk, Plasticity 2009, St.Thomas, US Virgin Is.,January 2009 Seminar, Monash University, Melbourne, Australia, May 12, 2009
N. El-Masry	Coordinate the opto-electronic program with army scientists at the Army Research Lab (ARL), Development and engineering Centers (RDEC). Coordinate the opto-electronic program with DoD agencies DARPA, BMDO, NASA, and National Labs. Chairperson for several symposium and conferences in the field of III-V Nitrides.
K. L. Murty	Program Director, Metals Research, Division of Materials Research, NSF (IPA assignment) - 6/2001-8/2003 UNDP-TOKTEN consultant to Andhra University & IGCAR, India (1999)
J. Narayan	Executive Council - electronic Magnetic and Photonic Materials Division of TMS DOE - National Labs. and NSF-major facilities reviewer NSF Chair for the Presidential Materials (AMPP) Initiative Member-Visiting Committee (School of Materials Science and Engineering) Georgia Tech. Member - SURA Materials Research Council
R. J. Spontak	Editor-in-chief, Open Colloid Science Journal (2008-); Editorial Advisory Board, Langmuir (2008-2010); Macromolecules (2002-2005); Macromol. Chem. Phys., Macromol. Rapid Commun., Int. J. Polym. Sci.; Invited instructor, International Center for Materials Research, UC Santa Barbara (2007); Prospects for European Integration, Embassy of the Federal Republic of Germany (2006); Guest co-editor, Materials Research Society Bulletin (2006); U.S. DOE Energy Challenge National Competition, 1st Place Prize, Kitty Hawk, NC (2003); Director of Graduate Admissions, Department of Chemical Engineering, NC State (1999-2003); Delegate in German Academic Exchange Program in Physics; Recipient of Humboldt and Tewkesbury fellowships; Reviewer for > 50 journals, such as Science, Nature, Nature Mater., Adv. Mater., Phys. Rev. Lett.

EXHIBIT 6-1. NCSU COURSE EVALUATION FORM

Online Class Evaluation (ClassEval)

CSC 295 W 001 ST-APPLIED WEB PRO SMITH MARK HENRY
Instructor: SMITH MARK HENRY

The purpose of this confidential evaluation is to improve the quality of courses and teaching effectiveness by providing faculty with constructive student feedback. Please indicate your response to each item in the following sections by marking "Strongly Agree" to "Strongly Disagree" or "Not Applicable".

Questions related to Instructor and Course	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
1. The instructor stated course objectives/outcomes	O	O	O	O	O	O
2. The instructor was receptive to students outside the classroom	O	O	O	O	O	O
3. The instructor explained difficult material well	O	O	O	O	O	O
4. The instructor was enthusiastic about teaching the course	O	O	O	O	O	O
5. The instructor was prepared for class	O	O	O	O	O	O
6. The instructor gave prompt and useful feedback	O	O	O	O	O	O
7. The instructor effectively used instructional technology	O	O	O	O	O	O
Questions related to Instructor and Course	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
8. The instructor consistently treated students with respect	O	O	O	O	O	O
9. Overall, the instructor was an effective teacher	O	O	O	O	O	O
10. The course readings were valuable aids to learning	O	O	O	O	O	O
11. The course assignments were valuable aids to learning	O	O	O	O	O	O
12. This course was intellectually challenging and stimulating	O	O	O	O	O	O
13. This course improved my knowledge of the subject	O	O	O	O	O	O
14. Overall, this course was excellent	O	O	O	O	O	O

Answer Questions 15-18 ONLY if this evaluation is for a course that is exclusively lab based OR if it is for the lab section/instructor for a course that includes a separate lab potion.

Questions related to Labs/Lab Courses	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
15. Lab sessions contributed to mastery of course concepts	O	O	O	O	O	O
16. Lab facilities, equipment, supplies, etc. were adequate	O	O	O	O	O	O
17. The degree of lab difficulty was appropriate	O	O	O	O	O	O
18. Overall, the labs were effective learning experiences	O	O	O	O	O	O

Please answer the following open-ended questions in the text areas below.

19. Comment on strengths and weaknesses of the instructor. ________________

20. Comment on strengths and weaknesses of the course. ________________

21. Comment on strengths and weaknesses of the lab (if applicable) ____________

22. Other comments

EXHIBIT 6-2. College of Engineering Faculty Development & Special Initiatives Unit
COE Faculty Opportunities: 2009

Date	Event, Hosting Unit, & Facilitator	Attendance
January 14, 2009	**DARPA Award Info Session for COE Junior Faculty** – COE & Mark Johnson, ECE, to facilitate & present	10 faculty; 3 faculty for a followup session
January 17, 2009	**Passport to Engineering** – COE & Women in Engineering Program	8 faculty
January 22, 2009	**NSF IGERT Futures Information Meeting & Collaboration Networking** – COE & PDU	16 faculty
February 26, 2009	**NAE Grand Challenges Pre-Meeting** with Dean Martin-Vega	26 faculty
March 3, 2009	**Building Future Faculty Program Engineering Component** – COE & Office of Diversity & Inclusion	6 students 7 faculty
March 20, 2009	**NIH Grand Challenges Information Session in Response to Stimulus Funding** – COE	22 faculty
April 13, 2009	**NIH Grants: Information on NIH Grant Submission – the process through the eyes of Contracts & Grants** ; COE w/Pat Hayes, Director of Research Administration to present; Ram Ramasubramanian to facilitate	9 faculty
June 30	**Visit from KNUST Provost, Ghana** – COE & OIA	16 faculty 3 students
September 30	**Faculty Development Planning** – COE	12 faculty
September 15 & September 17	**Research Opportunity Seminar: $50 Million in DOE Funding** – COE, John Gilligan, NE	15 faculty
September 25	**NSF IGERT Proposal Meeting, NSF Director Presentation** – COE	22 faculty
October 13	**Faculty Lunch**– COE	9 faculty
October 15	**Department of Defense Briefing: Research Funding Opportunities** – COE	49 faculty
November 4,	**NSF Proposal Writing Workshop** – COE, Robert Beichner to facilitate	23 faculty
November 12	**Collaborative Research Opportunities at Sandia National Labs for New Career Faculty** – COE, Thomas Ward, ECE to facilitate	10 faculty
November 18	**Faculty Lunch** - COE	9 faculty
November 19	**NSF Leadership Visit**, Thomas W. Peterson, AD of Engineering Directorate, National Science Foundation: Seminar – COE	57 combined faculty & students

CRITERION 7. FACILITIES

A. Space

In December 2004, the Materials Science and Engineering department moved into Engineering Building I (EBI), a 93,000 net square-foot, state-of-the-art facility located on the Centennial Campus at NCSU. This building houses the Department of Chemical and Biomolecular Engineering (CBE), as well as the Department of Materials Science and Engineering. Departmental faculty were consulted and provided input on the design and layout of offices, classrooms, research laboratories and teaching laboratories. With significant input and effort from both departments, EBI has turned out to be one most attractive buildings on NC State's campus. It is a three-story structure with an open atrium in the center which provides an attractive meeting place for important College and University events. The atrium areas on each floor also give students a place to meet, talk or study, and distinguished visitors to NCSU are often toured through EB1.

The MSE department occupies the third floor of EB1 and the CBE department occupies the second floor. The first floor contains four classrooms, a snack bar and laboratories belonging to both MSE and CBE.

1. Offices (Administrative, Faculty, Clerical, Graduate students)
The MSE department occupies space in four different buildings on Centennial Campus. In addition to EB1, MSE faculty offices and labs are also located in Research Building 1 (RB1), Research Building 2 (RB2) and the Monteith Research Center (MRC). Each of these buildings are within a ten-minute walk from EB1. The MSE administrative offices and most faculty offices are located in EBI. Faculty, research faculty, administrative and clerical staff have individual private offices. Some post-docs also have private offices, while others share larger offices. Graduate students have individually assigned private desks (modular furniture systems) in large rooms, typically located outside of their advisors' offices. Office size must comply with University regulations for the type of position held by the occupant.

2. Classrooms
The MSE department uses classrooms located in EB1 and Engineering Building II (EB2). Lower-level introductory classes are still held on main campus, although these will transition to the Centennial Campus as more engineering departments move to the newer campus. For example, in the Fall 2010 semester, half of the sections in MSE 200, 201 and 203 will be held on Centennial Campus. Additional Centennial Campus classroom space will become available when Engineering Building III opens in Fall 2010.

In EB1 there are six classrooms for general use and one dedicated solely for MSE. The general classrooms occupy a total of 9,621 square feet while the dedicated MSE classroom has 996 square feet. The three largest classrooms (EB1 1011, 1007, 1005) have theater-style seating for 130, 99 and 64 students and the fourth largest (EB1 1010) accommodates 60 students seated at long tables. The remaining two classrooms (EB1 2015 and 3035) also have seating at long tables and accommodate 40 and 47 students. All classrooms (and most of the campus) at NCSU have wireless internet access and power receptacles at the seats to accommodate laptop computers.

NCSU has upgraded the classrooms across the campus to include state-of-the art audio-visual equipment and technology. The classrooms in EB1 and all other Centennial Campus buildings conform to this new standard. The instructor's station at the front of each classroom includes a document camera, dedicated computer, laptop connections, DVD and VCR players, sound system, video projector, and retractable screen. These peripherals are all controlled by a touchscreen system mounted in the desk at the front of the classroom. The classroom facilities are maintained by a group at the university (ClassTech) that can provide on-the-spot troubleshooting via telephone which is also located at the instructor's station. The classrooms have dimmable florescent lighting controls which allow the instructor to adjust the lighting for different instructional needs. A whiteboard and retractable projector screen are located in the front of each classroom. The dedicated classroom HVAC system responds to both temperature and carbon dioxide levels in order to maintain maximum comfort in the classrooms.

3. Laboratories
The laboratory facilities in Engineering Building I are far superior than those previously occupied by MSE on the main campus. Much of the space previously occupied by the MSE undergraduate laboratories was located in a building originally constructed in 1936 where it did not receive the attention and care to keep it up to date. The undergraduate labs currently occupy 2500 square feet in EBI. Each lab has a fume hood. The labs are designed to have ten or more air exchanges per hour of once-through (not recirculated) air. The labs have recirculated hot water and tempered water systems. The labs have excellent safety systems, including a fire extinguisher, eyewashes and fume hoods. Safety showers are located nearby in the hallway. Building services such as equipment exhaust, compressed air, recirculated chilled water and electrical services are installed and easily modified to meet the needs of individual experiments. The labs are completely supported by wireless internet as well. Each laboratory has an electronic access control system which can be programmed to grant and rescind student access to the facilities as needed.

B. Resources and support

1. Computing resources, hardware and software used for instruction
The Office of Information Technology and Engineering Computer Services (ITECS) at NCSU supports and maintains Eos, an excellent academic computing environment for its students. Formerly an engineering-only system, Eos was expanded to the rest of campus during the mid-90s in a project called Unity. Today, all NCSU students, faculty and staff receive Unity accounts on a fully merged Eos/Unity realm. Freshman engineers learn how to use Eos during their first semester in the class E115: Introduction to Computing Environments.

Eos is a distributed client-server network running AFS, a location-independent file system that delivers an unparalleled suite of engineering software to three platforms: Sun Solaris, Microsoft Windows and Red Hat Linux. Eos unifies hundreds of workstations in labs across the college, as well as student-owned computers that connect to Eos through remote-access services and the Virtual Computing Lab. Guided by the COE Computer Committee, ITECS acquires and installs the software and hardware that faculty need for teaching. ITECS works with departmental IT personnel to meet the discipline-specific requirements of individual departments, and with university-level IT personnel to develop technologies that benefit both college and university computing.

EB1 has two Eos computing labs in rooms 1008 (in the CBE department) and 3003 (in the MSE department). EB1 1008 contains 35 Windows, 2 Linux and 2 Solaris machines, while EB1 3003 contains 32 Windows and 2 Solaris machines. These are used extensively by MSE students. Students can also connect to the Eos network on a wireless link with their own laptop computers. In addition, the MSE department supplies licenses to Microsoft and Adobe products for undergraduate students. This system provides all the necessary computing software and hardware needed by MSE undergraduate students.

2. Planning, acquisition and maintenance processes for laboratory equipment
Each year, the department gets an allotment of funds from student fees (Educational Technology Fund, ETF) to maintain and upgrade the undergraduate laboratory equipment. The department's annual allocation for maintenance and upgrades from ETF funds is approximately $60,000, which is barely sufficient to provide required maintenance of lab equipment. New equipment must be funded by either foregoing maintenance, competing with other departments in the College for additional undergraduate laboratory funds or from NSF educational grants. Over the last four years, the department has received approximately $175,000 in additional resources. In the Spring 2010 semester, all engineering departments received a one-time allocation from the dean's office for undergraduate laboratory equipment. MSE received $118,000, and used these funds to purchase the following undergraduate lab equipment:

- Ecopia Hall Effect measurement set
- Pre-owned Instron Tensile tester, 1100-lb capacity
- Mitotoya microhardness tester
- Stoneware jar rolling mill
- Radiant RT66B ferroelectric tester
- Keithley four-point probe electronics
- DC power supply for magnetron sputtering system
- Varian HS-2 diffusion pump
- Vacuum pump for spin coater
- UV cleaner
- Rame-Hart 200 contact angle goniometer
- SIINT Exstar 6200 DSC/DTA/TGA thermal analyzer

A newly-appointed (Fall 2009) undergraduate laboratory committee is composed of faculty and staff and is tasked with redesigning the layout and content of the undergraduate laboratories. This committee will also seek outside funding (*e.g.* from NSF) to acquire and upgrade the lab equipment. Day-to-day facility and lab equipment maintenance is provided by the department's Resource Manager (Roger Russell). The Resource Manager is responsible for responding to comments, complaints, and requests from those using the undergraduate laboratory equipment. Any problems that arise are handled appropriate to the need. If a malfunctioning piece of equipment is needed for an upcoming lab, the problem is treated as an emergency. Otherwise regular maintenance is provided on a semester basis. The maintenance of equipment is adequate.

3. Support personnel for maintenance of computer hardware, software and networks
The MSE department recently created a new IT and Instrumentation Manager staff position with the responsibility of installing, maintaining and managing the department's hardware, software and network resources. Basic internet network services are provided by the university’s communication technologies group, which is a separate cost center within the university. The current IT and Instrumentation Manager (Toby Tung) has a BS in MSE from NCSU, as well as six years of experience providing computer support. The MSE department’s IT support is excellent.

The MSE department also recently hired a staff person to maintain the department’s website (Dustin Wheeler). Dustin has a BS in Computer Science from NC State and in a short time has vastly improved and updated the MSE website.

4. Support personnel for installation, management and maintenance of laboratory equipment
General maintenance and management of the undergraduate lab equipment is carried out by the department's Resource Manager, with some support from the IT and Instrumentation Manager.

C. Major instructional and laboratory equipment

A list of laboratory equipment used for instructional purposes is provided in Appendix C.

CRITERION 8. SUPPORT

A. Program budget process and sources of financial support

The university fiscal year is from July 1 to June 30. Under ideal circumstances the NCSU central administration receives budget information from the University of North Carolina system office by the end of the summer and transmits budget information to the college deans early in the fall term. Thus, the MSE department typically receives budget information from the Dean in September or October.

About 80% of the department budget is for fixed faculty and staff salaries that are automatically in place, including merit and promotion raises, which provides significant continuity to the department. On July 1, the primary unknown budget information concerns operating funds, funds from open positions, TA funds, returned overhead funds, increased enrollment funds, undergraduate research allocation funds, and Education Technology Fee (ETF) funds. The COE Dean and financial affairs office solely determine allocation of these latter funds to the different COE departments using internally generated metrics. In AY08-09, a state mandated mid-year budget cut was implemented, but a significant fraction of the cut was absorbed by the COE. No mid-year cut was imposed during AY09-10.

To date, funds for open faculty lines have remained in the department and have been used to help cover salaries for additional TAs, non-state funded instructors, miscellaneous operating expenses for undergraduate labs and portions of start-up packages for new faculty.

One additional source of funds directly associated with the undergraduate program is the Education Technology Fee (ETF) that all students pay. The ETF program provides multiple support services for the students (*e.g.*, the general access Eos computer labs) and has brought approximately $60-65K into MSE annually over the past 5 years.

Institutional support for MSE has historically been very good. Long-term continuity is seen in that the number of state funded FTE faculty (18-20) and staff (7-8) have been relatively constant for the past fifteen years. Since the last EAC visit, the COE Dean has replaced retiring MSE faculty 1-for-1 with new MSE faculty, and six new tenured/tenure-track faculty have been added in the past three years. The recruitment of a new Department Head, who joined NCSU in Fall, 2009, includes a commitment to grow the Department by five additional FTE tenure/tenure-track faculty over the next five years.

B. Sources of financial support

As with many state funded universities nationwide, a preponderance of our support come from state-allocated funds, including filled and unfilled faculty and staff positions, and the additional allocations received from the College of Engineering. These funds are from augmented research activities, primarily returned indirect costs and faculty release time. Historically, release time has been optional for faculty, but departmental policy now requires one month of release time or equivalent from tenured faculty in exchange for a reduction in teaching load (but in no case is the teaching load to become less than two courses per academic year).

One important additional source of financial support is the direct support of senior design projects from industrial sponsors. These funds are essential to the successful implementation of the senior capstone design course. Typically, the industrial funds received are more than adequate for the senior design projects, and the additional funds are used for undergraduate scholarships. Additional undergraduate scholarship funds are also available from endowments.

C. Adequacy of budget

The MSE departmental budget has been adequate to meet the primary departmental missions. The size of the faculty has held steady and reasonable start-up packages have been offered to six new hires who have joined MSE in the past three years. All start-up commitments have been met despite the difficult economic times. Furthermore, the size of the staff has also remained steady and sufficient. During the spring, 2010 semester, two office staff positions became open and were filled quickly, and two technical support staff (IT/lab electronics support and the department webmaster) were converted from temporary positions to permanent positions.

D. Support of faculty professional development

Faculty professional development occurs by a number of means, some funded by NCSU (College and Department) and some funded by individual faculty research programs. MSE faculty are very active in materials-related professional societies like MRS, ASM, ASEE, TMS, AVS, APS and SPE. Attending and participating in seminars and conferences, usually paid from grant and contract funds, provides opportunities for professional development. Due to very tight operating budgets, the MSE department provides limited funds to assist faculty to attend these meetings. The COE has also provided assistance for some faculty to attend annual ASEE meetings. The department does offer travel support to junior faculty to visit funding agencies.

Professional development also occurs through department and university sponsored activities. The MSE department sponsors a fall and spring term weekly seminar series involving national and international visitors from universities, national laboratories and industry. NCSU offers a paid academic leave (sabbatical) program where faculty can request to take one semester at full salary or two semesters at half salary.

NCSU also offers many opportunities internally, including teaching effectiveness training for all new faculty and focused topics like software applications and distance education activities, including course web site development. A list of faculty development opportunities provided by the COE dean's office in 2009 is shown in Exhibit 6-2.

E. Support of facilities and equipment

Regarding space infrastructure, institutional support for MSE is excellent. MSE moved into a newly constructed building (EB1) on Centennial Campus during the Fall 2004 term. This $30M building, which has about 93,000 net square feet of classroom, lab and office space, is shared with Chemical Engineering. MSE occupies about 35% of the building, CHE occupies about 40% of the building and the remainder is classrooms and common areas. These facilities significantly enhance our ability to deliver a quality program because of modern, expanded undergraduate teaching lab space. The common area space is also excellent for Department social events that bring students, staff, faculty and alums together. In the past year, this has included a BBQ and a Chili Cook-off.

Support for equipment for undergraduate teaching (undergraduate lab classes and senior design) comes primarily from the ETF funds. MSE typically receives $60,000-$65,000 per year. These funds are not always sufficient, in which case the Department operating funds are used to ensure smooth operation of the undergraduate labs. Furthermore, in Spring 2010, a one-time allocation of $118,000 was received from the COE to upgrade and modernize our undergraduate laboratory equipment.

Lastly, support is received directly from the COE for renovating/upgrading building space. This is coordinated between the Department and the College.

F. Adequacy of support personnel and institutional services

The MSE department is fortunate to have two highly effective, state-funded technical support staff: Roger Russell and Toby Tung. Roger and Toby work as a coordinated team and cover all computer, facility and equipment issues, including machining and electronics troubleshooting. Both Roger and Toby first came to MSE as students so they are very familiar with the unique needs of MSE students. Roger has been in his current position for ten years providing invaluable continuity. He was actively involved in the planning of EB1 and oversaw the transition from main campus to EB1, so he is intimately knowledgeable about all building and lab-infrastructure issues. Roger also plays an active role in ensuring the smooth operation of the undergraduate laboratory courses and oversees the MSE safety program. Toby is a recent MSE graduate, so he is also very knowledgeable about our undergraduate program laboratory and electronics needs.

MSE is also fortunate to have an effective office staff, including Meghan Johnston who manages all of our state, service and endowment accounts, and Linda Simerson who manages all of our contract and grants accounts. The undergraduate and graduate students are supported by Edna Deas. Edna, who has been with MSE since 1988, directly interfaces with our students, assisting them with interpretations of university policy and procedures from the day they first enroll through graduation. Edna also supports the Directors of Undergraduate (Balik) and Graduate (Scattergood) Programs plus all MSE faculty advisors. In a recent anonymous survey, one faculty member referred to Edna as “a saint”.

CRITERION 9. PROGRAM CRITERIA

Program criteria

The 2009-10 program criteria for Materials, Metallurgical and similarly named engineering programs specifies that graduates must have:

1. the ability to apply advanced science and engineering principles to materials systems;
2. an integrated understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing and performance;
3. the ability to apply and integrate knowledge from each of the above four elements to solve materials selection and design problems;
4. the ability to utilize experimental, statistical and computational methods consistent with the program educational objectives.

These criteria map directly into the MSE PLOs as shown in Exhibit 3-2 and discussed in Section 3B,C. In that section it was shown that the MSE program is achieving all of its outcomes and therefore is meeting the MSE program criteria. Courses in MSE curricula 14MSE056 and 14MSE097 which have content related to each of the program criteria were identified in Section 5A-4. There it was demonstrated that both curricula allocate an adequate amount of coverage to each of the MSE program criteria. The table below, which is reproduced from Section 5A-4, shows the courses related to each program criterion. Detailed course contents can be found in the course syllabi located in Appendices A1 and A2.

MSE COURSES RELATED TO THE MSE PROGRAM CRITERIA

MSE Program Criterion	MSE Courses in 14MSE056	MSE Courses in 14MSE097
1	MSE 201, 301, 321, 330, 331, 350, 450	MSE 201, 301, 355, 360, 420
2	MSE 331, 425, 431, 435	MSE 300, 320, 370, 380, 480
3	MSE 423, 424, 440, 445, 455, 460, 556	MSE 423, 470, 440, 445, 455, 456, 460
4	MSE 210, 310, 324, 333, 430, 434	MSE 255, 260, 335

- Courses related to the first criterion are fundamental courses which apply the principles of chemistry, physics and engineering to all classes of materials.
- Courses related to the second criterion provide coverage of structure-property-performance relationships for all classes of materials.
- Courses related to the third criterion are senior design and technical elective courses oriented toward processing, materials selection and applications.
- Courses related to the fourth criterion are computer and laboratory courses.

Faculty
The 2009-10 MSE program criteria also specifies that the faculty expertise must encompass the four major elements of the field: structure, properties, processing and performance of materials. The size and expertise of the MSE faculty is adequate for this purpose, as discussed in Section 6. Further evidence that all MSE curricular areas are covered is provided in Tables Tables 5-2a and 5-2b, which show the faculty who have taught MSE courses over four recent semesters. This table indicates which faculty typically teach each undergraduate course as well as the curricular areas in which they specialize.

APPENDICES

A1. Course syllabi: MSE curriculum 14MSE056

A2. Course syllabi: MSE curriculum 14MSE097

B. Faculty resumes

C. Laboratory equipment

D. Institutional summary

APPENDIX A1

MSE Curriculum 14MSE056

Syllabi for the courses listed below can be found in Appendix A2. These courses did not change with the 2009 curriculum revision and are common to both the 14MSE056 and 14MSE097 curricula.

MSE 201	**Structure and Properties of Engineering Materials**
MSE 440	**Processing of Metallic Materials**
MSE 445	**Ceramic Processing**
MSE 455	**Polymer Technology and Engineering**
MSE 460	**Microelectronic Materials**
CSC 112	**Introduction to Programming- FORTRAN**
CSC 116	**Introduction to Programming- JAVA**

MSE 210
Materials Characterization Laboratory
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Concepts and applications of basic materials characterization techniques including diffraction, microscopy (optical and electron), thermal analysis, mechanical testing techniques, and spectroscopic analysis of materials.

Prerequisite(s): MSE 201

Textbook(s) and/or other required material: Lab manual provided.

Course learning outcomes. By the end of this course, the student should be able to:
- Select characterization techniques appropriate to the class of material and type of information needed
- Articulate the relationships between structure, properties and testing methods.
- List the intrinsic merits and resolution limits of several major materials characterization techniques
- Write a technical lab report and give an effective oral presentation

Topics covered:
- Treatment of experimental error
- Tensile properties of materials (1 lecture)
- Ductile to brittle transition in materials: The impact test (1 lecture)
- Strain hardening and annealing of metals (1 lecture)
- Observation of the microstructure of materials by an optical microscope (1 lecture)
- Strengthening of materials by age hardening (1 lecture)
- Phase equilibrium diagrams (1 lecture)
- Microstructure of eutectic alloys (1 lecture)
- Observation of the microstructure of materials with a scanning electron microscope (1 lecture)
- Chemical analysis by Auger electron spectroscopy (1 lecture)
- Magnetic properties of materials (1 lecture)
- X-ray diffraction (1 lecture)

Class/laboratory schedule (sessions per week and duration of each session)
This is a 1 credit hr course consisting of 12 50-minute lectures and 12 3-hr lab sessions spread over a 14 week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**2**	Methods for characterizing the structure and properties of materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	Data plotting and analysis, curve fitting
2b. Materials selection	
2c. Microscopy and diffraction	*Optical microscopy SEM and x-ray diffraction
2d. Mechanical and thermal methods	*Tensile, impact and hardness testing
2e. Electrical and magnetic methods	Magnetic properties are measured
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	*Written lab reports are required
3d. Basic computer skills	*Computers used for report preparation
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:

Dr. Lew Reynolds, November 2009

MSE 301
Equilibrium and Rate Processes in Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Review of classical thermodynamics and thermodynamic relationships. Use of statistical methods of describe entropy and other thermodynamic properties. Description of vapor-, liquid-, and solid-phase equilibrium in unary and other multicomponent material systems. Treatment of ideal and nonideal solution behavior in inorganic alloys and organic polymers. Application of gas-phase reaction kinetics and identification of the criteria required for reaction equilbria.

Prerequisite: MA 241 *Co-requisite:* MSE 201

Textbook(s) and/or other required material: Introduction to the Thermodynamics of Materials, David R. Gaskell, 4th edition. Typical price: $99.00.

Course learning outcomes. By the end of this course, the student should be able to:
- Calculate free energy changes for various thermodynamic processes
- Distinguish between reversible and irreversible processes
- Calculate the deviations from ideal behavior in real gas systems
- Directly relate deviations from ideal gas behavior to unary phase equilibria
- Calculate the equilibrium condition for gaseous mixtures as a function of temperature and pressure
- Determine feasibility criterion for gas-phase/condensed-phase chemical reactions, chemical mixing, and electrochemical cell operation
- Calculate intrinsic defect populations in condensed phases, and extrinsic defect populations as a function of partial pressure and temperature
- Calculate chemical mixing energies, and translate those energy calculations to predictions of binary phase equilibria
- Apply calculated equilibrium criterion to the selection of processing conditions for modern materials applications like multilayer capacitors and float glass

Topics covered:
- Entropy and introductory principles
- Reversible and irreversible processes
- Energies and evolution criteria
- Auxiliary functions
- Phase equilibria in the one component system
- Ideal and real gas behavior
- Partial molar properties
- Gas phase reactions and the equilibrium constant
- Reactions between pure and condensed phases

- Ellingham and Richardson diagrams
- Defects in solids
- Behavior of solutions
- Electrochemistry

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Introductory thermodynamics and application to materials systems
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	*Encompasses the course content
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	Introduction to statistical thermodynamics
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:

Dr. Mark Luo, November 2009

MSE 310
Computer Applications for Materials Engineering
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Introduction to numerical methods and computing codes for solving various types of equations, analyzing materials data, simulating materials processing, calculating electronic and mechanical properties of materials.

Prerequisite(s): none

Textbook(s) and/or other required material: none required. An extensive web site is provided containing lecture notes, computer codes and assignments.

Course learning outcomes. By the end of this course, the student should be able to:
- Apply numerical methods to solution of integrals, derivatives and nonlinear algebraic and differential equations
- Apply Fourier transform methods for data analysis
- Interpret elementary electronic structure data (e.g. electronic energy states) in terms of electron energies, and band gaps
- Perform elementary finite element and atomic-scale molecular dynamics/Monte Carlo modeling of materials processing and properties
- Write an effective report
- Work in small groups with other students

Topics covered:
- Numerical methods (6 lectures and 6 computer lab sessions)
- Fourier transforms (1 lecture and 1 computer lab session)
- Atomic-scale molecular dynamics and Monte Carlo modeling (3 lectures and 3 computer lab sessions)
- Finite element modeling (1 lecture and 1 computer lab session)
- Quantum mechanics and electronic structure (2 lectures and 1 computer lab session)

Class/laboratory schedule (sessions per week and duration of each session)
One 50-minute lecture and one 50 minute computer lab session per week for a 16-week semester. Laboratories involve either writing and implementing short codes, executing demonstrative codes developed by the instructor, or executing commercial modeling codes. Small groups of students give 20 minute presentations on a modern topic in materials modeling.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**2**	Application of numerical and computer methods to solution of materials problems; modeling of materials processes
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	Introduction to Fourier transforms, quantum mechanics, atomistic modeling
2a. Computer-based tools	*Numerical solution of integrals and differential equations, finite element analysis, atomistic computer modeling
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	Students conduct projects in small groups
3b. Oral communication	Groups of students give presentations on modeling topics
3c. Written communication	Students prepare reports describing modeling projects
3d. Basic computer skills	Students use spreadsheets for numerical analysis; students implement and run both specialized and commercial modeling computer codes.
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Don Brenner, January 2010.

MSE 321
Phase Transformations and Diffusion
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Types, mechanisms, and kinetics of solid state phase transformations are presented with selected applications of solid state transformations. Mechanisms of diffusion and techniques for diffusion calculations.

Prerequisite(s): MSE 330.

Textbook(s) and/or other required material:
Introduction to Phase Transformations in Metals and Alloys. 2nd ed. D.A. Porter and K.E. Easterling. Chapman and Hall (London) 1992.

Course learning outcomes. By the end of this course, the student should be able to:
- Apply basic principles of thermodynamics to phase transformations
- Articulate various mechanisms of atomic diffusion in metals and alloys
- Solve basic diffusion-related problems in materials science
- Describe the thermodynamics and kinetics of liquid-solid and solid-solid phase transformations in materials
- Apply the principles of phase transformations to materials engineering processes such as casting and heat treating

Topics covered:
- Review of Thermodynamics and Phase Diagrams
- Diffusion
- Crystal Interfaces and Microstructure
- Solidification
- Diffusional Transformations in Solids
- Diffusionless Transformation

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

8. Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Thermodynamics and kinetics of phase transformations. Relationship of phase transformations to materials processing
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	*Thermodynamics of phase diagrams and phase transformations
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	Introduction to kinetics of diffusion and phase transformations
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Mark Johnson, November 2009

MSE 324
Polymer Characterization Laboratory
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Laboratory experiments designed to illustrate the preparation and characterization of polymer materials, including: polymer synthesis, molecular weight measurement, microscopic examination, thermal properties, mechanical properties, and permeability.

Prerequisite(s): none *Co-requisite:* MSE 425 for MSE majors

Textbook(s) and/or other required material:
None required. Lab handouts are provided for each experiment.

Course learning outcomes. By the end of this course, the student should be able to:
- Measure polymer molecular weight using dilute solution viscosity
- Describe how interfacial polymerization can be used to prepare nylon polymers
- Identify glass transitions, melting endotherms and crystallization exotherms in a DSC thermogram and explain the effect of cooling rate on polymer crystallinity
- Explain the effect of strain rate on the mechanical properties of polymers
- Describe the appearance and internal structure of polymer spherulites, and explain the effect of crystallization temperature on spherulite size
- Determine the activation energy for permeation of small molecules through polymers
- Write an effective lab report

Topics covered:
- Laboratory safety and report preparation (1 lecture)
- Interfacial polymerization (1 lecture)
- Molecular weight measurement via dilute solution viscosity (1 lecture)
- Thermal analysis of polymers with differential scanning calorimetry (1 lecture)
- Mechanical properties of polymers (1 lecture)
- Optical microscopy of polymers (1 lecture)
- Permeability of polymers (1 lecture)

Class/laboratory schedule (sessions per week and duration of each session)
This is a 1 credit hour course consisting of seven 1-hr lectures and six 3-hour laboratory sessions spread over 1 semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**1**	Principles of DSC analysis, optical microscopy, tensile testing, small molecule permeability, molecular weight measurement for polymers
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Strain-rate dependence of mechanical properties, crystallinity dependence on cooling rate, spherulite size dependence on crystallization temperature
1f. Grad. school preparation	Introduction to basic polymer characterization methods
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	*Polarizing optical microscopy
2d. Mechanical and thermal methods	*Tensile testing, differential scanning calorimetry
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	*Written lab reports are required
3d. Basic computer skills	*Computers used for report preparation
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. C. M. Balik, October 2009

MSE 330
Crystal Chemistry and Phase Equilibria
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Structure of engineering materials from electronic to atomic and crystallographic considerations. Structural imperfections and their effects on properties. Applications of thermodynamic principles to the construction and use of phase diagrams in materials systems. Development of and correlation of microstructure with phase diagrams.

Prerequisite(s): MSE 301

Textbook(s) and/or other required material: None required, but reading recommendations from: Kingery, Bowen, and Uhlman, Introduction to Ceramics.
Course Notepack: provided electronically

Course learning outcomes. By the end of this course, the student should be able to:
- Identify important raw materials and minerals as well as their names and chemical formulas.
- Describe the crystal structure of important materials and to be able to build their atomic models.
- Learn the systematics of crystal and glass chemistry
- Use crystal structure to predict phase equilibria
- Understand how physical and chemical properties are related to crystal structure and microstructure.
- Appreciate the engineering significance of these ideas and how they relate to industrial products: past, present, and future.

Topics covered:

LECTURE 1	Outline chemical elements	LECTURE 15	Pauling's Rules for ionic structures
LECTURE 2	Minerals and raw materials	LECTURE 16	Prediction of structure for crystals and glasses
LECTURE 3	Chemical bonding in ceramic materials and Electronegativity	LECTURE 17	Zachariasen's Rules and structure of glass
LECTURE 4	Hardness, melting points, and boiling points	LECTURE 18	Phase diagrams and crystal chemistry
LECTURE 5	Crystal systems	LECTURE 19	Types of solid solutions
LECTURE 6	Theoretical density	LECTURE 20	Phase transformations and structure
LECTURE 7	Miller indices and zone axes	LECTURE 21	Structure changes with temperature and pressure
LECTURE 8	Morphology and crystal growth	LECTURE 22	Defect chemistry, conductivity and structure
LECTURE 9	Mechanical properties: cleavage and slip	LECTURE 23	Thermal expansion
LECTURE 10	Surface properties: wetting and etching	LECTURE 24	Specific heat, thermal conductivity, and structure
LECTURE 11	Symmetry elements and point groups	LECTURE 25	Diffusion and ionic
LECTURE 12	Neumann's law and tensor properties	LECTURE 26	Refractive index and birefringence
LECTURE 13	Bond lengths and atomic radii	LECTURE 27	Color, absorption, fluorescence, and structure
LECTURE 14	Ionic radii: trends and relationships	LECTURE 28	Dielectrics and ferroelectricity

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Phase diagrams, crystal chemistry
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	Atomic structure, chemical bonding, periodic table
1c. Thermodynamics of materials	*Phase equilibria and phase diagrams
1d. Statics and solid mechanics	
1e. Structure-property relationships	Relationship of crystal chemistry to properties of selected families of ceramics
1f. Grad. school preparation	
2a. Computer-based tools	*Use of Crystal Maker software to visualize complex unit cell structures
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. J-P. Maria, November 2009

MSE 331
Electronic Properties of Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Treatment of the role of electrons and electron energy (band) structures in determining the fundamental properties of materials- electrical, magnetic, optical, and thermal. Introduction to quantum mechanics; Brillouin zones; band structures. Theoretical and phenomenological basis of each property as manifested in various classes of materials; examples and demonstrations of technological applications.

Prerequisite(s): MSE 330

Textbook(s) and/or other required material: Principles of Electronic Materials and Devices, Second Ed. S.O. Kasap, McGraw-Hill (2002) ISBN: 0072456361 and course Web page.

Course learning outcomes. By the end of this course, the student should be able to:
- Discuss the electronic properties of all materials and explain the specific role of electrons in these properties.
- Predict the electrical and optical properties of materials based on electron energy band structure.
- Calculate macroscopic electronic, optical or magnetic properties from microscopic principles: resistivity from doping and mobility; photon wavelength from direct bandgap energy.
- Articulate the quantum mechanical model of electrons in solid materials; and compare with the classical models.
- Explain, compare and contrast the various experimental methods of electrical property measurements of materials.
- Identify the key materials science and engineering issues limiting the manufacture and performance of microelectronic devices.
- Plan and organize the processing steps involved in electronic device fabrication.

Topics covered:
- Electrical and Thermal Conduction in Solids
- Elementary Quantum Physics
- Band Theory and Statistics
- Semiconductors
- Semiconductor Devices
- Dielectrics
- Magnetic Materials
- Optical Properties

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Physics of electronic devices, device fabrication
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	Solution of Schrodinger's equation
1b. Chemistry and physics	*Electron behavior and transport in solids, semiconductor doping
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Conductivity vs. composition, defects and microstructure. Film thickness and grain boundary effects, amorphous semiconductors
1f. Grad. school preparation	Introduction to modern physics, quantum mechanics, E&M theory
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	Description of the Hall effect, 4-point probe measurements, magnetoresistance, photoluminescence
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Lew Reynolds, November 2009

MSE 333
Electronic Properties Laboratory
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Course contains laboratory experiments demonstrating major electronic properties of all classes of materials; electrical conduction (temperature and defect dependence); characterization of semiconductors; optical measurements and characterization; magnetic behavior and properties; electron beam techniques used to characterize devices. Laboratory experience designed to reinforce and demonstrate physical manifestation of electronic properties and concepts from lecture course MAT 331.

Prerequisite(s): MSE 330 *Co-requisite:* MSE 331

Textbook(s) and/or other required material:
Principles of Electronic Materials and Devices, Second Ed. S.O. Kasap, McGraw-Hill (2002) ISBN: 0072456361 and course Lab Handouts.

Course learning outcomes. By the end of this course, the student should be able to:
- Demonstrate the electronic properties of metal, semiconductor and insulator materials and explain the specific role of electrons (or holes) in these properties.
- Operate a voltmeter, ammeter, ohmeter and curve tracer to measure electronic behavior.
- Construct a simple circuit including resistor network, voltage divider and LED drive.
- Perform experiments to determine the electrical conductivity, mobility and carrier concentration in a material, such as Hall Effect (Van-der-Pauw) and 4 point probe.
- Differentiate by experiment the majority carrier type in a semiconductor (p-type vs. n-type)
- Simulate the quantum mechanical model of electrons in solid materials for a one dimensional model.
- Calculate photon wavelength from transition energy.
- Explain the composition, structure and property relationships for semiconductors.
- Explain, compare and contrast the various experimental methods of electrical property measurements of materials.
- Plan, organize and present data from an independent project demonstrating an electronic, optical or magnetic property of materials.

Topics covered:
- Introduction to Expectations and Lab Reports
- Measurement of Resistance, Voltage, Current, in Circuits
- Quantum Behavior: Scattering and Diffraction
- Contact resistance and conductivity measurement in Semiconductors
- Magnetic Fields and the Hall Effect
- Measurement of Semiconductor Devices (Diodes and FETs)
- Independent Projects

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for 90-minute sessions one time per week for a 14-week semester. Students work in laboratory groups of two to three students per team. Self-scheduled access to laboratory space and resources for Independent Project.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	1	Methods for electronic property measurements
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Conductivity vs. composition, defects and microstructural effects, Zener diode breakdown, LED wavelength vs. band gap energy
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	*Encompasses course content
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	*Written lab reports required
3d. Basic computer skills	*Computers used to prepare lab reports
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Lew Reynolds, November 2009

MSE 350
Mechanical Properties of Materials I
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Covers fundamental topics in stress analysis and mechanics of materials including statics and structures, elasticity, plasticity, fracture, fatigue, testing methods, and engineering applications.

Prerequisite(s): MSE 201, MA 341

Textbook(s) and/or other required material:
W. F. Riley, L. D. Sturgis and D. H. Morris, "Statics and Mechanics of Materials: An Integrated Approach," Wiley, ISBN 0-471-01334. Required handouts to supplement the textbook will be posted in the Wolfware course locker.

Course learning outcomes. By the end of this course, the student should be able to:
- Apply the equations of static equilibrium to free-body diagrams and structures
- Distinguish statically determinate (SD) vs. statically indeterminate (SID) problems
- Solve SD and SID planar truss problems for forces and displacements
- Solve SD and SID beam problems for shear, moments and displacements
- Rotate axes and find principal stresses for 2D stress states
- Solve thin-wall pressure vessel problems

Topics covered:
- Forces and Moments (6)
- Equilibrium and free-body diagrams (4)
- Frames and machines (2)
- Planar trusses (6)
- Shear, moments and stresses in beams (5)
- Deflections in beams (9)
- Transformation of stresses and strains (4)
- Pressure vessels (3)
- Quizzes (3)

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Statics and solid mechanics relevant for materials science and engineering
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	*Solution of linear, differential and integral equations
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	*Encompasses the course content
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	Use of Maple to solve complex problems
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Ron Scattergood, November 2009

MSE 423
Introduction to Materials Engineering Design
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Materials selection in engineering design involving lecture, cooperative and problem based learning techniques. Course stresses creative thinking, problem solving methodology, interdependence of design with analysis and evaluation, teamwork and sharpening of communication skills. Real industrial problems are introduced later which are analyzed by student teams. Well developed proposals are submitted to sponsors which define future work under MAT 424.

Prerequisite(s): MSE 434, 435, 450 and senior standing in MSE. *Co-req:* MSE 430, 431

Textbook(s) and/or other required material:
Dieter "Engineering Design"

Course learning outcomes. By the end of this course, the student should be able to:
- Conceptualize ideas
- Communicate orally and visually
- Analyze problems
- Prepare and write a professional project proposal
- Work in teams

Topics covered:
- The design process
- Conceptualization of ideas
- Brainstorming
- Evaluation of ideas
- Analysis of ideas
- Working in teams
- Material selection
- Ethics
- Design of experimentation
- Project management tools

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Selection of materials for specific applications
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	*Materials selection based on application (Ashby method)
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	Students work in teams to write proposals and give presentations
3b. Oral communication	*Oral presentations are required
3c. Written communication	*Written proposal is required
3d. Basic computer skills	
4a. Contemporary issues	Projects involve current issues in materials science and engineering
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Keith Dawes, November 2009

MSE 424
Materials Science and Engineering Design Project
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Design project in materials science and engineering requiring problem definition and analysis, synthesis, and presentation of a designed solution. Students work in groups with a faculty adviser on problems submitted by local industrial sponsors or emerging research issues that represent the major specialty areas including ceramics, metals, polymers, or electronic materials.

Prerequisite(s): MSE 423, 430, 431, 435, 434, 450 and senior standing

Textbook(s) and/or other required material:
Dieter "Engineering design" recommended but not required

Course learning outcomes. By the end of this course, the student should be able to:
- Develop a project plan
- Demonstrate an ability to work in a team
- Conceptualize the problem presented to the team
- Prepare and write professional project reports
- Verbally communicate
- Analyze data and draw conclusions

Topics covered:
- No lectures. Teams work independently during the semester.

Class/laboratory schedule (sessions per week and duration of each session)
Class meets at the beginning of the spring semester. After that time the teams give 3 updates during the semester with the final presentation on the last day of classes.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Application of materials engineering principles to real-world materials problems provided by local companies
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	Practical materials selection is often a component of the projects
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	*Projects are carried out by teams of 3-4 students.
3b. Oral communication	*Progress report presentations are given several times during the semester. Oral and poster presentations are also required at the end of the semester.
3c. Written communication	*Final written project report is required.
3d. Basic computer skills	
4a. Contemporary issues	Design projects are based on a current materials problem.
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Keith Dawes, November 2009

MSE 425
Introduction to Polymeric Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Covers fundamental concepts in polymer science, engineering and design including molecular weight distributions, polymer physical structure, morphology, crystalline and amorphous polymers, structure-property relationships, viscoelasticity, and rubber elasticity.

Prerequisite(s): CH 220, MSE 301. *Co-requisite:* MSE 324

Textbook(s) and/or other required material:
Introduction to Polymers, Young & Lovell, 2nd ed. Chapman and Hall (1991).

Course learning outcomes. By the end of this course, the student should be able to:
- Calculate polymer molecular weight averages from a given distribution
- Describe techniques for measuring polymer molecular weight and how to analyze data from these techniques to obtain molecular weight
- Explain how the kinetics or statistics of polymerization reactions affect polymer molecular weight and polydispersity
- Calculate the variation of copolymer composition with monomer feed composition and monomer reactivity ratios
- Describe how the chemical structure of the polymer molecule affects thermal and mechanical properties
- Explain how entropy controls the mechanical and thermal behavior of rubbery polymers, and solve simple problems using the thermodynamic theory of rubber elasticity
- Derive and solve the differential equations which apply to the Maxwell, Voigt and generalized models used to describe the viscoelastic behavior of polymers

Topics covered:
- Polymer molecular weight averages and molecular weight distributions
- Measurement of polymer molecular weight
- Reaction kinetics, statistics and molecular weight of step-growth polymers
- Reaction kinetics and molecular weight of chain-growth polymers
- Copolymerization
- Polymer structure, morphology and physical properties
- Rubber elasticity
- Polymer viscoelasticity and time-temperature superposition

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Polymer molecular weight distributions, structure-property relationships, rubber elasticity, viscoelasticity
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	*Reaction kinetics for chain polymerization, statistics of step growth polymerization, gelation in thermoset polymers
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Structure-property relationships for polymeric materials
1f. Grad. school preparation	Introduction to polymer solution thermodynamics and molecular weight measurement methods
2a. Computer-based tools	
2b. Materials selection	Typical applications for thermoplastic, thermoset and elastomeric materials are discussed
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. C. M. Balik, October 2009

MSE 430
Physical Metallurgy Laboratory
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Selected microstructures in ferrous and non-ferrous metals are examined using optical microscopy along with scanning electron microscopy and are interpreted. Mechanical properties measurements are made on some of the same alloys in order to develop structure-property relationships.

Prerequisite(s): none *Co-requisite:* MSE 431

Textbook(s) and/or other required material:
Write ups for the experiments will be provided by the instructor.

Course learning outcomes. By the end of this course, the student should be able to:
- Communicate through writing with others within the discipline of Materials Science and Engineering.
- Experimentally determine the parameters required for calculating yield strength and critical stress intensity factor.
- Prepare optical microscopy and scanning electron microscopy specimens.
- Use a digital camera, specialized software, and a computer in conjunction with an optical microscope for optical microscopy including quantitative metallography.
- Correlate selected microstructures in a specific steel formed by different heat treatment processes and observed by optical and scanning electron microscopy to the mechanical property hardness.
- Examine a two phase alloy system using X-ray diffraction techniques in conjunction with optical microscopy to identify the phases present.
- Analyze a failure using optical microscopy in conjunction with scanning electron microscopy to determine the fracture mode in different fracture zones on a fracture surface.
- Analyze a practical failure using visual inspection and optical microscopy observations of the fracture surface of the failed components.

Topics covered:
- Mechanical Properties: Yield strength, critical stress intensity factor, impact testing, and hardness
- Microscopic examinations of metals
- Quantitative Metallography
- Time –Temp. Transformation Diagrams: Correlate the microstructures formed in a 4140 steel by different heat treatment processes to the hardness
- Examination of a/b two phase brass using optical microscopy in conjunction with x-ray diffraction analysis techniques

- Determine the fracture mode using SEM in different fracture zones on the fracture surface of a failed component
- Failure analysis of a failed component by visual inspection and optical microscopy observation of the fracture surface of the failed component

Class/laboratory schedule (sessions per week and duration of each session)
One 3-hr laboratory session per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	1	Metallography, mechanical properties and microstructure of metals
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Correlation of microstructure of metals to mechanical properties
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	*Optical microscopy, SEM, x-ray diffraction
2d. Mechanical and thermal methods	*Tensile, hardness and impact tests, failure analysis
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	*Written lab reports are required
3d. Basic computer skills	*Use of a computer to prepare lab reports
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Lew Reynolds, November 2009

MSE 431
Physical Metallurgy
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Application and design of selected metals and alloys in a theoretical and practical context. Relationships between mechanical behavior and alloy chemistry, microstructure, and processing. Corrosion resistance; fatigue failure; creep; brittle fracture. Design of specific microstructures.

Prerequisite(s): MSE 321, 450 *Co-requisite:* MSE 430

Textbook(s) and/or other required material:
W.F. Smith, "Structure and Properties of Engineering Alloys," Second Edition (1993) Mc Graw-Hill

Course learning outcomes. By the end of this course, the student should be able to:
- Apply the basic microstructural concepts operating in metals.
- Describe the transformations of austenite to cementite, spherodite, bainite and martensite, along with the various transformations produced by the heat treatment of these microstructures in both plain carbon and low alloy steels.
- Recite the terminology used for plain carbon and low alloy steels.
- Correlate alloy chemistry, microstructure and processing with selected properties, emphasizing mechanical properties, for (1) plain carbon and low alloy steels and (2) aluminum-, copper-, nickel- and titanium-base alloy systems.
- Apply selected rate laws to study the kinetics and other related aspects of phase transformations in some of the alloy systems considered.
- Apply basic corrosion concepts to the various metal and alloy systems considered.
- Design a metal fastener using knowledge of metal alloys, microstructure, yield strength, fracture toughness and alloy processing.

Topics covered:
- Basic Microstructural Concepts
- Iron Carbon Alloys
- Plain Carbon Steels
- Low Alloy Steels
- Corrosion of Metals
- Aluminum and Aluminum Alloys
- Copper and Copper Alloys
- Nickel and Nickel Alloys
- Titanium and Titanium Alloys
- Fastener design using type of alloy, yield strength, fracture toughness and microstructural concepts

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Ferrous and nonferrous alloys, structure-property relationships, selection of metallic materials for specific applications
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Structure-property relationships for metallic materials
1f. Grad. school preparation	Introduction to metallic microstructures
2a. Computer-based tools	
2b. Materials selection	Selection of metallic materials for specific applications
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Lew Reynolds, November 2009

MSE 434
Ceramic Engineering Laboratory
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Ceramics are processed and examined in the laboratory. Topics include sintering, mechanical properties, sol gel processing, dielectric properties, defect chemistry, and optical property measurements. The laboratory course provides a technologically and scientifically pertinent combination of ceramic synthesis and property measurement activities.

Prerequisite(s): none. *Co-requisite:* MSE 435

Textbook(s) and/or other required material:
Class handouts specific to each of the laboratories

Course learning outcomes. By the end of this course, the student should be able to:
- Ceramic green body formation by pellet pressing
- Sintering and measurement of fractional density
- Interpret density measurements in terms of microstructural development
- Relate surface defects and strength in brittle materials
- Interpret the statistical variation of strength of individual ceramic test pieces
- Prepare a ceramic material using sol-gel process
- Fabricate a thin film capacitor and measure its non-linear dielectric properties
- Prepare a transparent ceramic conductor

Laboratories covered:
- Crystal chemistry of silicates
- Sol-gel thin film processing
- Brittle fracture
- Thin film characterization – dielectric and structural
- Optical property measurement
- Thin film deposition by sputtering

Class/laboratory schedule (sessions per week and duration of each session)
6 laboratory assignments (lecture, laboratory, independent data acquisition, and lab report preparation) in a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**1**	Design of sintering schedules, measurement of ceramic properties including strength and thermal behavior
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	*Weibull statistics for fracture analysis
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	*Fracture strength and thermal shock measurements
2e. Electrical and magnetic methods	*Dielectric measurements on capacitor materials
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	*Written lab reports are required
3d. Basic computer skills	*Use of a computer to prepare lab reports
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. J-P. Maria, November 2009

MSE 435
Physical Ceramics
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Physical and chemical nature of classical and modern ceramic materials. Emphasis on crystal structures, defect structures and microstructures, and their collective effects on thermal, mechanical and electrical properties.

Prerequisite(s): MSE 201, 210. Co-requisites: MSE 321, 434

Textbook(s) and/or other required material:

Optional:	Fundamentals of Ceramics M. Barsoum
Optional:	Introduction to Phase Equilibria in Ceramics, Bergeron and Risbud
Course Notepack:	Provided electronically by instructor

Learning outcomes – By the end of this course, students should be able to:
- Identify and describe the microstructure of ceramics
- Identify applications where ceramic materials offer the best properties and performance
- Correlate microstructural features with the development of mechanical, thermal, optical, and electrical properties
- Articulate structure-process-property relationships in ceramics

Topics covered
- Introduction
- Ceramic Structures and Chemical Forces
- Defects in Ceramics
- Diffusion and Conductivity
- Oxide Glass
- Sintering
- Mechanical Properties
- Thermal Properties
- Conducting Ceramics
- Dielectric Properties
- Magnetic Properties
- Optical Properties

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Ceramic crystal structures and defect, structure-property relationships, mechanical, thermal, electrical and magnetic properties
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	Nucleation and crystallization in glasses
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Structure-property relationships in ceramic materials
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. J. P. Maria, November 2009

MSE 450
Mechanical Properties of Materials II
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Plastic flow, fracture and/or failure phenomenon in solids are treated in terms of fundamental deformation mechanisms with emphasis on the role of crystal defects and microstructure. Tensile, creep and fatigue modes of deformation are included, along with design considerations and applications in-practice

Prerequisite(s): MSE 350

Textbook(s) and/or other required material:
Mechanical Metallurgy, G. E. Dieter, McGraw-Hill, 3rd edition, 1986

Course learning outcomes. By the end of this course, the student should be able to:
- Calculate the stresses and strains in a body due to multiaxial loading
- Estimate the damage accumulated in a material in a given structure, and thus the remaining useful life of the structure made of these materials
- Describe the various yielding criteria appropriate to a given case. Required for proper design of structures
- Identify problems (materials related with emphasis on mechanical and fracture) encountered in structures in technologies (aerospace, automotive, chemical, nuclear, electronic, etc.)
- Choose the best and optimum material for a given application. Compare two competing materials for a given application
- Predict the reliability (dimensional stability) of a given component

Topics covered:
- Review of elastic and plastic deformation; multiaxial flow
- Crystal structure and dislocation geometry; dislocations in real crystals and reactions
- Elastic fields; energy and force relations; dislocation motion and plastic strain tensor
- Dislocation-defect interactions; flow stress; grain boundaries; obstacles
- Thermal activation; climb and diffusion processes; Strain hardening
- Linear elastic fracture mechanics; Griffith and Irwin approaches; J-Integral and CTOD
- Ductile fracture processes; Brittle fracture processes; thermal shock
- Tensile deformation; instability; rate effects
- Fatigue; low and high cycle; failure mechanisms; crack-growth
- Creep; stress rupture; cavitation and grain boundary sliding
- Creep mechanisms; microstructure and alloy effects; superplasticity
- Fracture; fracture toughness; brittle fracture design
- Sheet metal forming

Class/laboratory schedule (sessions per week and duration of each session)

Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Deformation, fatigue and fracture mechanisms in metals, microstructural effects
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	Matrix methods applied to mechanics of metallic microstructures
1b. Chemistry and physics	*Physics related to deformation mechanisms and fracture mechanics
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Relationship of microstructure to deformation and failure mechanisms in metals, ceramics and polymers
1f. Grad. school preparation	Introduction to multiaxial deformation, dislocation theory
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. K. L. Murty, November 2009

MSE 491
Materials Engineering Seminar
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Survey of topics relevant to job placement for seniors including: resumes, career opportunities, writing and speaking skills, and interview skills. Written and oral presentations by students, presentations by faculty and guests, practice interviews, and critiques.

Prerequisite(s): Junior/Senior standing.

Textbook(s) and/or other required material: None

Course learning outcomes. By the end of this course, the student should be able to:
- Write clear concise resumes
- Convey technical information both written and orally
- List career path options

Topics covered:
- Resume writing
- Job search tools
- Career path choices
- Contemporary materials issues
- Effective oral and written communications for the workplace

Class/laboratory schedule (sessions per week and duration of each session)
One 50-minute lecture session per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**1**	Contemporary topics in materials science and engineering
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	Graduate programs in MSE are presented and discussed
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	Students are required to give a presentation on a contemporary topic in materials science and engineering
3c. Written communication	*Written report on a contemporary issue in materials science and engineering is required
3d. Basic computer skills	
4a. Contemporary issues	*Students are required to attend several MSE seminars which cover contemporary topics. Guest speakers also present contemporary topics.
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Roger Sanwald, November 2009

MSE 556
Composite Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Basic principles underlying properties of composite materials as related to properties of individual constituents and their interactions. Emphasis on design of composite systems to yield desired combinations of properties.

Prerequisite(s): MSE 450

Textbook(s) and/or other required material: no text required.

Course learning outcomes. By the end of this course, the student should be able to:
- articulate the various techniques for processing of composites
- distinguish the differences in the processing of different types of composites
- identify the processing parameters that control the properties of the composites

Topics covered:
- Anistropic behavior of composite materials
- Laminate theory
- Failure theories of the lamina
- Failure of the laminate
- Micromechanics of composites
- Load transfer mechanisms
- Interface engineering
- Processing of composites
- Fracture toughness of the composites
- Applications of composites

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Structure and engineering mechanics in composite materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	Mechanics of composites, laminate theory
1e. Structure-property relationships	
1f. Grad. school preparation	This is a graduate-level course
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	*Processing methods for composite materials
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Jag Kasichainula, November 2009

ECE 331
Principles of Electrical Engineering
Course Syllabus

Department: Electrical and Computer Engineering *Required/elective:* required

Course Description:
Concepts, units and methods of analysis in electrical engineering. Analysis of d-c and a-c circuits, characteristics of linear and non-linear electrical devices; principles of Operational Amplifiers; transformers; motors; and filters.

Prerequisite(s): MA 241, PY 208

Textbook(s) and/or other required material:
Electrical Engineering Principles and Applications, Allan R. Hambley, Prentice Hall, 4th Edition, 2008.

Course learning outcomes. By the end of this course, the student should be able to:
- Analyze AC and DC circuits using Kirchhoff's Laws.
- Solve basic circuit problems using nodal and mesh analysis.
- Perform the analysis of first order R-C and R-L transient circuits.
- Use transfer functions and Bode plots to analyze Filter circuits in the frequency domain.
- Explain AC steady-state power and basic principles of power delivery.
- Analyze currents and voltages in non-linear diode circuits.
- Perform analysis of motors.

Topics covered:
- Kirchhoff's Laws and basic R, L, C, Transformer concepts.(6)
- Resistor Networks. (2)
- Node Voltage Analysis(1)
- First Order R-C and R-L Transient Circuits. (2)
- AC Sinusoidal Circuit Analysis. (8)
- Filters. (5)
- Operational Amplifiers. (2)
- Diodes.(3)
- Motors.(3)
- Transistors.(1)

Class/laboratory schedule (sessions per week and duration of each session):
Three 50-minutes lectures per week.

Contribution of course to meeting the requirements of Criterion 5:
Other: N/A
Math and basic sciences: 4 hrs basic science
Engineering topics: N/A
General education: 3 hrs

Relationship of this course to program learning outcomes:

Outcome	Level of instruction	Course content related to outcome implementation/assessment
A	Major	Students analyze d-c and a-c circuits. They characterize linear and non-linear electrical devices, study transfer functions and analyze circuits in the frequency domain.
E	Major	Students solve Electrical Engineering problems using the analysis tools they are given in the course.
K	Intermediate	Students from other engineering departments learn basic electrical engineering analysis techniques to satisfy their program criteria.

Person who last prepared this description and date of preparation:
Hatice Ozturk - Aug 17, 2009

APPENDIX A2

MSE Curriculum 14MSE097

MSE 201
Structure and Properties of Engineering Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Introduction to the fundamental physical principles governing the structure and constitution of metallic and nonmetallic materials and the relationships among these principles and the mechanical, physical and chemical properties of engineering materials.

Prerequisite(s): CH 101

Textbook(s) and/or other required material:
Fundamentals of Materials Science and Engineering: An Introduction, Seventh ed., W.J. Callister, Jr.

Course learning outcomes. By the end of this course, the student should be able to:
- Describe the chemical bonding in metals, ceramics and polymers
- Draw unit cells showing atomic positions for simple crystalline metals and ceramics
- Describe defects in metallic and ceramic crystals and the roles they play in diffusion and mechanical properties
- Analyze binary phase diagrams, determine the amounts and compositions of phases present at a given temperature and alloy composition, and sketch the equilibrium microstructure present at any temperature and composition
- Describe the development of microstructure with time during a phase transformation
- Describe basic structure-property relationships for metallic, ceramic, polymeric, semiconducting and composite materials

Topics covered:
- Bonding and crystal structures
- Defects
- Diffusion and Fick's laws
- Mechanical properties
- Dislocations and strengthening
- Failure
- Phase diagrams, lever law
- Iron-carbon phase diagram
- Kinetics of phase transformations
- Ceramics and glasses
- Polymers and composites
- Electrical conductivity, semiconductors
- Magnetism

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	introductory coverage of crystallography, phase diagrams, mechanical, thermal, electrical, and magnetic properties of materials
General education		
Other		

Relationship of this course to program outcomes:
Since this is the first materials science course students take, it is not included in the MSE outcomes assessment.

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	Periodic table, chemical bonding, band structure, electrical and magnetic principles, stress/strain principles
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Introductory crystallography, defects, phase diagrams, microstructures, mechanical, thermal, electrical and magnetic properties for metals, ceramics, polymers, composites
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	Basics of tensile testing
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. C. M. Balik, October 2009

MSE 255
Experimental Methods for Structural Analysis of Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
The intent of this course is to present basic methods for characterizing the structure of materials at different length scales, including optical, electron and scanned probe microscopies, X-ray diffraction and infrared and ultraviolet spectroscopy. The principles of the various techniques will be emphasized, and samples from all classes of materials will be examined. Students will learn how to select and apply a characterization method based on the type of material and structural information needed.

Prerequisite: none *Co-requisite:* MSE 201

Textbook(s) and/or other required material:
MSE 255 Lab Manual, available from the bookstore. $20.00.

Course learning outcomes. By the end of this course, the student should be able to:
- Describe the principles, uses and limitations of basic characterization techniques designed to elucide structural features of materials at different length scales
- Demonstrate the ability to select structural characterization techniques appropriate to the class of material, size of the structure, and type of information needed
- Articulate structure-property-testing method relationships
- Write an effective technical report

Topics covered:
- Lab safety
- Data presentation and statistics
- Optical microscopy: metallographic and polymer samples
- Scanning electron microscopy and EDAX
- Transmission electron microscopy
- Atomic force microscopy
- X-ray diffraction: metal, ceramic and polymer powders
- Infrared spectroscopy
- UV spectroscopy, Beer's law

Class/laboratory schedule (sessions per week and duration of each session)
This is a 2 credit hour course consisting of a 1-hr lecture and a 3-hr lab session each week for a 14 week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**2**	Principles of microscopy (optical, SEM, TEM, AFM), x-ray diffraction and spectroscopy for structural characterization of materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	Data plotting and analysis, curve fitting
2b. Materials selection	
2c. Microscopy and diffraction	*Optical microscopy, SEM, TEM AFM, x-ray diffraction
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	*Written lab reports are required
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Lew Reynolds, November 2009

MSE 260
Mathematical Methods for Materials Engineers
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
This course covers mathematical methods and computer simulation techniques that are central to materials science and engineering. Excel spreadsheets are used to illustrate data analysis and plotting, curve-fitting, to solve linear, non-linear, differential and integral equations, and to carry out numerical integration and differentiation. Computer tools for carrying out molecular modeling, Monte Carlo simulation and finite element analysis of materials are introduced and illustrated.

Prerequisite: E 115, MA 141

Textbook(s) and/or other required material:
Excel for Scientists and Engineers, E. Joseph Billo (Wiley, 2007). $49.95. The text will be supplemented with course material developed by the instructor.

Course learning outcomes. By the end of this course, the student should be able to:
- graph, analyze and interpolate data using Excel
- apply numerical methods for solving linear, non-linear, differential and integral equations, and calculating integrals and derivatives using Excel
- articulate the principles of Monte Carlo simulation, molecular modeling, electronic structure and finite element analysis and apply them to modern problems in materials science and engineering

Topics covered:
- Fundamentals of Excel
- Visual Basic Programming in Excel
- Working with Arrays and Matrices
- Taylor and Other Number Series
- Data Interpolation and Differentiation
- Integration, Roots of Equations
- Solving Simultaneous Equations
- Numerical Integration of Ordinary Differential Equations
- Partial Differential Equations
- Linear and Non-linear Regression and Curve Fitting
- Random Numbers, Monte Carlo method, Fourier Transforms
- Introduction to Atomic Modeling
- Introduction to Finite Element Analysis
- Introduction to Electronic Structure Calculations

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Numerical analysis methods, introduction to matrices, partial differential equations, finite element analysis, atomistic modeling
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	*Numerical analysis methods, introduction to matrices, partial differential equations, finite element analysis
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	*Atomistic modeling, use of Excel
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Don Brenner, November 2009

MSE 270
Materials Science and Engineering Seminar
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
This course surveys the scientific and engineering breadth and contemporary issues in the field of materials science and engineering. The curriculum, including possible areas of specialization will be discussed. Job and career opportunities at the BS and graduate degree levels are discussed. Students will be introduced to opportunities for laboratory assistant jobs in the MSE department, summer internships, co-ops and summer research expereinces at NCSU and other institutions. Students will gain experience in the preparation of effective resumes, technical reports and oral presentations.

Prerequisite: none *Co-requisite:* MSE 201

Textbook(s) and/or other required material: None

Course learning outcomes. By the end of this course, the student should be able to:
- Explain the MSE undergraduate curriculum
- Discuss contemporary issues in materials science and engineering
- Describe job opportunities for students with BS, MS or PhD degrees
- Identify summer and intern job opportunities off campus
- Identify research experience opportunities on and off-campus
- Prepare an effective resume
- Prepare and present effective written and oral presentations

Topics covered:
- Introduction to Materials Science and Engineering
- Materials Specific Areas of Specialization
- Global Issues for Materials Scientists and Engineers
- Degrees and Career Paths
- Research and Job Opportunities for Undergraduates
- Contemporary Issues within MSE
- Preparation of an Effective Resume
- Preparation for an Effective Interview
- Preparation of an Effective Technical Report
- Preparation of an Effective Oral Presentation
- Student Oral Presentations

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for one 50-minute session per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**1**	Contemporary topics in materials science, global impact of engineering
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	*An oral presentation is required
3c. Written communication	*Written reports are required
3d. Basic computer skills	
4a. Contemporary issues	*Attendance at MSE seminars is required
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. George Rozgonyi, November 2009

MSE 300
Structure of Materials at the Nanoscale
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
MSE 300 covers the structure of materials at the nanometer scale. Structure includes the periodic arrangements of atoms and ions in crystalline solids, the amorphous networks of atoms, ions and molecules in glassy materials, and the molecular structure of polymeric and biological materials. Basic experimental methods for characterizing nanostructure are also reviewed. Finally, the course will introduce the structure of novel nanomaterials like nanotubes, buckyballs, and self-assembled monolayers.

Prerequisite: C- or better in MSE 201

Textbook(s) and/or other required material:
Doug to provide

Course learning outcomes. By the end of this course, the student should be able to:
- Identify and categorize the structure of elemental, inorganic, organic, and biological materials on the nanoscopic scale.
- Relate the driving force of free energy minimization to these structural arrangements
- Relate structure at the nanometer scale to basic material properties
- Identify experimental tools for characterizing nanoscale structure for the different classes of materials
- Describe the structure and properties of carbon-based nanostructures, other nanoparticles and self-assembled monolayers

Topics covered:
- Properties of the elements, electronic structure, orbitals and chemical bonds
- The crystalline lattice, symmetry elements, and point groups
- Bravais lattices, Miller indices, and crystal directions
- Characterization of crystals by diffraction
- Structure of metals
- Pauling's rules and coordination polyhedra
- Some important inorganic structures
- Amorphous materials: oxide and metallic glasses
- Crystal chemistry of silicates
- Crystal structure – physical property relationships
- Polymer synthesis
- Semicrystalline polymers
- Amorphous polymers
- The 20 common amino acids

- The structure of proteins, primary, secondary, and tertiary
- The cell
- Self assembled monolayers
- Nanoparticles and nanoclusters
- Nanostructures of carbon: buckyballs, nanotubes, and graphene

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Intermediate crystallography, polymer synthesis, nanoscale structure of biomaterials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Nanoscale structure-property relationships for all classes of materials
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Doug Irving, November 2009

MSE 301
Introduction to Thermodynamics of Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Review of classical thermodynamics and thermodynamic relationships. Use of statistical methods of describe entropy and other thermodynamic properties. Description of vapor-, liquid-, and solid-phase equilibrium in unary and other multicomponent material systems. Treatment of ideal and nonideal solution behavior in inorganic alloys and organic polymers. Application of gas-phase reaction kinetics and identification of the criteria required for reaction equilibria.

Prerequisite: MSE 201 or MSE 203. MSE majors must have a C- or better in MSE 201

Textbook(s) and/or other required material:
Thermodynamics in Materials Science, 2nd edition, Robert DeHoff, (CRC Press). $100.00

Course learning outcomes. By the end of this course, the student should be able to:
- Assess whether a thermodynamic system is at equilibrium.
- Predict the equilibrium composition of multicomponent systems.
- Explain the three laws of thermodynamics and how they relate.
- Identify variables in thermodynamics and how they are related mathematically and intuitively.
- Relate statistical equations to thermodynamics variables.
- Use thermodynamic equations to predict equilibrium and kinetics of multicomponent systems.
- Utilize *Mathematica* or *Maple* to solve homework and complex problems.

Topics covered:
- Introduction to Thermodynamics
- Classification of Systems
- The Laws of Thermodynamics
- Variables and Relationships
- Equilibrium in Systems
- Unary Heterogeneous Systems
- Multicomponent Homogeneous Systems
- Multicomponent Heterogeneous Systems
- Multicomponent Reacting Systems
- Kinetics and Rate Constants
- Statistical Thermodynamics
- In-class exams

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Engineering thermodynamics relevant to materials science and engineering
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	*Thermodynamics encompasses the course content
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	Introduction to statistical thermodynamics
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Joe Tracy, November 2009

MSE 320
Introduction to Defects in Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
This course covers the classification of defects in solids, their geometric and crystallographic aspects, and defects in specific metallic, ionic and covalent bonded crystal structures. Field quantities associated with defects will be used to evaluate their interactions in terms of real or virtual forces. Elastic, chemical, electronic and magnetic interactions will be covered for appropriate material classes. Novel aspects of defects in nanostructured and semicrystalline materials will be discussed.

Prerequisite: C- or better in MSE 201

Textbook(s) and/or other required material:
Crystallography and Crystal Defects, revised edition. A. Kelly, G.W. Groves and P. Kidd, John Wiley & Sons, 200 ISBN 0-471-72044-5.

Course learning outcomes. By the end of this course, the student should be able to:
- Describe the different types of defects in solids
- Explain the geometrical and crystallographic nature of defects
- Explain the important aspects of defects in different crystal structures
- Calculate the equilibrium (thermodynamic) properties of defects
- Describe non-equilibrium and kinetic processes involving defects
- Calculate defect forces and interactions

Topics covered:
- Classification and types of defects
- Point defects
- Line defects - dislocations
- Surface defects
- Volume defects
- Defects in metallic crystal structures
- Defects in ionic crystal structures
- Defects in covalent crystal structures - semiconductors
- Fields and forces associated with defects
- Elastic interactions
- Electrical interactions
- Magnetic interactions
- Defects in nanostructures
- Defects in semi-crystalline materials

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Defect structures in all classes of materials and effects on properties
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Defects in materials and their effect on properties
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Ron Scattergood, November 2009

MSE 335
Experimental Methods for Analysis of Materials Properties
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
The intent of this course is to present selected techniques for measuring the mechanical, thermal, electrical, magnetic and optical properties of materials. The principles of the various techniques will be emphasized, and samples from all classes of materials will be examined. Students will learn how to select and apply a characterization method based on the type of material and property to be measured.

Prerequisite: C- or better in MSE 201

Textbook(s) and/or other required material:
None. Lab handouts provided by instructor.

Course learning outcomes. By the end of this course, the student should be able to:
- Describe the principles, uses and limitations of basic characterization techniques for measuring mechanical, thermal, electrical, magnetic and optical properties of materials
- Demonstrate the ability to select property measurement techniques appropriate to the class of material and type of information needed
- Articulate structure-property-testing method relationships
- Write an effective technical report

Topics covered:
- Lab safety. Review of lab report preparation.
- Mechanical properties 1. Ductile metallic materials. Tensile, impact, and hardness testing.
- Mechanical properties 2. Brittle inorganic materials. Beam bending and indentation methods.
- Mechanical properties 3. Organic materials. Viscoelastic behavior and rate dependence of properties.
- Thermal properties 1. Dilatometry measurements on organic and inorganic materials to obtain thermal expansivities and transition temperatures.
- Thermal properties 2. Calorimetric measurements on organic and inorganic materials to illustrate melting, glass transition, crystallization and other phase transitions.
- Electrical properties. Temperature dependence of resistivity for inorganic, metallic and organic materials. Dielectric properties of inorganic and polymeric materials.
- Optical properties. Refractive index and wavelength dispersion in transparent materials.
- Magnetic properties. Magnetic susceptibility measurements for a variety of metallic, inorganic, organic and nanoparticle materials.

Class/laboratory schedule (sessions per week and duration of each session)
This is a 2 credit hour course consisting of a 1-hr lecture and a 3-hr lab session each week for a 14 week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**2**	Principles of methods used to analyze thermal, mechanical, electrical, magnetic and optical properties of materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Measurement of mechanical, thermal, optical, electrical and magnetic properties of materials
1f. Grad. school preparation	
2a. Computer-based tools	Data plotting and analysis, curve-fitting
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	*Written lab reports are required
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Lew Reynolds, November 2009

MSE 355
Electrical, Magnetic and Optical Properties of Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
This course provides a fundamental treatment of the electronic properties of materials, including the electrical, magnetic and optical characteristics. The interaction of electrons with electromagnetic fields in the various classes of materials is discussed from the semiclassical and quantum mechanical viewpoints. Application of the electronic structure-property relationships in materials to design of specific technological devices is also covered. Students will be required to complete a project in which they design a basic device such as an electromagnet, a photodiode, a transistor or a solar cell.

Prerequisite: PY 208, MA 341

Textbook(s) and/or other required material:
Electronic Properties of Engineering Materials, J. D. Livingston, Wiley (1999).

Course learning outcomes. By the end of this course, the student should be able to:
- Describe the structure-property relationships for conductors, semiconductors, superconductors, insulators, dielectrics and magnetic materials
- Derive the wave equation from Maxwell's equations
- Analyze the behavior of light incident on a boundary between two materials
- Calculate energy levels of an electron in a box
- Classify the behavior of materials based on their band structure
- Design a basic device: an electromagnet, a transistor, a solar cell, or a photodiode

Topics covered:
- Electron conduction
- Interaction of electrons with electromagnetic waves
- Electromagnetic fields in dielectrics
- Basic optics
- Magnetism
- Lattice waves
- Superconductivity
- Basics of quantum mechanics
- Electrons in atoms, molecules and crystals
- Free electrons in metals
- Electron energy bands and gaps
- Semiconductors and devices
- Putting materials to work (metal, semiconductor, and insulator structure-function relationships)

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Physical principles underlying the behavior of electrons in conducting, semiconducting and magnetic materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Electronic structure in materials and their effects on the electrical, magnetic and optical properties
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Anatoli Melechko, November 2009

MSE 360
Kinetic Processes in Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Types, mechanisms, and kinetics of solid state phase transformations are covered with selected applications to all classes of materials. Mechanisms of diffusion and techniques for diffusion calculations are presented. The role of surface energy and strain in the evolution of structure during transformation is presented. Phenomena at different size scales (atomic, nano, micro) are described relative to the evolution of structure during transformation.

Prerequisite: MA 341, MSE 301

Textbook(s) and/or other required material:
Introduction to Phase Transformations in Metals and Alloys, Porter and Easterling. 2nd edition. Chapman and Hall: London, 1992. Supplemental material provided by instructor.

Course learning outcomes. By the end of this course, the student should be able to:
- Apply principles of thermodynamics and transformation kinetics to phase transformations.
- Define and describe mechanisms of diffusion in materials, which are elemental or molecular.
- Solve diffusion-related mathematical problems in material science
- Explain the thermodynamics and kinetics of vapor-solid, liquid-solid, solid-solid phase transformations in materials
- Apply the principles of phase transformations to material engineering processes for representative materials types: metal, ceramic, semiconductor, polymer, and biomatter.
- Identify and describe effects of bulk, strain and surface energy in changes of state and structure, particularly over nanoscale dimensions (atomic, nano, micro) or reduced dimensions (3D, 2D, 1D).
- Describe diffusional and diffusionless transformations in thin films

Topics covered:
- Review of general and solution thermodynamics
- Interfaces and surface energies
- Nanostructures and surfaces
- Thermally activated and athermal reaction kinetics
- Macroscopic diffusion, flux and Fick's laws
- Random walk and atomic mechanisms of diffusion
- Specific diffusion applications: thin film, periodic boundaries, etc
- Reptation in polymers
- Surface and defects: high diffusivity paths
- Heterogeneous and homogeneous nucleation
- Strain and surface energy structural evolution
- Crystal growth and equilibrium shape

- Diffusional transformations
- Diffusionless transformations
- Transformations at reduced dimensions and size

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Diffusion, phase transformations and other kinetic processes in all classes of materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	*Solution of diffusion equations
1b. Chemistry and physics	
1c. Thermodynamics of materials	*Thermodynamics of phase transformations and diffusion
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Mark Johnson, November 2009

MSE 370
Microstructure of Inorganic Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
This course will emphasize structure-property relationships in metallic and ceramic materials. It will describe the crystal structures of important metallic and ceramic elements, alloys, and compounds. Binary and ternary phase diagrams for notable systems will be presented. Microstructural features to be covered include grain size and distribution, multiphase microstructures, and defects. Examples of important metallic and ceramic systems for structural, electrical, optical, and magnetic applications will be given.

Prerequisites: MSE 300, 301, 320

Textbook(s) and/or other required material:
Required: *Engineering Materials 2: An Introduction to Microstructures, Processing, and Design,* Ashby and Jones, 3rd Edition, Butterworth-Heinemann, Oxford, UK 2006. Price $50.00.
For reference only: *Fundamentals of Ceramics,* Barsoum, McGraw-Hill, 1997. $55.00; *Physical Metallurgy Principles,* Reed-Hill and Abbaschian, PWS-Kent, 3rd Edition, 1991. $123.00.

Course learning outcomes. By the end of this course, the student should be able to:
- Identify the microstructure - property relationships for structural, electrical, optical, and magnetic applications in metallic and ceramic materials.
- Identify the important ferrous, non-ferrous metallic systems such as Fe-C, Al alloys, Ni alloys, and Ti alloys
- Identify the important ceramic materials such as silicon nitride, silicon carbide, silica glasses, glass ceramics, etc.
- Select a given material and its microstructure for a given application.

Topics covered:
- Important metallic and ceramic crystal structures
- Curie symmetry groups
- Binary and ternary phase diagrams in metallic and ceramic systems
- Grain size; single crystal to nanocrystalline
- Multiphase systems, precipitates, dispersoids
- Defects; review of point, line, and surface defects
- Important metallic alloy systems: Al-, Al/Li-, Ni-, Ti-based alloys
- Strengthening mechanisms for metallic alloys
- Important ceramic materials and how their microstructures influence mechanical properties
- Fracture toughening by addition of acicular grains (i.e., self-reinforcement)
- Thermal or chemical tempering of silica glass
- Fluorophlogopite machinable glass ceramics (Macor)

- Microstructure-property relationships for electrical and magnetic properties of metallic systems
- Microstructure-property relationships for electrical/optical properties in ceramic systems

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Structure and properties of engineering metals, alloys and ceramic materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Microstructure of metals and ceramics and its relationship to properties
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Mike Rigsbee, November 2009

MSE 380
Microstructure of Organic Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
This course covers the microstructure and properties of soft materials including polymer molecular weight distributions, amorphous polymers, semicrystalline polymers, copolymers, elastomers, biopolymers, soft tissue, bone and cellular structure. The design and function of implantable biomaterials are also covered.

Prerequisite: CH 220, MSE 300

Textbook(s) and/or other required material:
Required: *Introduction to Polymers*, 2nd edition, R. J. Young & P. A. Lovell, (Taylor & Francis). $50.00 (also used for MSE 300). **For reference only:** *Structural Biological Materials: Design and Structure-Property Relationship*, Editor: Manuel Elices, (Pergamon 2000).

Course learning outcomes. By the end of this course, the student should be able to:
- Calculate polymer molecular weight averages from a given molecular weight distribution
- Describe techniques for measuring polymer molecular weight
- Explain how the kinetics and statistics of polymerization reactions affect polymer molecular weight and polydispersity
- Determine how copolymer composition varies with monomer feed composition and monomer reactivity ratios
- Describe how thermal and mechanical properties of polymers are related to their primary structure and morphology
- Explain the structure-property relationships for biological materials
- Describe differences in structures of cellular, extracellular, soft tissues, and biological composites
- Select biological materials based on their functions for different applications

Topics covered:
- Introduction to organic materials
- Polymer molecular weight distributions and averages
- Polymer molecular weight measurement
- Molecular weight of chain and step-growth polymers
- Copolymers, copolymerization, block copolymer morphologies
- Amorphous polymers: structure and properties
- Semicrystalline polymers: structure and properties
- Elastomers: structure and properties
- Time-temperature superposition
- Structure-property relationships for biomaterials
- Design and function of biomaterials

- Cellular and extracellular structures
- Structure of soft tissue
- Microstructure of biological bones
- Biological fibrous materials
- Structural biomaterials

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Structure-property relationships for engineering polymers and biomaterials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Microstructure of polymers, liquid crystals and biomaterials and its relationship to properties
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. C. M. Balik, October 2009

MSE 420
Mechanical Properties of Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
The course covers essential elements of elasticity and continuum plasticity theory. Discrete defect theory is used to develop an understanding of the microstructure interactions that control strengthening, creep, fatigue and fracture in crystalline solids. Phenomenological relations are used to predict failures for creep rupture and fatigue fracture. Important aspects of the mechanical behavior of polymers, composite materials and biomaterials are covered.

Prerequisite(s): MSE 370, 380

Textbook(s) and/or other required material:
Mechanical Behavior of Materials, M. A. Meyers and K. K. Chawla, Prentice Hall 2nd edition, 2008.

Course learning outcomes. By the end of this course, the student should be able to:
- Calculate stress and strain using transformation equations
- Explain elastic and viscoelastic deformation in hard and soft materials
- Describe the role of defects in plastic deformation and fracture
- Explain how microstructure affects strength, creep, fatigue and fracture
- Estimate lifetimes for creep and fatigue failures
- Explain the performance and design concepts for composite materials
- Choose conditions and microstructures that optimize properties

Topics covered:
- Introduction: Structure, properties and performance
- Elasticity, viscoelasticty and rubber elasticity
- Plastic deformation
- Review – defects in solids
- Plastic deformation in single crystals
- Fracture mechanics
- Toughening mechanisms
- Fracture testing
- Solid solution and particle strengthening
- Other strengthening and deformation mechanisms
- Creep and superplasticity
- Fatigue
- Composite materials
- Environmental effects

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Mechanical behavior of materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	*Effect of structure on mechanical properties of materials including elastic, plastic, viscoelastic, rubbery elastic, fatigue and creep behavior
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. K. L. Murty, November 2009

MSE 423
Introduction to Materials Engineering Design
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
This course covers materials selection in engineering design and involves lecture, cooperative and problem based learning techniques. The course stresses creative thinking, problem solving methodology, interdependence of design with analysis and evaluation, teamwork and sharpening of communication skills. Real industrial problems are introduced midway through the course which are analyzed by student teams. Well-developed proposals are submitted to industrial sponsors which define future work under MSE 470.

Prerequisite: Senior standing in MSE

Textbook(s) and/or other required material:
No textbook required. Supplemental material provided by instructor.

Course learning outcomes. By the end of this course, the student should be able to:
- Describe the design process
- Conduct literature searches
- Work in teams
- Write an effective technical report
- Make an effective technical oral presentation
- Produce a team project proposal
- Use software-based project management tools

Topics covered:
- Course overview and objectives
- The design process
- Design in a broader context (global awareness, life-cycle, etc.)
- Design of experiments
- Critical thinking and problem solving
- Materials properties and selection
- Literature searching
- Description of the projects and team assignments
- Team proposal presentation

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute sessions per week for the first half of the semester. In the second half of the semester, student teams work independently to develop a project plan and prepare the project proposal.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	1	Engineering design process, design of experiments, materials selection
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	*Ashby method for materials selection
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	*Oral presentation of the project proposal is required
3c. Written communication	*Written project proposal is required
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Keith Dawes, November 2009

MSE 440
Processing of Metallic Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* elective

Course description:
Fundamental concepts of solidification and their application to foundry and welding practices; metal forming concepts applied to forging, rolling, extrusion, drawing, and sheet forming operations; machining mechanisms and methods; powder metallurgy; advanced processing methods including rapid solidification and mechanical alloying.

Prerequisite(s): MSE 360, 370. *Corequisite:* MSE 420

Textbook(s) and/or other required material:
John A. Schey, "Introduction to Manufacturing Processes," 3rd edition, McGraw-Hill Book Co., New York (2000)

Course learning outcomes. By the end of this course, the student should be able to:
- Demonstrate an understanding of the physical principles related to processing of metallic materials including solidification theory, metal forming theory, and theory of chip formation in machining
- Compare and contrast the common metal processing technologies and predict which method is best suited for manufacture of a given product
- Optimize the design of processing variables to obtain sound materials free from defects

Topics covered:
- Solidification theory
- Casting processes
- Joining processes
- Principles of deformation processing
- Bulk deformation processes (forging, rolling, extrusion, drawing)
- Sheet metal processing
- Machining
- Powder metallurgy
- Surface processing methods
- Advanced processing methods
- 3 field trips to manufacturing plants

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester. Field trips require about 6 hours each.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	Solidification theory, principles of deformation processing, machining, powder metallurgy, advanced manufacturing processes
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	Nucleation and growth thermodynamics and kinetics
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	*Principles and methods for processing metallic materials
3a. Team skills	
3b. Oral communication	
3c. Written communication	Written field trip reports are required
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Carl Koch, November 2009

MSE 445
Ceramic Processing
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* elective

Course description:
Ceramic processing of powders includes powder synthesis, characterization, mixing, and size reduction. Theoretical aspects include particle packing, particles in suspension, and some aspects of surface chemistry. Forming methods include compaction, casting, and extrusion. Firing and sintering are examined.

Prerequisite(s): MSE 370

Textbook(s) and/or other required material:
Principles of Ceramics Processing- Reed. Selections from Ceramics Processing and Sintering – Rahaman

Course learning outcomes. By the end of this course, the student should be able to:
- Classify types of raw materials used for ceramic raw materials
- Identify characteristics of the ideal powder
- Propose a method for making a ceramic and develop the method in the laboratory
- Explain aspects of particle packing which lead to processing optimization
- Select forming methods for a particular article
- Optimize a firing method for a particular material
- Explain the relationship between aspects of powder selection and processing to final microstructure and properties
- Identify critical parameters for various forming methods

Topics covered:

Lecture topics	*Laboratory topics*
• Intro and processing history • Raw materials and powder synthesis • Elements of microstructural development in ceramics made from powders • Powder characterization • Particle Packing • Powder communition and modification • Particles in suspension • Forming Methods • Sintering and Firing methods • Problems in firing • Microstructural development and process optimization	• Powder synthesis project (semester-long, about 6 total lab sessions) • Particle size measurement and communition • Sintering schedule design • Particle packing • Casting • Plant trip (1 or 2) • Special fabrication methods

Class/laboratory schedule (sessions per week and duration of each session)
30 50-minute lectures and 14 3-hour laboratory sessions per semester

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Processing methods for ceramic materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	*Principles and methods for processing ceramic materials
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. J. P. Maria, November 2009

MSE 455
Polymer Technology and Engineering
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* elective

Course description:
Covers classes of commercially important polymers, advanced topics in the phase behavior, viscoelasticity, fracture and ultimate properties of polymers; polymer rheology, processing and permeability; and the design of polymeric materials.

Prerequisite(s): MSE 380

Textbook(s) and/or other required material:
N.G. McCrum, C.P. Buckley and C.B. Bucknall, *Principles of Polymer Engineering*, 2nd ed., Oxford Science, Oxford, 1997 (supplemental).

Course learning outcomes. By the end of this course, the student should be able to:
- Identify the attributes of the various classes of commercially important polymers for materials selection
- Apply fundamental principles of polymer science to the design of polymeric materials
- Design polymeric alloys through the compatibilization of chemically dissimilar polymers
- Select the most appropriate polymer processing technique for a particular end-use application
- Design polymeric materials with enhanced thermal, mechanical and barrier properties

Topics covered:
- Commercial classification of polymers (4 lectures)
- Polymer miscibility and compatibilization (5 lectures)
- Advanced topics in polymer viscoelasticity (6 lectures)
- Ultimate properties of polymers (5 lectures)
- Polymer rheology (6 lectures)
- Polymer processing (7 lectures)
- Packaging with polymers (3 lectures)
- Designing with polymers (4 lectures)
- In-class exams (2 lectures)

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Polymer viscoelasticity, rheology, compatibilization, processing and design
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Effect of additives on polymer properties
1f. Grad. school preparation	Dynamic mechanical behavior of polymers, Boltzmann superposition principle
2a. Computer-based tools	
2b. Materials selection	Commercial classes of polymeric materials and their applications
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	*Principles and methods for processing polymeric materials, formulation and design of plastic compounds
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Keith Dawes, November 2009

MSE 456/556
Composite Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* elective

Course description:
This course covers the basic principles underlying properties of composite materials as related to the properties of individual constituents and their interactions. Polymer, metal and ceramic matrix composites are included. Property averaging and micromechanics of composites are covered at an introductory level. Emphasis is placed on design and processing of composite systems to yield desired combinations of properties. Credit for both MSE 456 and MSE 556 is not allowed.

Prerequisite(s): MSE 420

Textbook(s) and/or other required material:
An Introduction to Composite Materials: Science and Engineering, 2nd ed. by K. K. Chawla. Springer-Verlag 1998.

Course learning outcomes. By the end of this course, the student should be able to:
- Describe the structure-property relationships for metal, ceramic and polymer matrix composites
- Calculate average properties for simple composite structures
- Describe methods used to process metal, ceramic and polymer matrix composites
- Design or select a specific type of composite for a particular application

Topics covered:
- Fiber types and properties
- Matrix types and properties
- Interface structure and design
- Processing and properties of polymer matrix composites
- Processing and properties of metal matrix composites
- Processing and properties of ceramic matrix composites
- Recent advances in composites
- Micromechanics of composites

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Structure, properties, processing and applications of composite materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	*Principles and methods for processing composite materials
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Jag Kasichainula, November 2009

MSE 460
Microelectronic Materials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* elective

Course description:
Processes and characterization techniques relevant to microelectronic materials science and technology. Boule growth, wafer preparation, oxidation, epitaxial growth, doping techniques, metallization, and device applications of elemental and compound semiconductors. Electrical, structural and chemical characterization of semiconductors is included as well as materials considerations relevant to device fabrication.

Prerequisite(s): MSE 355

Textbook(s) and/or other required material:
No textbook required. Information supplied by instructor.

Course learning outcomes. By the end of this course, the student should be able to:
- Perform oxide thickness measurements on semiconductor wafers
- Operate an optical microscope with Nomarski interference contrast
- Describe the crystallographic basis of structural defects in silicon
- Collect electrical data on capacitors and diodes and silicon substrates
- Understand the issues in forming ion implanted p/n junction diodes
- Characterize photolithographic material defects
- Research the literature on an assigned topic and give oral/written reports

Topics covered:
- Safety issues
- Silicon oxidation
- Crystal growth, defects and characterization
- Photolithography
- Metallization and silicides
- Formation of p-n junctions
- Electrical characterization of semiconductors

Class/laboratory schedule (sessions per week and duration of each session)
This course consists of two 75-minute sessions twice per week for a 14-week semester. The classes include 18 lecture sessions and 6 “double-lecture” lab demo sessions.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	**3**	Fabrication and processing of semiconductor devices and materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	*Principles and methods for processing silicon-based semiconducting materials
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. George Rozgonyi, November 2009

MSE 470
Materials Science and Engineering Design Project
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
Students will work in teams with an MSE faculty mentor and industrial advisor on real-world materials engineering problems provided by the sponsoring companies. Periodic progress reports will be given during the semester. Students will prepare a poster and an oral presentation describing their results which will be given during the last week of classes.

Prerequisite(s): MSE 423

Textbook(s) and/or other required material: No textbook required.

Course learning outcomes. By the end of this course, the student should be able to:
- Work effectively in teams to solve an engineering problem
- Cope with failure in experimentation and view it in a positive way
- Apply principles of materials science and engineering to real-world problems
- Give an effective oral presentation and prepare a professional technical report

Topics covered:
- Teams work independently on projects. No specific topics are covered.
- Project poster presentations
- Final project oral presentations

Class/laboratory schedule (sessions per week and duration of each session)
Two 75-minute class sessions per week are available for team meetings and interim project reports.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Application of materials engineering principles to real-world materials problems provided by local companies
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	Design projects often involve materials selection
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	*Projects are carried out by teams of 3-4 students.
3b. Oral communication	*Progress report presentations are given several times during the semester. Oral and poster presentations are also required at the end of the semester.
3c. Written communication	*Final written project report is required.
3d. Basic computer skills	
4a. Contemporary issues	Design projects are based on a current materials problem.
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Keith Dawes, November 2009

MSE 480
Materials Forensics
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* required

Course description:
This course covers mathematical methods and computer simulation techniques that are central to materials science and engineering. Excel spreadsheets are used to illustrate data analysis and plotting, curve-fitting, to solve linear, non-linear, differential and integral equations, and to carry out numerical integration and differentiation. Computer tools for carrying out molecular modeling, Monte Carlo simulation and finite element analysis of materials are introduced and illustrated.

Prerequisite(s): MSE 370, 380

Textbook(s) and/or other required material: No textbook required.
For reference only: D. A. Jones, "Principles and Prevention of Corrosion" McMillan, New York, 1992. Instructor will provide supplementary material.

Course learning outcomes. By the end of this course, the student should be able to:
- Describe the mechanisms responsible for degradation in metals, ceramics, polymers, electronic materials
- Design strategies to eliminate or minimize materials degradation
- Describe the general approaches taken to analyze material failures
- Determine the cause of and solutions to material failures

Topics covered:
- Direct dissolution mechanisms, polymer and ceramic materials
- Electrochemical corrosion, half cell potentials, kinetics of corrosion reactions
- Corrosion prevention
- Oxidation of polymers
- Protective and non protective solid oxides
- Kinetics of oxidation
- Methods of improving resistance to atmospheric attack
- Polymer degradation during processing
- Maximum use temperature, fire and flammability
- Weathering of polymers
- Environmental stress cracking of polymers
- Radiation effects on polymers
- Friction and wear (solid-solid interactions)
- Degradation of electrical device components
- Bio-deterioration of materials
- Failure analysis and case studies

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	Cr. hr.	Related course content
Basic math and science		
Engineering topics	3	Corrosion, degradation and environmental deterioration of materials, case studies
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	Related course content (*used for outcome assessment)
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	Kinetics of corrosion and oxidation
1d. Statics and solid mechanics	
1e. Structure-property relationships	Effect of structure on environmental degradation for metallic, ceramic and polymeric materials
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Carl Koch, November 2009

MSE 490: Special Topics
Introduction to Nanomaterials
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* elective

Course description:
Introduction to nanoparticles, nanotubes, nanowires, and nanostructured thin films, emphasizing their synthesis, structural and property characterization, novel physical and chemical properties, applications, and contemporary literature.

Prerequisite(s): MSE 201 or equivalent, or permission of instructor

Textbook(s) and/or other required material:
These electronic textbooks are available through NCSU libraries and will be posted to the course website:
1. Kenneth J. Klabunde: *Nanoscale Materials in Chemistry*
2. Luis M. Liz-Marzán and Prashant V. Kamat: *Nanoscale Materials*
3. Günter Schmid: *Nanoparticles*: *From Theory to Application*
4. Jin Z. Zhang, Zhong-Lin Wang, Jun Liu, Shaowei Chen, and Gang-Yu Liu: *Self-Assembled Nanostructures*

Course learning outcomes. By the end of this course, the student should be able to:
- Describe methods for fabricating nanoparticles, nanotubes, nanowires, and nanostructured thin films.
- Describe the physical properties of nanomaterials.
- Describe tools for structure and property characterization of nanostructures.
- Describe applications for nanomaterials.
- Use literature resources for further self-guided learning about nanoscale materials.

Topics covered:
- Top-down and bottom up approaches
- Nanoscale characterization
- Chemical approaches to synthesizing nanomaterials
- Metal nanoparticles
- Self-assembled monolayers
- Semiconductor quantum dots
- Ceramic nanomaterials
- Fullerenes and carbon nanotubes and nanofibers
- Magnetic nanoparticles
- Nanolithography
- Self-assembly and soft lithography
- Bionanomaterials
- Toxicology of nanomaterials

- Composite nanomaterials
- Computational nanomaterials
- Applications of nanomaterials
- Physical methods for nanostructure fabrication
- Ion-implantation-based methods for nanostructure fabrication

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute or three 50-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	electrical, optical, and magnetic properties of materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	size effects in nanomaterials
1f. Grad. school preparation	reports on contemporary research
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	characterization of nanomaterials
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	synthesis of nanomaterials
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. J. B. Tracy, January 2010

MSE 490: Special Topics
Biomaterials Science
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* elective

Course description:
This course first introduces general aspects of bulk and surface properties of biomaterials and covers polymers, hydrogels, natural materials, metals, ceramics, and composites. Later, emphasis is on the concepts of biomaterials and degradation of biomaterials in biological environment; important topics include surface phenomena, surface modification, host-guest responses, chemical and biochemical degradation, and biomaterials in medical applications. Novel materials in drug delivery and biomedical sensors will also be discussed.

Prerequisite(s): MSE 201 or MSE/BME 203

Textbook(s) and/or other required material:
Biomaterials Science: An Introduction to Materials in Medicine, 2nd ed., Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, and Jack E. Lemons

Course learning outcomes. By the end of this course, the student should be able to:
- Explain relationships between bulk and surface properties of biomaterials.
- Explain surface phenomena and surface concepts for implanted biomaterials.
- Determine the properties and classify materials for various biomedical applications.
- Predict host response to various biomaterials, degradation and failure of biomaterials.
- Select materials and optimize surface property for enhanced biocompatibility.

Topics covered:
- Bulk properties of materials
- Surface properties and surface characterization
- Polymeric biomaterials and hydrogels
- Metallic and ceramic biomaterials
- Composites and biological biomaterials
- Textured and porous materials
- Surface adsorption and cell-biomaterials interactions
- Surface modification and immobilization, nonfouling and nonthrombogenic treatment
- Degradation of polymers, metals, and ceramics in biological environmental
- Applications of biomaterials
- Integrated biomaterials system and biomedical devices

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute sessions per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science	**1**	Chemistry and introductory biology
Engineering topics	**2**	Introductory coverage of bulk and surface properties, structures, degradation of materials, surface modification techniques, biomaterials selection and applications.
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	Atomic properties, chemical bonding, structures, and reactions
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Introductory surface structure and property relationship
1f. Grad. school preparation	Introductory to research procedures and techniques
2a. Computer-based tools	
2b. Materials selection	Materials selection for biomedical applications and devices
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	Surface processing, surface modification and treatments
3a. Team skills	
3b. Oral communication	
3c. Written communication	
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:

Dr. Mark Luo, January 2010

MSE 490: Special Topics
Nanobiotechnology and Bionanotechnology
Course Syllabus

Department: Materials Science and Engineering *Required/elective:* elective

Course description:
The course is designed to assist engineering students in learning the fundamentals and cutting-edge nature of new and emerging multidisciplinary science which either applies nanotechnology to living systems or makes use of the biological structures to create novel materials. In this course, introductory structural biological and molecular engineering, principles of bionanotechnology and nanobiotechnology, will be reviewed. The basic understanding of immune responses, biological assemblies, and device applications (implants, drug delivery systems, biomedical sensors, electronics) will be introduced.

Prerequisite(s): The course is appropriate for advanced undergrads and graduate students in materials science, engineering, chemistry, physics and biomedical fields. Previous knowledge of chemistry, biology or macromolecular structure is not required.

Textbook(s) and/or other required material. ***For reference only:***
Biotechnology Demystified (2006) by Sharon Walker, ISBN-10: 0071448128 ;
Bionanotechnology: lessons from nature (2004) by David S. Goodsell ISBN-13: 978-0471417194 ;
Nanobiotechnology: Bioinspired Devices and Materials of the Future (2008), Editors: Oded Shoseyov & Ilan Levy, ISBN: 9781588298942 ;
Nanoscale Technology in Biological Systems (2004) by Ralph S. Greco (Editor), Fritz B. Prinz (Editor), R. Lane Smith (Editor) ISBN-10: 0849319404.

Course learning outcomes. By the end of this course, the student should be able to:
- understand the basic concepts in biological systems;
- demonstrate a working knowledge of bionanotech principles and industry applications
- understand, explain, and discuss scientific papers in the bionanotech field
- apply nanotechnology and biotechnology approaches in future research.

Topics covered:
- Structural Principles of bionanotechnology: Bonding, biomolecular structure: proteins, lipids, nucleic acids, self-assembly
- Cell structure and cell division, types of cell, information methods in cell
- Genetics, inheritance, mutations, genetic disorder, cancer, role of environment
- Immunology: antigens, antibodies, immune response
- Functional principles of bionanotechnology: biomolecular motors, biomolecular sensing
- Hard Nanomaterials: silicon and glass materials, quantum dots, gold nanoparticles
- Soft nanomaterials: hydrogels, PDMS
- Interfacing bio and inorganic materials: biocompatibility, toxicity
- Nanoparticles-biomolecules hybrid nanodevices
- Nanotechnology and cancer

- Nanomedicine
- Bioelectronics
- Nanotoxicology
- Lab-on-a-chip devices, Biosensors, Biotemplating
- Artificial organs and stem cell biology

Class/laboratory schedule (sessions per week and duration of each session)
Classes meet for two 75-minute per week for a 14-week semester.

Contribution of this course to Criterion 5:

Curriculum component	**Cr. hr.**	**Related course content**
Basic math and science		
Engineering topics	**3**	introductory coverage of biology, biomaterials, nanomaterials, processing techniques, mechanical, thermal, electrical, and magnetic properties of materials
General education		
Other		

Relationship of this course to program outcomes:

MSE program outcome	**Related course content (*used for outcome assessment)**
1a. Apply math skills	
1b. Chemistry and physics	Periodic table, chemical bonding, band structure, electrical and magnetic principles are covered
1c. Thermodynamics of materials	
1d. Statics and solid mechanics	
1e. Structure-property relationships	Biomolecular structure, structure of nanomaterials, defects, microstructures, mechanical, thermal, electrical and magnetic properties for nanomaterials
1f. Grad. school preparation	
2a. Computer-based tools	
2b. Materials selection	
2c. Microscopy and diffraction	
2d. Mechanical and thermal methods	
2e. Electrical and magnetic methods	
2f. Processing methods, material-specific	Processing of materials for medicine
3a. Team skills	
3b. Oral communication	Final report
3c. Written communication	Final report
3d. Basic computer skills	
4a. Contemporary issues	
4b. Professional and ethical responsibility	
4c. Global impact of engineering	Nanotoxicology
4d. Life-long learning	

Person(s) who prepared this description and date of preparation:
Dr. Y. G. Yingling, April 2010

CSC 112
Introduction to Computing - FORTRAN
Course Syllabus

Department: Computer Science *Required/elective:* elective

Course Description:
Problem solving through writing FORTRAN programs. Particular elements include: careful development of FORTRAN programs from specifications; documentation and style; appropriate use of control structures, data types and subprograms; abstraction and verification; engineering applications.

Prerequisite(s): E115, MA 141

Textbook(s) and/or other required material:
Fortran 90/95 for Scientists and Engineers, by Stephen Chapman, McGraw-Hill Pub.

Course learning outcomes. By the end of this course, the student should be able to:
Upon successful completion of this course, a student will be able to solve problems through writing FORTRAN programs. Students are expected to be able to develop FORTRAN programs from specifications and document those programs in a style permitting the maintaining and altering of the programs by a third party. Students will understand the use of control structures, data types, input and output processes, and both recursive and nonrecursive subprograms, and the use of modules. Students will know how to verify that programs are running correctly, and will be equipped to write FORTRAN programs for engineering applications.

Students will comprehend some of the theory that underpins computation and the FORTRAN family of programming languages including number systems and representations in the computer, machine language protocols (e.g., floating point representations), program correctness, automata theory (e.g., Turing machines), formal languages (e.g., Chomsky hierarchy) and recursion.

Topics covered:
- Programming structures
- Variable/data types
- Read/write/print statements
- Debugging/error corrections
- IF statements
- DO Loops
- Formatting
- File Input and Output
- Arrays
- Subroutines and Functions
- Modules
- Recursive Functions and Subroutines

Class/laboratory schedule (sessions per week and duration of each session):
Two 50-minute lectures and three 1-hour laboratory sessions each week

Contribution of course to meeting the requirements of Criterion 5:
Other: 3 hours - programming
Math and basic sciences: N/A
Engineering topics: N/A
General education: N/A

Relationship of this course to program learning outcomes:

Outcome	Level of instruction	Course content related to outcome implementation/assessment
K	Major	Students solve problems by writing various FORTRAN programs.

Person who last prepared this description and date of preparation:
Dianne Raubenheimer – March 2, 2010

CSC 116
Course Syllabus
Introduction to Computing – Java

Department: Computer Science *Required/elective:* elective

Course Description:
An introductory course in computing in Java. Emphasis on algorithm development and problem solving. Careful and methodical development of Java applications and applets from specifications; documentation and style; appropriate use of control structures; classes and methods; data types and data abstraction; object-oriented programming and design; graphical user interface design.

Prerequisite(s):
Prerequisite: Introduction to Computing Environments

Textbook(s) and/or other required material:
Big Java, by Cay Horstmann, Wiley, 3rd (latest) edition, 2007.

Course learning outcomes. By the end of this course, the student should be able to:
- apply classic problem-solving techniques to simple computational and information-management problems (without reference to any programming language), specifically
  -- breaking large problems into smaller ones,
  -- sequential analysis of solution steps,
  -- logical analysis of alternative cases,
- evaluate an arithmetic expression using order of operations, promotion from integer to floating-point types, and integer division
- use a programming language to write code that selects one of several alternatives based on more than one predicate
- use a programming language to write a loop whose exit depends on more than one predicate
- correct syntax errors and distinguish between them and runtime errors or errors in logic
- find and correct logical programming errors using debugging printout, pencil-and-paper tracing, and systematic search (to locate where an incorrect decision or value first appears)
- implement an object-oriented design that has at least two interacting classes
- write and document programs that adhere to specific coding and documentation standards (e.g., javadoc for documentation; conventions regarding the naming of classes and methods, definition of constants, indention, etc.)
- use the Java system classes to do text-based input and output
- construct and use arrays with one and two dimensions

Topics covered:
- Languages, compilers, memory organization, objects, networks (WWW)
- Expressions, statements, sample applications, code organization;-Numeric, character, Boolean, and string data types
- Classes, methods, arguments, references, scope

- Object-oriented program development
- Documentation and Java Style; Code organization
- Conditionals: if, if/else, switch, Boolean expressions & recursion
- Applets and graphical user interfaces
- Loops: while, do, for;-Input and string tokenizing
- Arrays; Arrays as lists and list operations: traversals, insertions, deletions, sorting, searching

Class/laboratory schedule (sessions per week and duration of each session):
Two 1 hour 50 minute integrated lecture and laboratory each week

Contribution of course to meeting the requirements of Criterion 5:
Math and basic sciences: N/A
Engineering topics: N/A
Other: 3 hours- programming
General education: N/A

Relationship of this course to program learning outcomes:

Outcome	Level of instruction	Course content related to outcome implementation/assessment
A	Basic	Expressions and statements; data types; control structures; data structures.
B	Basic	Classical computational problem solving techniques, such as divide-and-conquer.
B	Basic	Code organization; coding and documentation standards.
I	Basic	Introduction to the Java programming language.
J	Basic	Computer arithmetic and logic; control structures; etc., as applied to software design.
K	Major	Data structures, algorithms, computer organization and architecture, concepts of programming languages, software design.

Person who last prepared this description and date of preparation:
Rob St. Amant - Jan 4, 2010

APPENDIX B

Faculty Resumes

Curriculum Vitae for C. Maurice Balik

Academic Rank: Professor

Degrees (fields, institutions, and date):
B.S. (1975) Chemical Engineering and Mathematics, Grove City College, PA
M.S. (1977) Macromolecular Science, Case Western Reserve University, Cleveland, OH
Ph.D. (1981) Macromolecular Science, Case Western Reserve University, Cleveland, OH

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
28 years on the faculty
1982- Assistant Professor, Department of Materials Science and Engineering, NCSU. Associate appointment with Department of Chemical Engineering, NCSU. Member of Fiber and Polymer Science Faculty, NCSU
1989- Associate Professor, Department of Materials Science and Engineering, NCSU.
2003- Professor, Department of Materials Science and Engineering, NCSU.

Related experience (teaching, industrial experience, etc.):
1981- Post-doctoral research associate, Department of Macromolecular Science, Case Western Reserve University
1975- 1981 Graduate research assistant, Department of Macromolecular Science, Case Western Reserve University
1977- Summer employee at Diamond-Shamrock Corp., Painesville, OH
1970- 1976 Military service in the Pennsylvania Air National Guard (Avionics Systems Specialist; rank: E5)

Consulting, patents, etc.:
Past- consultant for 15 industrial and governmental organizations and 6 law firms.
Current- consultant for Teague, Campbell, Dennis & Gorham, Raleigh, NC

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Structure and Stability of Columnar Cyclomaltohexaose (α–cyclodextrin) Hydrate, M.A. Hunt, C.C. Rusa, A. E. Tonelli, and C.M. Balik, *Carbohydrate Research*, **2004**, 339, 2805-2810.
2. Solid-State Complexation of Poly(ethylene glycol) with α–Cyclodextrin, Jeffrey Peet, C.C Rusa, M.A. Hunt, A. E. Tonelli, and C.M. Balik, *Macromolecules*, **2005**, 38,537-541.
3. Effects of Preparation Procedure and Electric Field Frequency on the Dielectric Constants and Electrorheology of a Zeolite/Silicone Oil Suspension, D. McNeish, K. Jung, C. M. Balik, and H. Conrad, accepted for publication in *Int. J. of Modern Physics B*, **2005**, 19, 1191-1197.
4. Structure and Stability of Columnar Cyclomaltooctaose (γ–cyclodextrin) Hydrate, M.A. Hunt, C.C. Rusa, A. E. Tonelli, and C.M. Balik, *Carbohydrate Research*, **2005**, 340, 1631-1637.

5. The Nano-threading of Polymers, C.C. Rusa, M. Rusa, J. Peet, T. Uyar, J. Fox, M.A. Hunt, X. Wang, C.M. Balik and A.E. Tonelli, submitted to *J. of Inclusion Phenomena and Macrocyclic Chemistry*, **2006**, 55, 185-192.
6. Crystalline Inclusion Compounds of Poly(vinyl chloride) of Different Stereoregularity with Cyclodextrins, G. Mart nez, M.A. G mez, S. Villar, L. Garrido, A.E. Tonelli and C.M. Balik. *Journal of Polymer Science A: Polymer Chemistry*, **2007**, 45, 2503-2513.
7. Effect of Guest Hydrophobicity on the Water Sorption Behavior of Oligomer/Cyclodextrin Inclusion Complexes, M. A. Hunt, A. E. Tonelli and C. M. Balik, *Journal of Physical Chemistry B*, **2007**, 111(15), 3853-3858.
8. Characterization of Titanium Alkoxide Sol-Gel Systems Designed for Anti-Icing Coating Applications: I. Chemistry, J. Ayres, W. H. Simendinger, and C. M. Balik, *Journal of Coatings Technology Research*, **2007**, 4(4), 463-471.
9. Characterization of Titanium Alkoxide Sol-Gel Systems Designed for Anti-Icing Coating Applications: II. Mass-loss Kinetics, J. Ayres, W. H. Simendinger, and C. M. Balik, *Journal of Coatings Technology Research,* **2007**, 4(4), 473-481.
10. The Effect of Water and Guest Hydrophobicity on the Complexation of Oligomers with Solid $\alpha-$Cyclodextrin, M. A. Hunt, A. E. Tonelli and C. M. Balik, *Polymer*, **2008**, 49, 985-991.

Scientific and professional societies of which you are a member:
Materials Research Society, American Physical Society, American Chemical Society, Society of Plastics Engineers, Sigma Xi, North Carolina ACS Polymer Group, Alpha Sigma Mu

Honors and awards:
Outstanding Teacher Award, N.C. State University, 1986
George Blessis Outstanding Advisor Award, N.C. State University, 1999
SPE Star Award while President of the Piedmont-Coastal Section (1991)
President's Award, Piedmont-Coastal Section of SPE, 1995
Outstanding Achievement Award, SPE, 1996
Distinguished Alumnus Award, Shenanago High School, 2006

Institutional and professional service in the last five years:
Editorial board: Materials Science & Engineering A: Structure and Properties
Undergraduate Program Director, MSE Dept.
Coordinator of Advising, MSE Dept.
ABET Coordinator, MSE Dept.
Course & Curriculum Committee, College of Engineering
Education Committee Chair, Piedmont-Coastal Section of SPE

Professional development activities in the last five years:
Two months as a visiting scientist at the Institute for Science and Technology of Polymers, Madrid, Spain (2005).

Percentage of time available for research or scholarly activities: 30%

Percentage of time committed to the program: 100%

Curriculum Vitae for Donald W. Brenner

Academic Rank: Professor

Degrees (fields, institutions, and date):
Ph.D. in Chemistry, Pennsylvania State University, 1987
B.S. in Chemistry, State University of New York, 1982

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
15 years, August 1994
Associate Professor, 1994-2003.
Professor, 2003-present.
Kobe Steel Distinguished Professor, 2008-present.

Related experience (teaching, industrial experience, etc.):
Research Chemist, Theoretical Chemistry Section, Naval Research Laboratory, Washington, DC, 1987-1994.

Consulting, patents, etc.:
Nanotechnology Partners, L.P.Member Scientific Advisory Board (2001-present).
Apex Nanotechnologies, Member Scientific Advisory Board (2002-present)
Junius Tech. Consultant on molecular modeling in Nanotechnology (2002-2004).
Member, Editorial Board, Molecular Simulation, (2002-2008).
Member, Editorial Board, J. of Comp. and Theoretical Nanoscience, (2003-present).
Consultant, International Technology Research Institute, (2003).
Member, Nanoscale Technologies Focus Group of the Research Triangle Regional Partnership for Economic Development, 2003.
Member, Panel of Technology Experts, Nalysts, LLC. (2004-present)
Consultant, Army Research Office, 2007.

States in which professionally licensed or certified: N/A

Principal publications of the last five years:

1. D. Irving, C. Padgett, Y. Guo, J. Mintmire and D. Brenner, Multiscale Modeling of Metal-Metal Contacts under High Electromagnetic Stress: Timescales and Mechanisms for Joule Melting of Al-Cu Asperities . IEEE Trans. Magnetics 45, 331 (2009).
2. Y. Shi and D.W. Brenner, Molecular Simulation of Influence of Interface Faceting on Shock Sensitivity of a Plastic Bonded Explosive , J. Phys. Chem. 112, 14898 (2008).
3. Rezvanian, Brown, Zikry, Kingon, Krim, D. Brenner, Role of Creep in Time-Dependent Resistance of Ohmic Contacts in RF-MEMS, J. Appl. Phys. 104, 24513 (2008).
4. L. Sun, D.L. Irving, M.A. Zikry and D.W. Brenner, First Principles Investigation of the Structure and Synergistic Chemical Bonding of Ag and Mg at the Al | Ω Interface in a Al-Cu-Mg-Ag Alloy , Acta Materialia, in press (2009).

5. A.M. Dongare, A.M. Rajendran, B. LaMattina, M.A. Zikry and D.W. Brenner, Atomic-Scale Simulations of the Micromechanics Related to Ductile Failure in Nanocrystalline Cu at High Strain Rates , Phys. Rev. B 80 104108 (2009).
6. S. Jang, Y. Purohit, D. Irving, C. Padgett, D. Brenner and R. Scattergood, Influence of Pb Segregation on the Deformation of Nanocrystalline Al: Insights from Molecular Simulation , Acta Materialia, 56, 4750 (2008).
7. N. Gibson, O. Shenderova, T.J. M. Luo, S. Moseenkov, V. Bondar, A. Puzyr, K. Purtov, Z. Fitzgerald and D. Brenner, Colloidal Stability of Modified Nanodiamond Particles , Diamond and Related Materials 18, 620 (2009).
8. Y. Shi, L. Huang and D.W. Brenner, Computational Study of Nanometer-Scale Self-Propulsion Enabled by Asymmetric Chemical Catalysis , J. Chem. Phys., in press (2009).

Scientific and professional societies of which you are a member:
American Chemical Society

Honors and awards:
RJ Reynolds Award, NC State College of Engineering, 2009
Feynman Award for Research in Nanotechnology (theory), 2002
Alcoa Foundation Engineering Research Achievement Award, 2000
Co-author, Veridian Medal Paper, 1999
NC State College of Engineering Outstanding Teacher Award, 1999
Inducted into the NC State University Academy of Outstanding Teachers, 1999
NSF Faculty Early Career Development Award, 1995

Institutional and professional service in the last five years:
Associate Department Head, 2009-present.
Member University and College Research Committees, 2008-present
Member Advisory Board, Office of Postdoctoral Affairs, 2007-present
Member Army Chemistry Coordinating Group on Energetic Materials, 2008
Co-organizer, Symposium Modeling Covalent Bonding, SERMACS, 2007.
Member Argonne Center for Nanoscale Mat. Proposal Evaluation Board, 2006-2009.

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 34%

Percentage of time committed to the program: 100%

Curriculum Vitae for Jerome J. Cuomo

Academic Rank: Professor

Degrees (fields, institutions, and date):
Odense Universitet, Denmark 1979 Ph.D. Physics
St. Johns University, New York 1960 M.S. Physical Chemistry
Manhattan College, New York 1958 B.S. Chemistry

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
Appointed 1993 as Distinguished University Research Professor

Related experience (teaching, industrial experience, etc.):
1963-1993 IBM, T. J. Watson Research Center, Yorktown Heights, New York
1975-1993 Senior Manager, Materials Laboratory, Central Scientific Services
1968-1975 Manager, Materials Processing Group, Central Scientific Services
1963-1968 Staff Member, Special Techniques of Central Scientific Services
1960-1963 Chief Chemist, Secon Metal

Consulting, patents, etc.:
Number of Patents Issued: >125; papers >350; expert witness; Co-edit 2 books; 8 Book Chapters

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. J.W. Lee, J.J. Cuomo, Y.S. Cho, etal "AlN Thin Films on an LTCC Substrate" J.ACS 88 (7) (2005).
2. Wojak, E.A. Preble, W.B. Choi, J.J. Hren, and J.J.Cuomo ... JAPAN, 2004-137261 (5/6/2004).
3. Rabiei, B. Thomas, J. Narayan, J. Cuomo, Y. Yang and J. Ong "A study on Functionally Graded HA Coatings processed using Ion Beam Assisted Deposition With In-Situ Heat Treatment" Surface and Coating Technology, 200:6111- 6116, 2006.
4. N. Oh, B. Thomas, Y. Yang, S. Oh, J. Cuomo, A. Rabiei and J. Ong, "Initial cell response to functionally graded hydroxyapatite coating", 83th meeting of International Association of Dental Research, IADR 2005.
5. J.W. Lee, J.J. Cuomo and M. Bourhm "Plasma Diagnostics of AlN etc. JVS&T, A. 22 (2004).

Scientific and professional societies of which you are a member:
IEEE; AVS, European Academy of Science; AAAS, MRS

Honors and awards
- 2003 Elected a Fellow of the European Academy of Science
- Fellow of the following: 2008 IEEE; AVS; World Innovation Foundation

- Recognized by Thompson ISI as having being in the top 1/2 of 1% of Most Highly Cited Researchers
- in Materials Science.
- 1999-02; & 2007-8 National Research Council Board on Assessment for Electronics and Electrical Engineering & NIST Board of Assessment for Chem. Sci. and Tech.
- 1995 Recipient of National Medal of Technology
- 1993 Elected Fellow of American Vacuum Society.
- 1993 Elected a member of the National Academy of Engineering.
- 1993-94 Appointed member of the National Research Councils Advisory Board Committee on High Temperature Semiconductor Devices.
- 1992 Co-recipient of the 1992 Morris N. Liebmann Memorial Award of the IEEE for the discovery of amorphous magnetic films in magneto-optic data storage system.
- 1989 Elected a Member of Advisory Committee to the Materials Research Lab, Pennsylvania State University.
- 1988 Appointed a Member of the National Research Council's Advisory Board Committee on Superhard Materials 2/12/88.
- 1988 Advisor to Puerto Rico's Governers Scientific Community Council on Science & Technology.
- 1987 Elected as a Scientific Member in the Bohmische Physical Society 5/1/87
- 1987 Co-chairman of Symposium N, MRS Symposium: Plasma-Assisted Deposition of New Materials November 30-December 5,
- 1987-1988 Organizer and Chairman of Diamond Coating Conference (Engineering Foundation Conferences)
- 1985 Outstanding Paper Award from the American Society of Metals for the paper "Sputter Deposition -- From Plasmas to Ion Beams -- Back to Plasmas," delivered at the ASM Georgia Tech Centennial Year Symposium on the Application of Ion Plating and Implantation to Materials in June 1985.
- 1975 Industrial Research IR-100 Award: For the development of dendritic solar energy conversion surfaces.
- 1974 Industrial Research IR-100 Award: For the development of amorphous magnetic bubble films.

Institutional and professional service in the last five years:
Nominated 5 people to the National Academy of Engineering
Nominated 1 person for the National Medal of Technology

Professional development activities in the last five years:
Co-founder and Director of the Institute for Maintenance Science and Technology

Percentage of time available for research or scholarly activities: 90%

Percentage of time committed to the program: 100%

Curriculum Vitae for Keith Dawes

Academic Rank: Teaching Professor

Degrees (fields, institutions, and date):
Ph.D., University of Manchester, Manchester, England, 1969, Organic Chemistry
Master of Science, University of Manchester, Manchester, England, 1967, Organic Chemistry
Bachelor of Science (Honors - First Class), University of Newcastle-Upon-Tyne, 1966, Chemistry

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
2000 to Present, 10 years

Related experience (teaching, industrial experience, etc.):
NORTH CAROLINA STATE UNIVERSITY 2000- Present
Raleigh, NC
Visiting Professor

RAYCHEM, CORPORATE TECHNOLOGY 1979- 1999
California, North Carolina and the United Kingdom
Global Supplier Technology Manager
Manager, Material Design Group
Technical Manager
Senior Technologist

MALAYSIAN RUBBER PRODUCERS RESEARCH ASSOCIATION1973-1979
United Kingdom
Senior Scientist

OXFORD UNIVERSITY 1971-1973
Post Doctoral Research Fellow

COLUMBIA UNIVERSITY 1969-1971
Post Doctoral NATO Fellow

Consulting, patents, etc.:
12 Patents
Expert Witness - Patent Infringement

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
K. Dawes, L.C. Glover and D Vroom, "The Effects of Electron Beam and Gamma Irradiation on Polymeric Materials", *Physical Properties of Polymers Handbook,* 2nd Ed., Editor J. Mark, Springer, **2007**.

Scientific and professional societies of which you are a member:
Member American Chemical Society
Member ASEE

Honors and awards: none

Institutional and professional service in the last five years:
- Chairman of the North Carolina Local ACS Polymer discussion group, 2002
- Served on the Committee for SERMACS 2004
- Currently serving on the Committee for SERMACS 2012, Registration Chair

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 45%

Percentage of time committed to the program: 100%

Curriculum Vitae for Nadia A. El-Masry

Academic Rank: Professor

Degrees (fields, institutions, and date):
B.Sc., Chemical Engineering, Alexandria University, Egypt, l972
M.Sc., Chemical Engineering, Alexandria University, Egypt, l975
Ph.D., Materials Engineering, North Carolina State University, Dec. l980

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
1996-present: Professor, Materials Science and Engineering Dept., NC State University.
1990-1996: Associate Professor, Materials Science and Engineering Dept., NC State Univ.
1985-1990: Assistant Professor, Materials Science and Engineering Dept., NC State Univ.

Related experience (teaching, industrial experience, etc.):
198l-l984: Visiting Assistant Professor/Research Associate, Materials Engineering Dept., NC State University
1980-1981: Assistant Professor, Nuclear Engineering Dept., Alexandria University, Egypt
Jan 1999-Dec 2000: Program Manager, Army Research Office (ARO), Opto-electronic program - Electronic Division under the Intergovernmental Policy Act

Consulting, patents, etc.:
1. H.H.Stadelmaier and N.A.El-Masry, "Method of Producing High Performance Permanent Magnets," U.S.Patent # 4,541,877 , Sept.17, 1985.
2. F.G. McIntosh, S.M.Bedair, N. A. El-Masry, J.C. Roberts,"Stacked quantum Well AlInGaN Light Emitting Diodes," U.S. Patent #5,684,309, Nov. 4, 1997.
3. F.G. McIntosh, S.M.Bedair, N. A. El-Masry, J.C. Roberts,"Methods of Forming Indium Gallium Nitride on Aluminium Galium Indium Nitride Using Controlled Hydrogen Gas Flows,"U.S. Patent #5,851,905, Dec. 22, 1998.
4. N. A. El-Masry, S.M. Bedair, M.F. Reed, H.H.Stadelmaier," "Magnetic III-V Nitride Semiconductors," US provisional application # 60/338,226 filed Dec.7,2001, NCSU file # 01-141. US Patent Application No. 10/313,975, filed December 6 2002.

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. M.L. Reed, S.X. Liu, J.C. Roberts, H.H. Stadelmaier, S.M. Bedair, and N.A. El-Masry, "The Planar Hall Effect in MnSb Films and MnSb-Based Multilayers Structures Grown on (111)B GaAs," J. Magn. Magnetic Materials, 218(2000)177.
2. M. J. Reed, N.A. El-Masry, C. A. Parker, J. C. Roberts, S. M. Bedair,"Critical Layre Thickness Determination of GaN/InGaN/GaN Double Heterostructures," Appl. Phys. Letters, 2000 Dec 18, 77(25): 4121-4123.

3. D. Alexson, L. Bergman, R. J. Nemanich, M. Dutta, M. A. Stroscio, C. A. Parker, S. M. Bedair, N. A. El-Masry, F. Ada, ”Ultraviolet Raman Study of A(1)(LO) and E-2 Phonons in InxGa1-xN Alloys,” J. Appl. Physics, 2001 Jan. 1, 89(1):798-800.
4. M.L. Reed, M.K.Ritums, H.H. Stadelmaier, M.J. Reed, C.A. Parker, S.M. Bedair, N.A. El-Masry, "Room temperature magnetic (Ga,Mn)N: a new material for spin electronic devices, Mat. Lett., 51 (6), p. 500 (2001).
5. M. L.Reed, N. A. El-Masry, H. H. Stadelmaier, M. K. Ritums, and M. J. Reed, C. A. Parker, J. C. Roberts, and S. M. Bedair,) "Room temperature ferromagnetic properties of (Ga, Mn)N" App. Phys. Lett., 79 (21), p. 3473 (2001).
6. N.A. El-Masry, M.K. Behbehani, S.F. LeeBoeuf, M.E. Aumer, J.C. Roberts, and S.M. Bedair,"Self Assembled AlInGaN quaternary Superlattice Structures," Appl. Phys. Lett. 79 (#11), 1616 (2001).
7. M.L. Reed, M.K. Ritums, M.J. Reed, S.M. Bedair, N.A. El-Masry, and J.M. Zavada, "Room temperature ferromagnetic properties of Mn-doped InxGa1-xN", In press, Journal of Electronic Materials.
8. M.L. Reed, E.A. Berkman, M.J. Reed, F.E. Arkun, S.M. Bedair, J.M. Zavada, and N.A. El-Masry, "Magnetic properties of Mn-doped GaN, InGaN, and AlGaN", M.L. Reed, Mat. Res. Soc. Symp. Proc. Vol. 798, 2003, Y8.6.1.

Scientific and professional societies of which you are a member:
American Soc. for Metals
The Metallurgical Society, AIME
The Minerals, Metals &Materials Society, TMS
Materials Research Society, MRS
Institute of Electrical and Electronic Engineers, IEE.

Honors and awards:
NSF Women Career Advancement Award
Nominated for engineering school teaching award (1995,1996)
Honor Society Phi Kappa Phi
Honor Society Sigma Xi

Institutional and professional service in the last five years:
Executive for ASM-Carolina Chapter 1983-1985
Chairman for MRS- Carolina chapter (2003)
Undergraduate Course and Curriculum Committee
Search Committee for the Dean of Engineering College
Elected to the mediation panel,1993.
Elected for the University Faculty Senates (1999-2000)

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 100%

Percentage of time committed to the program: 100%

Curriculum Vitae for Yusef Fahmy

Academic Rank: Teaching Associate Professor

Degrees (fields, institutions, and date):
PhD Materials Science & Engineering, North Carolina State University, 1996
MS Materials Science & Engineering, North Carolina State University, 1991
BS Mechanical Engineering, North Carolina State University, 1988

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
12 years, Appointed 1998 as Visiting Professor, 2000 as Teaching Assistant Professor, 2006 as Teaching Associate Professor

Related experience (teaching, industrial experience, etc.):
1996-1998 Postdoctoral Research Associate, Advanced Materials Technology Labs, NCSU, Raleigh, NC.

Consulting, patents, etc.: N/A

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Jimmerson, B., Fahmy, Y., Fender, J., Nelms L., Powell T., Yearout R., The Impact of a Material's Inherent and Process Stress on Meeting Specifications and Tolerances: A Six Sigma Case Study, International Journal of Industrial Engineering, 16(3), 162-170, 2009
2. S. Jernigan, Y. Fahmy, G. Buckner, Implementing a Remote Laboratory Experience Into a Joint Engineering Degree Program: Aerodynamic Levitation of a Beach Ball, Transaction/Journal: IEEE Transactions on Education, Volume: 52, Issue: 2, May 2009
3. M.D. Martin, Y. Fahmy, A.M. Khasanov, J.G. Stevens, A Mossbauer Investigation of Zirconium Distribution and Diffusion in Ball Milled Nanocrystalline Iron Powders, Transaction/Journal: Hyperfine Interactions, Volume: 183, Oct. 2008
4. Y.Fahmy, Engineering and Liberal Arts: The Creativity Connection, Proceedings of the International Conference: Integrating Engineering and Humanities in Higher Education: The Bologna Process and Beyond, Darmstadt, Germany, 2008
5. R. Keltie, Y.Fahmy, ABET Accreditation Issues in a Two-Campus, Distance Education Program In Mechatronic Engineering, Proceedings of the ASEE Conference, 2007

Scientific and professional societies of which you are a member:
ASM, IEEE, ASEE, Sigma Xi

Honors and awards:
United Technologies Corporation Activity Grant: 2001
Pratt & Whitney Graduate Research Award: 1994
NCSU Outstanding Teaching Assistant Award: 1994, 1995, 1996
Institutional and professional service in the last five years:

- Mechatronics Program Assessment Committee
- Mechatronics Program Curriculum Committee
- Mechatronics Faculty Committee
- Mechatronics Departmental Committee
- Manuscript review: IEEE Transactions on Education, "A Project-Based Learning Approach for Mechatronic Control Engineering" for the Transactions on Education. Feb. 2009.
- Manuscript review: National Conference for Undergraduate Research (NCUR), Performer Activated Mist and Light: A Mechatronic System for Triggering and Controlling “Explosions” with a Simple Motion of the Hand. April, 2009.
- Course Development: EGM 180, EGM 360, EGM 482, Development Engineering 'Intensives': 'Writing Intensive' and 'Information Literacy Intensive', ECE 482 Senior Design Project in Mechatronics, UNCA Integrated Liberal Studies Committee, Nov. 2008.

Professional development activities in the last five years:
- International Conference: Integrating Engineering and Humanities in Higher Education: The Bologna Process and Beyond, Darmstadt, Germany, 2008
- TMS: Minerals, Metals & Materials Society, Conference, Orlando, Florida, 2007
- Association for General and Liberal Studies, Conference, Portland, ME, 2007
- American Society for Engineering Education, Conference, Honolulu, Hawaii, 2007

Percentage of time available for research or scholarly activities: 0%

Percentage of time committed to the program: 100%

Curriculum Vitae for Douglas L. Irving

Academic Rank: Assistant Professor

Degrees (fields, institutions, and date):
B.S., Physics, Furman University, 1997
M.S., Materials Science and Engineering, University of Florida, 2002
Ph.D., Materials Science and Engineering, University of Florida, 2004

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
1 year (Appointment: August 2008), Assistant Professor, 2008-present

Related experience (teaching, industrial experience, etc.):
Research Professor, Department of Materials Science and Engineering, North Carolina State University
Postdoctoral Associate, Department of Materials Science and Engineering, North Carolina State University

Consulting, patents, etc.:

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. L. P. Sun, D. L. Irving, M. A. Zikry and D. W. Brenner, Acta Materialia **57**(12): 3522-3528 (2009)
2. D. L. Irving, C. W. Padgett, Y. Guo, J. W. Mintmire and D. W. Brenner, IEEE Transactions on Magnetics **45**(1): 331-335 (2009)
3. D. L. Irving, C. W. Padgett and D. W. Brenner, Modelling and Simulation in Materials Science and Engineering **17**(1): 015004 (2009)
4. K. Elkhodary, L. P. Sun, D. L. Irving, D. W. Brenner, G. Ravichandran and M. A. Zikry, Journal of Applied Mechanics-Transactions of the ASME **76**(5): 051306 (2009)
5. O. Rezvanian, C. Brown, M. A. Zikry, A. I. Kingon, J. Krim, D. L. Irving and D. W. Brenner, Journal of Applied Physics **104**(2): 024513 (2008)
6. Y. Purohit, S. Jang, D. L. Irving, C. W. Padgett, R. O. Scattergood and D. W. Brenner, Materials Science and Engineering A, **493**(1-2): 97-100 (2008)
7. S. Jang, Y. Purohit, D. L. Irving, C. Padgett, D. Brenner and R. O. Scattergood, Acta Materialia **56**(17): 4750-4761 (2008)
8. S. Jang, Y. Purohit, D. Irving, C. Padgett, D. Brenner and R. O. Scattergood, Materials Science and Engineering A, **493**(1-2): 53-57 (2008)
9. D. L. Irving, B. D. Devine and S. B. Sinnott, Journal of Luminescence **126**(2): 278-288 (2007)
10. D. W. Brenner, D. L. Irving, A. I. Kingon and J. Krim, Langmuir **23**(18): 9253-9257 (2007)
11. D. L. Irving, S. B. Sinnott and R. F. Wood, Physical Review B **74**(19): 195403 (2006)
12. D. L. Irving and D. W. Brenner, Journal of Physical Chemistry B **110**(31): 15426-15431 (2006)

13. Y. H. Hu, D. L. Irving and S. B. Sinnott, Chemical Physics Letters **422**(1-3): 137-141 (2006)
14. M. Abdelmaksoud, S. M. Lee, C. W. Padgett, D. L. Irving, D. W. Brenner and J. Krim, Langmuir **22**(23): 9606-9609 (2006)
15. D. L. Irving, S. B. Sinnott and A. S. Lindner, Chemical Physics Letters **389**(1-3): 96-100 (2004)

Scientific and professional societies of which you are a member:
Materials Research Society, Keramos, Sigma Xi

Honors and awards:
Inducted into Sigma Xi honors society (2007)
NSMMS Outstanding Poster (1st Prize), Operating in Space Session, Douglas L. Irving et al., North Carolina State University (2005)
Inducted into Keramos honors society (2002)

Institutional and professional service in the last five years:
Reviewer, National Science Foundation (2009-present)
Reviewer, Journal of Applied Physics (2009-present)
Reviewer, Mechanics of Materials, (2009-present)
Reviewer, Research Letters in Materials Science (2009-present)
Fall COE Open House, Materials Science and Engineering (2008)
Spring COE Open House, Materials Science and Engineering (2009)
MSE Summer Camp (2008-present)
MSE Undergraduate Advisor (2008 - present)

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 70%

Percentage of time committed to the program: 100%

Curriculum Vitae for Mark Johnson

Academic Rank: Associate Professor

Degrees (fields, institutions, and date):
PhD - Material Science and Engineering, NC State University, December 1999
SB - Material Science and Engineering, Masssachusetts Institute of Technology, June 1984

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
7 Years, (Appointed April 2002) 1 Years, Associate Professor with Tenure (Promoted April 2008)

Related experience (teaching, industrial experience, etc.):
Associate Professor, NC State University, Raleigh, NC 2008-Present
Director of Industry and Innovation Programs, Future Renewable Electric Energy Delivery and Management Systems Center - NSF-ERC 2008-Present
Assistant Professor, NC State University, Raleigh, NC 2002-2008
Visiting Scientist, NC State University, Raleigh, NC 2001-2002
Founding President and CEO, Nitronex Corporation, Raleigh, NC 1999-2000
Research Assistant, NC State University, Raleigh, NC 1993-1999
MBE Products Manager, EPI-MBE Systems (now: Veeco), St. Paul, MN 1992-1993
Senior Engineer, Quantum Epitaxial Designs, Bethlehem, PA, 1989-1991
(now: Int'l Quantum Epitaxy)
Engineer, Raytheon Corporation, Waltham, MA 1985-1988
Student Intern, C.S. Draper Laboratories, Cambridge, MA 1983-1985

Consulting, patents, etc.:
Technical Advisory Board - OSemi, Inc., Kyma Technologies, GaN Devices, Inc.
Co-Founder - Nitronex Corp.
Significant Consulting Activities - Nextreme Thermal Solutions, Dupont Microelectronics, Northrop-Grumman Electronic Systems

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Enlargement of bulk non-polar GaN substrates by HVPE regrowth K-Y. Lai , V.D. Wheeler , J. A. Grenko , M.A.L. Johnson , A.D.Hanser , E.A.Preble, L. Liu, T. Paskova, K.R. Evans Phys Status Solidi-C Vol 5 (6) Pg 1886-1888 (May 2008).
2. Transmission Electron Microscopy Study of Epitaxial Gate Oxide on III-N Semiconductor Structures Y.N.Saripalli, X-Q Liu, D.W.Barlage, M.A.L.Johnson, D.Braddock, N.G.Stoddard, A Chugh GaN, AlN, InN and Their Alloys Editors: C.Wetzel, B.Gil, M.Kuzuhara, M.Manfra MRS. Proc Vol 831 E11.21 (2005)
3. D.W. Barlage and M.A.L. Johsson Channel and Source-Drain Materials for Aggressively Nanoscaled Non-Silicon MOSFETs , SRC e-workshop, (Sept 13, 2005).

4. "Prospects for III-Nitride Heterojunction MOSFET Structures and Devices" M.A.L. Johnson, D.W. Barlage, D. Braddock, Progress in Compound Semiconductors IV - Electronic and Optoelectronic Applications, Eds: G.Brown, R. Biefeld, C. Gmachl, M.O Manasreh, K. Unterrainer Mater Res. Soc Symp. Proc Vol 829 p301 (2005).
5. Polar and nonpolar HVPE GaN substrates: impact of doping on the structural, electrical and optical characteristics T. Paskova, E.A. Preble, A.D. Hanser, K.R.Evans, R.Kr ger, P.P.Paskov, A.J.Cheng, M.Park, J.A.Grenko, M.A.L.Johnson, Physica Status Solidi (c), 1-4 (2009).

Scientific and professional societies of which you are a member:
Materials Research Society (MRS)
American Society for Engineering Education (ASEE)
American Academy for the Advancement of Science(AAAS)

Honors and awards:
Ralph Powe - ORAU Faculty Advancement Award (2004)
DARPA Young Faculty Award (2007)

Institutional and professional service in the last five years:
Member, University Intellectual Property Committee (2007-present)
Member, Search Committee, University Technology Transfer Director (2007)
Coordinated College of Engineering and University Openhouse Programs for Department - 2002-2003
Departmental representative to College of Engineering Research Committee

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 80%

Percentage of time committed to the program: 100%

Curriculum Vitae for Jag Kasichainula

Academic Rank: Associate Professor

Degrees (fields, institutions, and date):
B. Tech Indian Institute of Technology, Madras, India Metallurgy 1966
M. Tech Indian Institute of Technology, Madras, India Metallurgy 1970
Ph.D Indian Institute of Technology, Madras, India Metallurgy 1973

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
08/01/85 Research Associate Professor
08/01/90 Research Associate Professor with tenure
05/01/97 Associate Professor

Related experience (teaching, industrial experience, etc.):
Associate Metallurgist in Metallurgy and Ceramics Division, Ames Laboratory, Ames, Iowa from December 1982 to May 1985.
Assistant Professor in Engineering Science and Mechanics, Tennessee Technological University, Cookeville, Tennessee, from September 1981 to December 1982.

Consulting, patents, etc.: n/a

States in which professionally licensed or certified: n/a

Principal publications of the last five years:
1. K. Jagannadham, Diffusion at a planar interface using continuous distribution of sources, Journal of Applied Physics, v 105, n 2, p 023504 (3 pp.), 15 Jan. 2009.
2. K. Jagannadham, E. A. Berkman, N. Elmasry, Thermal conductivity of semi-insulating, p-type, and n-type GaN films on sapphire, Journal of Vacuum Science & Technology A (Vacuum, Surfaces, and Films), v 26, n 3, p 375-9, May 2008
3. K. Jagannadham, M. L. Reed, M.J. Lance,T.R. Watkins,K. Verghese, J. E. Butler, A. Smirnov, Neutron transmutation of 10B doped diamond, Diamond and Related Materials, v 16, n 1, p 50-62, Jan. 2007.
4. K. Jagannadham, Compound semiconductor bonded to AlN heat spreader substrate using graded intermediate layer, Journal of Vacuum Science & Technology A (Vacuum, Surfaces, and Films), v 25, n 3, p 536-42, May 2007.
5. K. Jagannadham, Thermal conductivity of AlN-diamond particulate composite films on silicon, Journal of Vacuum Science & Technology A (Vacuum, Surfaces, and Films), v 24, n 4, p 895-9, July 2006.
6. K. Jagannadham, T. R. Watkins, M. J. Lance, Interfacial characterization and residual stress analysis in diamond films on LiNbO3, Journal of Vacuum Science & Technology A (Vacuum, Surfaces, and Films), v 24, n 6, p 2105-12, Nov. 2006.
7. C. C. Scheffing, K. Jagannadham, M.-S. Yim,M. A. Bourham, J. C. Farmer, J.J. Haslam, S. D. Day, D. V. Fix, N. Y. Yang, Properties of titanium-nitride for high-level waste packaging enhancement, Nuclear Technology, v 156, n 2, p 213-21, Nov. 2006.

8. M. L. Reed, M. J. Reed, K. Jagannadham, K. Verghese, S. M. Bedair, N. El-Masry, J. E. Butler, Electrical characterization of 10B doped diamond irradiated with low thermal neutron fluence, Journal of Vacuum Science & Technology A (Vacuum, Surfaces, and Films), v 22, n 4, p 1191-4, July 2004.
9. K. Jagannadham, M. J. Lance, T. R. Watkins, Growth of diamond film on single crystal lithium niobate for surface acoustic wave devices, Journal of Vacuum Science & Technology A (Vacuum, Surfaces, and Films), v 22, n 4, p 1105-9, July 2004.

Scientific and professional societies of which you are a member:
American Society of Metals –ASM
Minerals, Metals, and Materials Society –TMS

Honors and awards:
- Developed "Structural analysis of TiN/Si and TiN/GaAs Epitaxial systems by TEM and Image Simulation," and submitted a poster to Microscopy Society of America-First prize in the Physical Sciences for the paper in New Orleans 1994.
- T. Watkins, A. McGinnis, and K. Jagannadham, Residual stresses in multilayer system of coatings, Proc. of Advanced X-ray Analysis, Denver, Co, August, 1997 (Received the best poster paper award).

Institutional and professional service in the last five years:
Scheduling Officer for MSE Department.
Member of Committee for NCSU Book Stores
Member of Committee for NCSU Common Reading Committee

Professional development activities in the last five years:
Reviewer to Journal of Applied Physics, Materials Science and Engineering, Diamond and Related materials, and European Journal of Applied Physics, Journal of Vacuum Science and Technology, Journal of Crystal Growth
Reviewer for National Science Foundation

Percentage of time available for research or scholarly activities: 20%

Percentage of time committed to the program: 100%

Curriculum Vitae for Carl C. Koch

Academic Rank: Professor

Degrees (fields, institutions, and date):
Ph.D. Metallurgy, Case Institute of Technology, 1964
M.S. Metallurgy, Case Institute of Technology, 1961
B.S. Metallurgical Engineering, Case Institute of Technology, 1959

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
26 years , appointed professor in July, 1983.

Related experience (teaching, industrial experience, etc.):
Oak Ridge National Laboratory, Metals and Ceramics Division, group leader, 1970-1983, staff scientist 1965-1970.

Consulting, patents, etc.:
3 U.S Patents
Consulting for various companies and law firms, including Lord Corporation, ILCO Unicam

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. X. Zhang, H. Wang, and C. C. Koch, Mechanical Behavior of Bulk Ultrafine-grained and Nanocrystalline Zn , Reviews of Advanced Materials Science, 6, 34-40 (2004).
2.C. C. Koch, K. M. Youssef, R. O. Scattergood, and K. L. Murty, Breakthroughs in Optimization of Mechanical Properties of Nanostructured Metals and Alloys Advanced Engineering Materials, 7, 787-794 (2005)
3.K. M. Youssef, R. O. Scattergood, K. L. Murty, and C. C. Koch, Nanocrystalline Al-Mg Alloy with Ultrahigh Strength and Good Ductility , Scripta Mater., 54, 251-256 (2006)
4.C. C. Koch, Structural Nanocrystalline Materials: An Overview , Journal of Materials Science,42, 1403-1414 (2007).
5.C. C. Koch, K. M. Youssef, and R. O. Scattergood, Mechanical Properties of Nanocrystalline Materials Produced by in situ Consolidation Ball Milling , Materials Science Forum, 579, 15-28 (2008)
6. C. C. Koch, R. O. Scattergood, K. A. Darling, and J. E. Semones, Stabilization of Nanocrystalline Grain Sizes by Solute Additions , Journal of Materials Science, 43,7264-7272 (2008).

The above 6 examples from a total of 41 papers published during the last 5 years.

Scientific and professional societies of which you are a member:
TMS, Fellow; APS, Fellow; MRS, Fellow; ASM International, Fellow; AAAS, Fellow

Honors and awards:
Fellow of MRS, 2009
Kobe Steel Distinguished Professor,2008
The Alexander Quarles Holladay Medal for Excellence, 2006
R.J.Reynolds Tobacco Co. Award for Excellence in Teaching, Research, and Extension, 2003
ISI Highly Cited Researcher Award, 2002
Fellow of TMS - one of no more than 100 living Fellows, 2001
NCSU Alumni Distinguished Professor for Research Award, 1996
ALCOA Distinguished Research Award, NCSU 1991
NSF Research Award for Special Creativity 1990-1992
1983 "I-R 100" Award
NSF Post-doctoral Fellowship, Birmingham University, UK 1964-1965.

Institutional and professional service in the last five years:
Honorary Member of the Editorial Board of Materials Science and Engineering A
Member College of Engineering Reappointment, Promotion and Tenure Committee, 2005-2008, Chair to this committee, 2006-2007.
Associate Department Head, 1990 to 2009
Chairman of Department Course and Curriculum Committee 2000-2009
Department Awards Committee (of one) 2005-2009.
Invited talks at TMS meetings
Reviewer for many journals (typically about 50 per year) including Acta Materialia, Scripta Materialia, Applied Physics Letters, Philosophical Magazine, Advanced Materials, Materials Science and Engineering A, Journal of Materials Science, Journal of Alloys and Compounds, etc.
Reviewer for proposals from NSF, DOE, Australian Research Council
External examiner for Ph.D theses from India, IIT Madras, University of Hyderabad.

Professional development activities in the last five years:
Invited lectures :Keynote talk at Plasticity January,2005, Kauai, Hawaii
Lecture on nanomaterials at the Research and Development Caucus of the US House of Representatives, May 12, 2005
Seminar at Georgia Tech, April 3, 2007
Seminar at Pennsylvania State University, April 10, 2007
Keynote talk, RQ13, Dresden, Germany, August, 2008,
Keynote talk, Plasticity 2009, St.Thomas, US Virgin Is., January 2009
Seminar, Monash University, Melbourne, Australia, May 12, 2009

Percentage of time available for research or scholarly activities: 45%

Percentage of time committed to the program: 100%

Curriculum Vitae for Mark Luo

Academic Rank: Assistant Professor

Degrees (fields, institutions, and date):
Materials Science and Engineering, Brown University, RI, 2003

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
Assistant Professor: 2005 – present

Related experience (teaching, industrial experience, etc.):
Courses taught:
MSE/BME 203 Introduction to the Materials Science of Biomaterials
MSE 301 Equilibrium and Rate Processes
MSE 490-B/791-B Biomaterials Science

Consulting, patents, etc.:
Patent Pending: Luo, T. J. M., Ko, C. C., Tulloch, C. "Formable Bioceramics"

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Gibson, N. M., Luo, T. J. M., Shenderova, O., Choi, Y. J., Fitzgerald, Z., Brenner, D. W. Fluorescent Dye Adsorption Substrates through Electrostatic Interactions *Diamond and Related Materials*, Accepted.
2. Choi, Y., Huh, U., Luo, T. J. M. Spontaneous formation of silver nanoparticles in aminosilica J. Sol-gel Sci & Tech. 2009, 51, (1), 124-132.
3. Gibson, N., Shenderova, O., Luo, T. J. M., Moseenkov, S., Bondar, V., Puzyr, A., Purtov, K., Fitzgerald, Z., Brenner, D. W. Colloidal stability of modified nanodimaond particles *Diamond and Related Materials*, 2009, 18, (4), 620-626
4. Ko, C. C., Luo, T. J. M., Chi, L., Ma, A. Hydroxyapatite/Gemosil Nanocomposite *Advances in Bioceramics and Porous Ceramics* 2008, 29.7, 123-134
5. Valamehr, B., Jonas, S. J., Polleux, J., Qiao, R., Guo, S., Gschweng, E. H., Stiles, B., Kam, K., Luo, T. J. M., Witte, O. N., Liu, X., Dunn, B., Wu, H. Hydrophobic surfaces for enhanced differentiation of embryonic stem cell-derived embryoid bodies *PNAS* 2008, 105, (38), 14459
6. Luo, T. J. M., Soong, R., Lan, E., Dunn, B., Montemagno, C., Photo-induced proton gradients and ATP biosynthesis produced by vesicles encapsulated in a silica matrix *Nature Materials* 2005, 4, (3), 220.
7. Luo, T. J. M., MacDonald, J. C., Palmore, G. T. R. In situ AFM studies on the growth of crystals of bis(imidazolium 2,6-dicarboxylatepyridine) Cu(II) dihydrate *Trans. Amer. Cryst. Assoc.* 2004, 39, 73.

Scientific and professional societies of which you are a member:
The Minerals, Metals & Materials Society
Materials Research Society
American Society for Engineering Education

Honors and awards:
Faculty Research and Professional Development Award, NCSU 2006
Powe Junior Faculty Enhancement Award, 2007

Institutional and professional service in the last five years:
Reviewer for ASEE, ACS journals, NSF, and AFSOR
MSE curriculum committee
College Engineering Day Committee

Professional development activities in the last five years:
Academic organizer for 1st Biothreat Workshop at Winston Salem NC, 2008
Joint development with UNC-Duke-NCSU on commercialization of GEMOSIL technology 2009

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Curriculum Vitae for Jon-Paul Maria

Academic Rank: Associate Professor

Degrees (fields, institutions, and date):
B.S. Ceramic Science and Engineering, The Pennsylvania State University, May 1994
M.S. Ceramic Science and Engineering, The Pennsylvania State University, May 1996
Ph.D. Ceramic Science, The Pennsylvania State University, August 1998

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
September, 1998 - April 2002: Research Assistant Professor, NCSU Materials Science and Engineering April 2002 - April 2006: Assistant Professor, NCSU Materials Science and Engineering April 2006 - present: Associate Professor, NCSU Materials Science and Engineering

Related experience (teaching, industrial experience, etc.): N/A

Consulting, patents, etc.: Since 2006
Thin film dielectrics with co-fired electrodes for capacitors and methods of making thereof Number: EP 1879202: Borland, William J.; Daniels, Patrick; Face, Dean W.; Ihlefeld, Jon Frederick; Maria, Jon-Paul.

Glass flux assisted sintering of chemical solution deposited thin dielectric films.
Number: WO 2007145630: Borland, William J.; Suh, Seigi; Maria, Jon-Paul; Ihlefeld, Jon Fredrick; Burn, Ian.

Barium titanate based high-k dielectric precursor solution comprising barium acetate for capacitor that satisfies the XR7 requirements for capacitance. Number: EP 1777713
Borland, William J.; Maria, Jon-Paul; Ihlefeld, Jon Frederick.

Preparation of Mn-doped barium titanate thin dielectric films for capacitors on printed circuit boards. Number: US 2006287188: Borland, Willian J.; Burn, Ian; Ihelfeld, Jon Fredrick; Maria, Jon-Paul: Suh, Seigi

Pending Applications:

EL0679USNA Title: Thin Film Dielectrics with Co-fired Electrodes for Capacitors and Methods of Making Thereof, Inventors: W. J. Borland, Patrick R. Daniels, Dean W. Face, J. F. Ihlefeld, and J-P. Maria, Filing Date: July 14, 200

EL0818USPRV, EL0825USPRV, EL0821USPRV, EL0819USPRV, EL0858USPRV
Title: Compositions and processes for forming photovoltaic devices. Inventors: William Borland, Jon-Paul Maria, Filing Date: August 13, 2008

States in which professionally licensed or certified: N/A

Principal publications of the last five years:

1. Craft, H.S., Collazo, R., Losego, M.D., Mita, S., Sitar, Z., and Maria, J.P., Band offsets and growth mode of molecular beam epitaxy grown MgO (111) on GaN (0002) by x-ray photoelectron spectroscopy. Journal Of Applied Physics, 2007. 102(7).

2. Losego, M.D., Mita, S., Collazo, R., Sitar, Z., and Maria, J.P., Epitaxial growth of the metastable phase ytterbium monoxide on gallium nitride surfaces. Journal Of Crystal Growth, 2008. 310(1): p. 51-56.
3. Losego, M.D., Ihlefeld, J.F., and Maria, J.P., Importance of solution chemistry in preparing sol-gel PZT thin films directly on copper surfaces. Chemistry Of Materials, 2008. 20(1): p. 303-307.
4. Losego, M.D., Fitting-Kourkoutis, L., Mita, S., Craft, H.S., Muller, D.A., Collazo, R., Sitar, Z., and Maria, J.P., Epitaxial Ba0.5Sr0.5TiO3 heterostructures with abrupt interfaces. Journal Of Crystal Growth,211, p. 1106-1109, 2009.
5. Craft, H.S., Collazo, R., Losego, M.D., Mita, S., Sitar, Z., and Maria, J.P., Spectroscopic analysis of the epitaxial CaO (111)-GaN (0002) interface. Applied Physics Letters, 2008. 92(8).
6. Aygun, S.M., Daniels, P., Borland, W., and Maria, J.P., Hot sputtering of barium strontium titanate on nickel foils. Journal Of Applied Physics, 2008. 103(8).
7. Ihlefeld, J.F., Borland, W.J., and Maria, J.P., Enhanced dielectric and crystalline properties in ferroelectric barium titanate thin films. Advanced Functional Materials, 2007. 17(7): p. 1199-1203.

Scientific and professional societies of which you are a member:
The Materials Research Society, IEEE Ultrasonics, Ferroelectrics, and Frequency Control

Honors and awards:
NSF CAREER grant, August 2006
IEEE-UFFC Ferroelectrics Young Investigator Award 2008
NCSU ALCOA Research Award, May 2009

Institutional and professional service in the last five years: Since 2006:
Course and Curriculum Committee member
Search Committee member, 2006, 2008, 2009
Graduate Program Committee Chair, 2009
Conference Chair for IEEE UFFC/ISAF conference, August, 2006
Reviewer for Journal of Materials Research, Electroceramics, Applied Physics Letters, and Vacuum Science and Technology
Technical Program Chair for ONR US-Japan Seminar on Dielectric and Ferroelectric Materials

Professional development activities in the last five years: N/A

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Curriculum Vitae for Anatoli V. Melechko

Academic Rank: Associate Professor

Degrees (fields, institutions, and date):
M.S. Physics, Novosibirsk State University, Novosibirsk, Russia, 1992
Ph.D. Physics, University of Tennessee, Knoxville, USA, 2001

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
1 year. Original appointment August 16, 2008.

Related experience (teaching, industrial experience, etc.):
- 2006-2008 R&D staff member, Materials Science and Engineering Division and Center for Nanophase Materials Sciences, Oak Ridge National Lab, Oak Ridge, TN
- 2004-2006 Research Assistant Professor, Department of Materials Science and Engineering, The University of Tennessee, Knoxville, TN
- 2001-2004 Postdoctoral Research Associate, Center for Environmental Biotechnology, University of Tennessee, Knoxville
  1996-2001 Graduate Research Assistant, Department of Physics, University of Tennessee, Knoxville
- 1992-1996 Junior Research Scientist, Institute of Semiconductor Physics, Novosibirsk, Russia

Consulting, patents, etc.:
1. US7144287-B2, Fabrication of individually electrically addressable vertically aligned carbon nanofibers
2. US7245068-B2, Alignment control apparatus for catalytically grown nano structures
3. US7408186-B2, Nanostructure containing composition for controlled alignment of catalytically grown nanostructures
4. US7229692-B2, Nanotransfer and nanoreplication comprises growing aligned elongated nanostructure on substrate
5. US7151256-B2, Cantilever structure e.g. chemical force microscope tip, fabricating method for use in scanning probe microscope
6. US6958572-B2, Formation of nanostructure for, e.g. biological sensor,
7. US6982519-B2, Electrically addressable vertically aligned carbon nanofiber
8. US6858455-B2; Gate field emission device fabrication method

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Peckys, D.B., A.V. Melechko, M.L. Simpson, and T.E. McKnight, Immobilization and release strategies for DNA delivery using carbon nanofiber arrays and self-assembled monolayers. Nanotechnology, 2009. 20(14): p. 145304.

2. Park, J., S. Kwon, S.I. Jun, T.E. McKnight, A.V. Melechko, M.L. Simpson, M. Dhindsa, J. Heikenfeld, and P.D. Rack, Active-Matrix Microelectrode Arrays Integrated With Vertically Aligned Carbon Nanofibers. Ieee Electron Device Letters, 2009. 30(3): p. 254-257.
3. Melechko, A.V., R. Desikan, T.E. McKnight, K.L. Klein, and P.D. Rack, Synthesis of vertically aligned carbon nanofibres for interfacing with live systems. Journal of Physics D: Applied Physics, 2009. 42(19): p. 193001.
4. Sorge, K.D., K.L. Klein, A.V. Melechko, C.L. Finkel, O. Malkina, T. Leventouri, J.D. Fowlkes, P.D. Rack, and M.L. Simpson, Magnetic properties of Fe-Co catalysts used for carbon nanofiber synthesis. Journal of Applied Physics, 2008. 104(3): p. 033909.
5. Retterer, S.T., A. Melechko, D.K. Hensley, M.L. Simpson, and M.J. Doktycz, Positional control of catalyst nanoparticles for the synthesis of high density carbon nanofiber arrays. Carbon, 2008. 46(11): p. 1378-1383.
6. Rack, P.D., Y. Guan, J.D. Fowlkes, A.V. Melechko, and M.L. Simpson, Pulsed laser dewetting of patterned thin metal films: A means of directed assembly. Applied Physics Letters, 2008. 92(22): p. Artn 223108.
7. Mann, D.G.J., T.E. McKnight, J.T. McPherson, P.R. Hoyt, A.V. Melechko, M.L. Simpson, and G.S. Sayler, Inducible RNA interference-mediated gene silencing using nanostructured gene delivery arrays. ACS Nano, 2008. 2(1): p. 69-76.
8. Klein, K.L., A.V. Melechko, T.E. McKnight, S.T. Retterer, P.D. Rack, J.D. Fowlkes, D.C. Joy, and M.L. Simpson, Surface characterization and functionalization of carbon nanofibers. Journal of Applied Physics, 2008. 103(6): p. -.
9. Guan, Y.F., R.C. Pearce, A.V. Melechko, D.K. Hensley, M.L. Simpson, and P.D. Rack, Pulsed laser dewetting of nickel catalyst for carbon nanofiber growth. Nanotechnology, 2008. 19(23): p. Artn 235604.

Scientific and professional societies of which you are a member:
American Vacuum Society
Materials Research Society

Honors and awards: n/a

Institutional and professional service in the last five years:
Undergraduate Program Committee Chair

Professional development activities in the last five years:
Molecular biology boot camp

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Curriculum Vitae for K. Linga Murty

Academic Rank: Professor

Degrees (fields, institutions, and date):
Ph.D. (Applied Physics, Cornell University, 1970)
M.S. (Materials Science & Engineering, Cornell University, 1967)
M.Sc. (Physics, Andhra University, 1963)
B.Sc. (Hons) (Physics, Andhra University, 1962)

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
Associate Professor, 1981 Professor, 1985

Related experience (teaching, industrial experience, etc.):
Senior Engineer, Westinghouse Research Center, Pittsburgh PA, 1979-81
Senior Research Engineer, Babcock & Wilcox Cp., Lynchburg VA, 1974-79

Consulting, patents, etc.:

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Charit and K.L. Murty, Effect of Radiation Exposure on the Hall-Petch Relation and Its Significance on Radiation Embrittlement in Iron and Ferritic Steels, in proceedings of SMiRT-19, Toronto, Canada, Aug. 2007.
2. C.S. Seok, I. Charit, B. Marple and K.L. Murty, High Temperature Deformation Characteristics of ZirloTM Tubing via Ring Creep and Burst Tests, proceedings of SMiRT-19, Toronto, Canada, Aug. 2007, paper C02/1.
3. Charit, K.L. Murty and C.C. Koch, Creep Properties of Advanced Steels for High Efficiency Fossil-Fuelled Power Plants, Proceedings of 5th International Conference on Advances in Materials Technology for Fossil Power Plants, Marco Island, FL Oct. 3-5, 2007.
4. S. Gollapudi, I. Charit and K.L. Murty, Creep Mechanisms in Ti-3Al-2.5V Tubing Deformed under Closed-end Internal Gas Pressurization, Acta Mat., 56 (2008) 2406-2419.
5. S. Gollapudi, V. Bhosle, I. Charit and K. L. Murty, Newtonian Viscous Creep in Ti3Al2.5V, Phil Mag., 88:9 (2008) 1357-1367.
6. Charit and K.l. Murty, Creep Behavior of Niobium-Modified Zirconium Alloys, Journal of Nuclear Materials, 374 (2008) 354-363.
7. K. Rajulapati, R.O. Scattergood, K.L. Murty, Z. Horita, T.G. Langdon and C.C. Koch, Mechanical properties of bulk nanocrystalline Aluminum-Tungsten alloys, Metallurgical and Materials Transactions A, 39 (2008) 2528.
8. K. Linga Murty, S. Gollapudi and I. Charit, Newtonian Viscous Creep in Metals, invited paper in Proceedings of 5th International Conference on Creep, Fatigue and Creep-Fatigue Interaction, Sep. 24-26, 2008, Kalpakkam, India.

9. Pei-Yuan Cheng, Young-Jun Song, Tasnim Hassan and K. Linga Murty, Ratcheting Failure Mechanisms of Welded Piping Joints, Proceedings of International Symposium on Plasticity 2009, St. Thomas, Jan 3-8, 2009.
10. C.S. Seok, B. Marple, Y.J. Song, S. Gollapudi, I. Charit and K.L. Murty, High Temperature Deformation Characteristics of ZirloTM Tubing via Ring Creep and Burst Tests, to be published in Nuclear Engineering and Design.

Scientific and professional societies of which you are a member:
ASM, TMS, ANS, APS, IIM, MRS-I

Honors and awards:
Alcoa Foundation Research Achievement Award (1988)
ANS Mishima Award (1993)
Fellow of ASM International (1996)
Life Fellow, IIM (1996)
Best Paper Award, 14th WCNDT (1996)
Fellow of ANS (2002)

Institutional and professional service in the last five years:
Key Reader, Met Trans, ASM/TMS
Professional Committees :
- Flow and Fracture Committee of TMS/ASM
- Nuclear Metallurgy Committee of TMS/ASM [Chairman 1995-97]; committee representative for Journal of Metals [2000; 2001; 2009-10]
- Electronic Packaging Committee of TMS

Professional development activities in the last five years:
Program Director, Metals Research, Division of Materials Research, NSF (IPA assignment) - 6/2001-8/2003
UNDP-TOKTEN consultant to Andhra University & IGCAR, India (1999)

Percentage of time available for research or scholarly activities: 30%

Percentage of time committed to the program: 25%

Curriculum Vitae for Jagdish Narayan

Academic Rank: Professor, The John C. C. Fan Distinguished Chair

Degrees (fields, institutions, and date):
Ph.D. (Materials Science and Engineering), University of California, Berkeley, 1971
M.S. (Materials Science and Engineering), University of California, Berkeley, 1970
B. Tech. (With Distinction and University First Hons.), IIT, Kanpur, India, 1969

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
Years of Service at NCSU: 26 Years May 1983- Present Full Professor 1990- Distinguished Professor 2003- The John C. C. Fan Family Distinguished Chair Professor

Related experience (teaching, industrial experience, etc.):
1971-72, Research Metallurgist, Lawrence Berkeley National Lab.
1972-84, Senior Scientist and Group Leader, Solid State Division, Oak Ridge National Lab.
1984-86, Director, Microelectronics Center of North Carolina.
1990-92, Director, Division of Materials Research, National Science Foundation.
1984-2003, Distance Education Instructor, NTU.
2007- Distinguished Visiting Scientist, Oak Ridge National Laboratory

Consulting, patents, etc.:
35 US Patents, 3 Licensed to Kopin Corp. and one licensed to H. C. Starck, Inc, and 3 Patents led to 3 IR-100 Awards.
Consultant to: 1) Kopin Corporation; 2) Oak Ridge National Lab.; 3)H. C. Starck, Inc.

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Title: Raman Studies of GaN/sapphire thin film heterostructures
   Author(s): Hushur, A; Manghnani, MH; P; Narayan, J.
   Source: JOURNAL OF APPLIED PHYSICS Volume: 106 Issue: 5 Article Number: 054317 Published: 2009
2. Title: Thin film epitaxy and structure property correlations for non-polar ZnO films
   Author(s): Pant, P; Budai, JD; Aggarwal, R; Narayan, RJ; Narayan, J
   Source: ACTA MATERIALIA Volume: 57 Issue: 15 Pages: 4426-4431 Published: 2009
3. Title: Formation of single and multiple deformation twins in nanocrystalline fcc metals
   Author(s): Zhu, YT; Narayan, J; Hirth, JP; Mahajan, S; Wu, XL; Liao, XZ
   Source: ACTA MATERIALIA Volume: 57 Issue: 13 Pages: 3763-3770 Published: 2009
4. Title: Twinning partial multiplication at grain boundary in nanocrystalline fcc metals
   Author(s): Zhu, YT; Wu, XL; Liao, XZ, et al.
   Source: APPLIED PHYSICS LETTERS Volume: 95 Issue: 3 Article Number: 031909 Published: 2009
5. Title: Defect mediated room temperature ferromagnetism in VO2 thin films
   Author(s): Yang, TH; Nori, S; Zhou, H; and Narayan, J.

Source: APPLIED PHYSICS LETTERS Volume: 95 Issue: 10 Article Number: 102506 Published: 2009

6. Title: The synthesis and magnetic properties of a nanostructured Ni-MgO system
   Author(s): Narayan, J; Nori, S; Ramachandran, S, et al.
   Source: JOM Volume: 61 Issue: 6 Pages: 76-81 Published: 2009
7. Title: New frontier in thin film epitaxy and nanostructured materials
   Author(s): Narayan, J
   Source: INTERNATIONAL JOURNAL OF NANOTECHNOLOGY Volume: 6 Issue: 5-6 Pages: 493-510 Published: 2009
8. Title: Magnetic Properties of Self-Assembled Ni Nanoparticles in Two Dimensional Structures
   Author(s): Gupta, A; Narayan, J; Kumar, D
   Source: JOURNAL OF NANOSCIENCE AND NANOTECHNOLOGY Volume: 9 Issue: 6 Pages: 3993-3996 Published: 2009

Scientific and professional societies of which you are a member:
ASM-International, TMS, American Physical Society, AAAS, National Academy of Sciences, India, Materials Research society

Honors and awards:
Inaugural MRS Fellow (First 34 MRS members worldwide); TMS Fellow (limit 100 members worldwide); NAS (India) Fellow (limit 100 foreign members), ASM Gold Medal, ASM Edward DeMille Campbell Lecture and Prize, US-DOE Outstanding Research Award, Three IR-100 Awards, APS fellow, AAAS Fellow, MRS-I Fellow, ASM Fellow, Fellow BPS. One of Narayan s former students (Assistant Professor at Texas A&M) received NSF CAREER & Presidential PECASE Award last year (only one in the field of materials science and engineering in USA)

Institutional and professional service in the last five years:
Chair COE research Committee; Member University Research Committee; Member ASM Awards Policy Committee; Chair TMS Bruce Chalmers Award Committee; Chair ASM Gold Medal Committee; Member TMS John Bardeen Award Committee; Chair ARO Board; Member TMS&ASM International Affairs Committee;

Professional development activities in the last five years:
Executive Council - electronic Magnetic and Photonic Materials Division of TMS
DOE - National Labs. and NSF-major facilities reviewer
O. Max Gardner Award Council - NCSU (1995 – 1
NSF Chair for the Presidential Materials (AMPP) Initiative
Member-Visiting Committee (School of Materials Science and Engineering) Georgia Tech. Member - SURA Materials Research Council

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Curriculum Vitae for Lewis Reynolds

Academic Rank:
Teaching Assistant Professor

Degrees (fields, institutions, and date):
BS Physics, Virginia Military Institute, 1970
MS Materials Science, University of Virginia, 1972
PhD Materials Science, University of Virginia, 1974

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
7 years initial appointment 1/9/2003 Teaching Assistant Professor, 8/15/2006.

Related experience (teaching, industrial experience, etc.):
2003-present Research Professor/Teaching Assistant Professor, Department of Materials Science and Engineering, North Carolina State University
1992-2003 Distinguished Member of Technical Staff, Bell Laboratories, Agere Systems (Lucent, AT&T), Breinigsville, PA
1980-1992 Distinguished Member of Technical Staff, Bell Laboratories, AT&T, Reading, PA
1977-1980 Senior Project Engineer, Union Carbide Corporation, Indianapolis, IN
1975-1977 Research Associate, Physics, University of Illinois
1974-1975 Senior Scientist, University of Virginia

Consulting, patents, etc.:
Has been issued 8 patents: 4,470,368, September 11, 1984; 4,615,032, September 30, 1986; 5,041,393, August 20, 1991; 5,539,762, July 23, 1996; 6,440,764, August 27, 2002; 6,503,768, January 7, 2003; 6,542,686, April 1, 2003; 6,862,394, March 1, 2005.

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. D.K. Young, C.L. Reynolds Jr., V. Swaminathan, and F.S. Walters, Influence of Zn Doping Profile on the Excitation Dependence of Photoluminescence Intensity in InGaAsP Heterostructures, Electronics Letters 41, 1008(2005).
2. S.M. Bishop, C.L. Reynolds Jr., Z. Liliental-Weber, Y. Uprety, J. Zhu, D. Wang, M. Park, J.C. Molstad, D.E. Barnhardt, A. Shrivastava, T.S. Sudarshan, and R.F. Davis, Polytype Stability and Microstructural Characterization of Silicon Carbide Epitaxial Films Grown on [1120]- and [0001]-Oriented Silicon Carbide Substrates, Journal of Electronic Materials 36, 285(2007).
3. K.A. Darling, R.K. Guduru, C.L. Reynolds Jr., V.M. Bhosle, R. Chan, R.O. Scattergood, C.C. Koch, and M.O. Aboelfotoh, Thermal Stability, Mechanical and Electrical Properties of Nanocrystalline Cu3Ge, Intermetallics 16, 378(2008).
4. K.A. Darling, C.L. Reynolds Jr., D.N. Leonard, G. Duscher, R.O. Scattergood, and C.C. Koch, Self-assembled 3D Cu-Ge Nanoweb Composite, Nanotechnology 19, 135603(2008).

5. C.L. Reynolds Jr. and A. Patel, Tunneling Entity in Different Injection Regimes of InGaN Light Emitting Diodes, Journal of Applied Physics 103, 086102(2008).
6. S.M. Bishop, C.L. Reynolds Jr., Z. Liliental-Weber, Y. Uprety, C.W. Ebert, F.A. Stevie, J.-S. Park, and R.F. Davis, Sublimation Growth of an In-Situ Deposited Buffer Layer in SiC Chemical Vapor Deposition on 4H-SiC(11-20), Journal of Crystal Growth 311, 72(2008).
7. J.A. Grenko, C.W. Ebert, C.L. Reynolds Jr., M.A.L. Johnson, A.D. Hanser, E.A. Preble, T. Paskova, and K.R. Evans, Modulation of Mobility in Homoepitaxially-Grown AlGaN/GaN Heterostructures, Physica Status Solidi C 6, S1037(2009).
8. C.L. Reynolds Jr. and J.A. Grenko, Crystallographic Plane Dependent Fe and Si Dopant Incorporation and Activation in InP, Physica Status Solidi A 206, 691(2009).
9. S.M. Bishop, C.L. Reynolds Jr., J.C. Molstad, D.E. Barnhardt, and R.F. Davis, On the Origin of Aluminum-Related Emissions from Sublimation Grown 4H-SiC(11-20), Applied Surface Science 255, 6535(2009).
10. C.W. Ebert, M. Belousov, C.L. Reynolds, D. Lee, Z. Pulwin, W.E. Quinn, T.L. Biggerstaff, J.A. Grenko, G. Duscher, and K.C. Wong, In Situ Strain Measurements of InGaAs and Metamorphic Buffer Layers Used in MOVPE Solar Cell Structures, Proceedings of the XIII European Workshop-MOVPE, Ulm, B.06(2009).
11. T.L. Biggerstaff, C.L. Reynolds Jr., T. Zheleva, A. Lelis, D. Habersat, S. Haney, S.-H. Ryu, A. Agrawal, and G. Duscher, Relationship between 4H-SiC/SiO2 Transition Layer Thickness and Mobility, Applied Physics Letters 95, 032108(2009).

Scientific and professional societies of which you are a member:
APS, MRS, IEEE, AAAS, AAPT, Sigma Xi

Honors and awards:
Distinguished Member of Technical Staff AT&T Bell Laboratories, September, 1988

Institutional and professional service in the last five years: n/a

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 15%

Percentage of time committed to the program: 100%

Curriculum Vitae for J. Michael Rigsbee

Academic Rank: Professor

Degrees (fields, institutions, and date):
B.S. Metallurgical Engineering North Carolina State University 1969
M.S. Materials Engineering North Carolina State University 1971
Ph.D. Materials Engineering North Carolina State University 1974

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
12 years; Appointed 1998

Related experience (teaching, industrial experience, etc.):
- 1993 - 1998 The University of Alabama at Birmingham, Professor and Chairman, Department of Materials and Mechanical Engineering, Birmingham, AL
- 1979 - 1993 University of Illinois at Urbana-Champaign Assistant Prof. (1979), Associate Prof. (1985), Professor (1991), Urbana, IL
- 1988 - 1989 National Science Foundation Program Director, Metallurgy and Ceramics Programs, Division of Materials Research
- 1976 - 1979 Republic Steel Corporation, Senior Research Metallurgist, Corporate Research Center, Cleveland, Ohio
- 1973 - 1976 Post Doctoral Research Associate, Department of Metallurgical Engineering, Michigan Technological University, Houghton, MI
- 1969 - 1973 North Carolina State University, NSF Fellow and Graduate Teaching Assistant, Department of Materials Engineering

Consulting, patents, etc.:
- Method of Making Mixed Metal Oxide Coated Substrates, V. F. Hock, Jr., J. H. Givens, J. E. Suarez, and J. M. Rigsbee, Patent Number 5,055,169, October 8, 1991.
- Method of Bonding Metals to Ceramics and Other Materials, D. M. Gruen, A. R. Krauss, A. B. DeWald, C. P. Ju, and J. M. Rigsbee, Patent Number 5,176,950, January 5, 1993.
- Method for Sputter Deposition of a Chromium, Carbon, and Fluorine Crystalline Films, M. J. O'Keefe and J. M. Rigsbee, Patent Number 5,628,882, May 13, 1997.

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Roger J. Narayan, Sarit B. Bhaduri, Gary Fischman, J. M. Rigsbee and Xinghang Zhang, "Next Generation Biomaterials," Materials Science and Engineering C, 27, 345-346 (2007).
2. J.M. Rigsbee, "Development of Nanocrystalline Copper-Refractory Metal Alloys," Materials Science Forum, 561-565, 2373-2378 (2007).
3. P. Maheshwari, H. Tian, C. E. Reece, M. J. Kelley, D. P. Griffis, G. R. Myneni, F. A. Stevie, J. M. Rigsbee, A. D. Batchelor, Surface Analysis of Nb Materials for SRF Cavities," published in proceedings of SIMS XVII, Toronto, September 2009.

Scientific and professional societies of which you are a member:
ASM International
American Society for Engineering Education
Journal of Materials Education
The Minerals, Metals and Materials Society

Honors and awards:
European Academy of Sciences - elected 2002; ASM Fellow - elected 2000; Honor Societies: Alpha Sigma Mu, Sigma Xi and Phi Kappa Phi; Research Commendations - Department of the Army - 1985 and 1986, Letter of Appreciation, Office of Assistant Secretary, 1988; Invited Professor at the Technion, Haifa, Israel (June 4-14, 1990); Burnett Materials Science Teaching Award (1991); U.S. Army Distinguished Public Service Award (1992)

Institutional and professional service in the last five years:
Served as department head from 11/1998 to 8/2009
Member of multiple college and department committees
Serving on MS and PhD committees of 14 students
Reviewer of proposals and publications
Treasurer and on executive committee of ASM Central Carolinas Chapter
Editorial Board for International Materials Reviews
Reviewer (since 1993) for Louisiana Board of Regents EPSCoR programs

Professional development activities in the last five years:
Began involvement with distance learning through workshops and teaching
Granta Design workshop for information technology in support of materials education

Percentage of time available for research or scholarly activities: 30%

Percentage of time committed to the program: 100%

Curriculum Vitae for George Rozgonyi

Academic Rank: Professor

Degrees (fields, institutions, and date):
1958 B.S. Aeronautical Engineering, University of Notre Dame
1960 M.S. Engineering Science, University of Notre Dame
1963 Ph.D. Aero-Space Sciences, University of Arizona

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
28 years. Hired as Full Professor August 1982

Related experience (teaching, industrial experience, etc.):
- 1982-present Professor of Materials Science and Engineering, NC State U
- 2008-present Founding Director, Silicon Solar Consortium (SiSoC), an NSF sponsored Industry/University Cooperative Research Center(I/UCRC)
- 1997-2007 Founding Director, Silicon Wafer Engineering and Defect Science Center (SiWEDS), an NSF sponsored Industry/University Cooperative Research Center(I/UCRC)
- 1963-1982 Bell Telephone Laboratories, Murray Hill, NJ, MTS, including
- 1979-1981 Sabbatical at Max Planck Institute, Stuttgart, Germany CNET, Grenoble, France

Consulting, patents, etc.: N/A

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Xuegong Yu, J. Lu, K. Youssef and G. Rozgonyi, Proximity gettering of Cu contaminant at a (110)/(001) interface in direct silicon bonded wafer with hybrid orientation technology, Appl. Phys. Lett., June 2009.
2. J. Lu, X. Yu, Y. Park, and G. Rozgonyi, Investigation of iron impurity gettering at dislocations in a SiGe/Si heterostructure, J Appl. Phys. 105, 073712 , (2009)
3. J. Lu, G. Rozgonyi, and A. Schönecker, Carrier lifetime limitation defects in polycrystalline silicon ribbons grown on substrate (RGS), Materials Science in Semiconductor Process, 11, 20, (2008)
4. J. Lu and G. Rozgonyi, Capacitance transient study of the influence of iron contamination on electrical characteristics of Si grain boundaries, Appl. Phys. Lett. 92, 082110 (2008)
5. J. Lu, G. Rozgonyi, M. Seacrist, M. Chaumont, and A. Campion, Effect of strained-Si layer thickness on dislocation distribution and SiGe relaxation in strained-Si/SiGe heterostructures, J. Appl. Phys. 104, 074904 (2008)
6. J. Lu, Y. Park, and G. Rozgonyi, Deep level transient spectroscopy and capacitance-voltage study of dislocations and associated defects in SiGe/Si heterostructures, J. Appl. Phys. 103, 073716 (2008)
7. J. Lu, G. Rozgonyi, and M. Seacrist, Effect of Strained-Si Layer Thickness on Dislocation Distribution and SiGe Relaxation in Thin Buffer Layer Strained-Si/SiGe Heterostructures, ECS Transactions, 16(10), p.293-298, (2008)

8. J. Lu, Y. Park, X. Yu, and G. Rozgonyi, Electrical Properties of the Bonding Interface in a (110)/(100) Direct-Silicon-Bonded (DSB) Wafer, ECS Transactions, 16(8), 433, (2008)
9. "MOS Capacitor Evaluation of Deep States at the Interfacial Grain Boundary in (110/100) Bonded Silicon", Liya Yu, J Lu, MC Wagener, X Yu and G Rozgonyi, ECS Transactions, 16 (8), 393-399 (2008)
10. Xuegong Yu, Jinggang Lu and George Rozgonyi, Deep-level transient spectroscopy study on a direct silicon bonded (110)/(100) interfacial grain boundary, Semicond. Sci. Technol. 23, (2008) 125005.
11. Xuegong Yu, Jinggang Lu, and George Rozgonyi, Impact of Cu contamination on the electrical properties of a direct silicon bonded (110)/(100) interfacial grain boundary, J. Appl. Phys. 104, 113702 (2008).

Scientific and professional societies of which you are a member:
Member of the MRS, ECS (Fellow) and APS
1975-present: Executive Committee, Electronics Division of The Electrochemical Society
Member, various SEMATECH Semiconductor Industry Roadmap committees

Honors and Awards:
Electrochemical Society Electronics Division Award 1981:
For advancing our fundamental understanding of defects in device processing
Fellow of the Electrochemical Society – 1995

Institutional and professional service in the last five years: n/a

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 50%

Percentage of time committed to the program: 100%

Curriculum Vitae for Ronald O. Scattergood

Academic Rank: Professor

Degrees (fields, institutions, and date):
BS in Mining, BS in Metallurgy: Lehigh University 1961
MS in Metallurgy, MIT 1963
PhD in Metallurgy, MIT 1968

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
28 years on NCSU faculty 1981 - present Professor

Related experience (teaching, industrial experience, etc.):
12 years experience as a scientist at the Argonne National Laboratory

Consulting, patents, etc.: Most recent consulting - Praxair Inc.

States in which professionally licensed or certified: N/A

Principal publications of the last five years:

1. G. R. Trichy, R. O. Scattergood, C. C. Koch and K. L. Murty, Ball Indentation tests for a Zr-based Bulk Metallic Glass , Scripta Mater., 53, 1461 (2005).
2. K. M. Youseff, R. O. Scattergood, K. L. Murty, J. A. Horton and C. C. Koch, Ultrahigh Strength and High Ductility of Bulk Nanocrystalline Copper , App. Phys. Lett., 87 (9) 091904 (2005).
3. K. Rajulapati, R. O. Scattergood, K. L. Murty, G. Duscher and R. O. Scattergood, Effect of Pb on the Mechanical Properties of Nanocrystalline Al , Scripta Mater., 55, 155 (2006).
4. R. K. Guduru, K. A. Darling, R. O. Scattergood, C. C. Koch, K. L. Murty, M. Bakkal and A. J. Shih, Shear Punch Tests for a Bulk Metallic Glass , Intermetallics, 14, 1411 (2006).
5. R. K. Guduru, A. V. Nagasekhar, R. O. Scattergood, C. C. Koch and K. L. Murty, Finite Element Analysis of a Shear Punch Test , Metall. and Mater. Trans., 37A, 1477 (2006).
6. C. C. Koch, R. O. Scattergood and K. L. Murty, The Mechanical Behavior of Multiphase Nanocrystalline Materials , Jour. of Mater., 66 (2007).
7. R. K. Guduru, A. V. Nagasekhar, R. O. Scattergood, C. C. Koch and R. O. Scattergood, Thickness and Clearance Effects in Shear Punch Testing , Adv. Engr. Materials, 9, no. 3, 1 (2007).
8. R. O. Scattergood, C. C. Koch, K. L. Murty and D. Brenner, Strengthening Mechanisms in Nanocrystalline Alloys , Mat. Sci. Engr. A, 493, 3 (2008).
9. Y. Purohit, S. Jang, D. L. Irving, C. W. Padgett, R. O. Scattergood and D. W. Brenner, Atomistic Modeling of the Segregation of Lead Impurities in and Aluminum Bicrystalline Solid , Mat. Sci. Engr. A, 493, 97 (2008).
10. S. Jang, Y. Purohit, D. Irving, C. Padgett, D. Brenner and R. O. Scattergood, Molecular Dynamics Simulations of Deformation in Nanocrystallinbe Al-Pb Alloys , Mat. Sci. Engr. A, 493, 53 (2008).

11. S. Jang, Y. Purohit, D. L. Irving, C. Padgett, D. Brenner and R. O. Scattergood, Influence of Pb Segregation on the Deformation of Nanocrystalline A; Insights from Molecular Simulations , Acta Mater., 56, 4750 (2008).
12. K. A. Darling, R. N. Chan, P. Z. Wong, J. E. Semones, R. O. Scattergood and C. C. Koch, Grain Size Stabilization in FeZr Alloys , Scripta Mater., 59, 530 (2008).
13. K. A. Darling, C. L. Reynolds Jr., D. N. Leonard, G. Duscher, R. O. Scattergood and C. C. Koch, Seld-Assembled Three-Dimensional Cu-Ge Nanoweb Composite , Nanotechnology, 19, 1 (2008).
14. R. K. Guduru, K. L. Murty, K. M. Youssef, R. O. Scattergood and C. C. Koch, Mechanical Behavior of Nanocrystalline Copper , Mat. Sci. and Engr. A, 463, 14 (2007).
15. K. A. Darling, R. K. Guduru, C. L. Lewis Jr., V. M. Bhosle, R. N. Chan, R. O. Scattergood, C. C. Koch, J. Narayan and M. O. Aboelfotoh, Thermal Stability, Mechanical and Electrical Properties of Nanocrystalline Cu3Ge . Intermetallics, 16, 378 (2008).
16. K. V. Rajulapati, R. O. Scattergood, K. L. Murty, Z. Horita, T. G. Langdon and C. C. Koch, Mechanical Properties of Bulk Nanocrystalline Aluminum-Tungsten Alloys , Met. and Mater. Trans. A, Vol. 39A, 2528 (2008).
17. R. K. Guduru, P. Z. Wong, K. A. Darling, C. C. Koch, K. L. Murty and R. O. Scattergood, Determination of Activation Volume in Nanocrystalline Cu Using the Shear Punch Test , Adv. Engr. Matls., v9, issue 10, 855 (2007).
18. C. C. Koch, R. O. Scattergood, K. A. Darling and J. E. Semones, Stabilization of Nanocrystalline Grain Sizes by Solute Additions , J. Mater. Sci., 43, 7264 (2008).

Scientific and professional societies of which you are a member:
American Society for Materials
American Ceramics Society
American Society for Precision Engineering
Sigma Xi

Honors and awards:
Outstanding Teacher Award NCSU
Reynolds Award for Excellence in Research and Teaching NCSU
Fellow of the American Society for Materials
Fellow of the American Ceramics Society
Charter Member American Society for Precision Engineering

Institutional and professional service in the last five years:
Associate Director, Precision Engineering Center, NCSU
Director of Graduate Programs, MSE
Department and College committees, MSE, COE

Professional development activities in the last five years:
ASPE Workshop tutorials - materials for precision engineering

Percentage of time available for research or scholarly activities: 30%

Percentage of time committed to the program: 100%

Curriculum Vitae for Justin Schwartz

Academic Rank: Professor

Degrees (fields, institutions, and date):
Ph.D., Nuclear Engineering, Massachusetts Institute of Technology, January 1990
B.S., Nuclear Engineering, University of Illinois at Urbana, May 1985

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
Original Appointment: August 16, 2009

Related experience (teaching, industrial experience, etc.):
Florida State University:
- 4/05-8/09: Jack E. Crow Professor of Engineering
- 8/99-4/05: Professor of Mechanical Engineering
- 12/93-8/99: Associate Professor of Mechanical Engineering

University of Illinois at Urbana
- 2/90-12/93: Assistant Professor of Nuclear Engineering

Consulting, patents, etc.:
- Muons, Inc., Nove Technologies, Inc., Supercon, Inc., Oxford Superconducting Technology, American Superconductor Corporation
- J. Schwartz, T. Asano, H. Sekine, D.R. Dietderich, K. Inoue and H. Maeda, Wire in tube process for bismuth system superconductors, Patent Agency of Japan #2 272159, 1990
- J. Schwartz, Ch. Wolters, and K.M. Amm, Process for preparing mercury-barium-calcium-copper-oxide-based superconductor materials, U.S. Patent Office, patent # 5,858,926, 1999

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. D.C. van der Laan, et al., Effect of tensile strain on grain connectivity and flux pinning in Bi2Sr2Ca2Cu3Ox tapes, Appl. Phys. Lett. 88, 022511 (2006)
2. X.R. Wang, U.P. Trociewitz and J. Schwartz, Near adiabatic quench experiments on short YBa2Cu3O7−δ coated conductors, J. Appl Phys 101(5) 053904 (2007)
3. A.L. Mbaruku and J. Schwartz, Statistical analysis of electro-mechanical properties of AgMg sheathed Bi2Sr2CaCu2O8+x superconducting tapes using Weibull distributions, J. Appl Phys 101(7) 073913 (2007)
4. Ph. Vanderbemden et al., Behavior of bulk high-temperature superconductors of finite thickness subjected to crossed magnetic fields, Phys Rev B 75 174515 (2007)
5. J. Schwartz and G.A. Merritt, Proof-of-principle experiments for react-wind-sinter manufacturing of Bi2Sr2CaCu2O8+x magnets, Supercond Sci Tech 20 L59 L62 (2007)
6. T. Effio, U.P. Trociewitz, X. Wang and J. Schwartz, Quench induced degradation in Bi2Sr2CaCu2Ox tape conductors at 4.2 K, Supercond Sci Tech 21 045010 (2008)
7. D.C. van der Laan et al., Limits to the critical current in Bi2Sr2Ca2Cu3Ox tape conductors: The parallel path model, Phys Rev B 77 104514 (2008)

8. J. Schwartz et al., High field superconducting solenoids via high temperature superconductors, IEEE Transactions on Applied Superconductivity 18(2) 70 81 (2008)
9. J. Kim et al., Magnetic field effect for cellulose nanofiber alignment, J. Appl Phys 104 (2008)

A. Oliver et al., Mechanical properties of non-functionalized multiwall nanotube reinforced polycarbonate at 77 K, Nanotechnology 19, 505702 (2008)

10. X.T. Liu and J. Schwartz, On the influence of magnetic field processing on the texture, phase assemblage and properties of low aspect ratio Bi2Sr2CaCu2Ox/AgMg wire, Sci Tech Adv Matls 10 014605 (2009)
11. C.G. Carson et al., Synthesis and Structure Characterization of Copper Terephthalate Metal-Organic Frameworks, Eur J Inorg Chem 16 2338 (2009)

Scientific and professional societies of which you are a member:
IEEE (Fellow), ASM

Honors and awards:
Plenary Speaker, 20th International Conference on Magnet Technology, 2007; Special Award for Exceptional Service, FAMU - FSU College of Engineering, 2007; Engineering Research Award, FAMU - FSU College of Engineering, 2005; Engineering Research Award, FAMU - FSU College of Engineering, 2001; Roger W. Boom Award, Cryogenic Society of America, 1998

Institutional and professional service in the last five years:
Leader, FSU Cluster Hire Initiative in Materials Processing, Growth and Characterization
Board of Trustees of the Federation of Materials Societies
Editor-In-Chief, IEEE Transactions on Applied Superconductivity, 2005-present
Applied Superconductivity Conference, Inc., Board of Directors, 1996 – 2008
Intl Advisory Board, 6th Intl Conf of the 5th Forum on New Materials
Review Panel Member, Naval Research Laboratory, Advanced Functional Oxides, 2007
European Conference on Applied Superconductivity, Board of Directors, 2002 - 2008
Review Panel, Director s Review of the Fermilab Superconducting Magnet Program, 2006

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 40%

Percentage of time committed to the program: 100%

Curriculum Vitae for Zlatko Sitar

Academic Rank: Professor

Degrees (fields, institutions, and date):
B.S. Physics (1982), University of Ljubljana, Slovenia.
M.S. Physics (1987), University of Ljubljana, Slovenia.
Ph.D. Materials Science and Engineering (1990), North Carolina State University.

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
1995 Assistant professor 1998 Associate Professor 2002 Professor On this faculty since 1995.

Related experience (teaching, industrial experience, etc.):
2001-present President, HexaTech, Inc.
2001-2006 Director Multidisciplinary University Research Initiative
1992-1995 Visiting Assistant Professor, Swiss Federal Institute of Technology, Z rich, Switzerland.
1990-1991 Research Associate, Materials Research Center, NCSU.
1987-1990 Graduate Research Assistant, Materials Research Center, NCSU.
1982-1987 Research Scientist, Research Institute Jozef Stefan and University of Ljubljana, Slovenia, and Fotona, Slovenia.

Consulting, patents, etc.:
Consulting: HexaTech
4 US patents
3 International patents

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. Mita S , Collazo R, Rice A, Dalmau RF, Sitar Z, Influence of gallium supersaturation on the properties of GaN grown by metalorganic chemical vapor deposition, J. Appl. Phys. 104, 013521 (2008).
2. R. Collazo, S. Mita, A. Rice, R. F. Dalmau and Z. Sitar, "Simultaneous growth of a GaN p/n lateral polarity junction by polar selective doping," Appl. Phys. Lett. 91, 212103 (2007).
3. R. Dalmau, R. Collazo, S. Mita, Z. Sitar, X-ray photoelectron spectroscopy characterization of aluminum nitride surface oxides: Thermal and hydrothermal evolution, J. Electronic Materials 36, 414-419 (2007).
4. Aleksov, R. Collazo, S. Mita, R. Schlesser, Z. Sitar, "Current-voltage characteristics of n/n lateral polarity junctions in GaN," Appl. Phys. Lett. 89, 052117 (2006).
5. D. Zhuang, Z. G. Herro, R. Schlesser, and Z. Sitar, "Seeded growth of AlN single crystals by physical vapor transport," J. Cryst. Growth, 287(2), 372-5 (2006).
6. R. Collazo, S. Mita, A. Aleksov, R. Schlesser and Z. Sitar. "Growth of Ga- and N- polar gallium nitride layers by metalorganic vapor phase epitaxy on sapphire wafers," J. Cryst. Growth 287, 586-590 (2006).

7. Z. G. Herro, D. Zhuang, R. Schlesser, R. Collazo, and Z. Sitar, "Seeded growth of AlN on N- and Al-polar (0001) AlN seeds by physical vapor transport," J. Cryst. Growth 286, 205-8 (2006)

Scientific and professional societies of which you are a member:
MRS, APS, AVS

Honors and awards:
2004 Alcoa Foundation Distinguished Engineering Award
2008 Distinguished Kobe Steel Professor

Institutional and professional service in the last five years:
- Associate editor: Diamond and Related Materials (since 2000), New Diamond and Frontier Carbon Technology (since 1998);
- Proceedings Editor: Diamond and Related Materials (1998-2007);
- Co-chair: Diamond (international meeting on diamond and wide bandgap semiconductors, ~600 attendees), (1998-2007);
- Program committee: Diamond (since 1997); Applied Diamond Conference 2000-2006; New Diamond and Nanocarbons (2006-present);
- Chair, Co-chair: International Workshop on Bulk Nitrides (2000-2005);
- International Scientific Committee: International Workshop on Expert Evaluation and Control of Compound Semiconductor Materials and Technologies (EXMATEC), International Symposium on Growth of III-nitrides (ISGN);
- NSF Review: panel review for CAREER proposals, regular proposal review;
- Journal Review: Journal of Applied Physics, Applied Physics Letters, Diamond and Related Materials, New Diamond and Frontier Carbon Technology, Journal of Vacuum Science and Technology, Physica Status Solidi, Journal of Crystal Growth, Thin Solid Films, Solid State Communications.

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Curriculum Vitae for Richard J. Spontak

Academic Rank: Professor

Degrees (fields, institutions, and date):
Pennsylvania State University, Chemical Engineering, B.S. with honors/high distinction), 1983
University of California at Berkeley, Chemical Engineering, Ph.D., 1988
University of Cambridge, Materials Science & Metallurgy, Post-doctoral study, 1988-89

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
2002 -present Professor of Chemical Eng. and Mater. Sci. & Eng., NCSU
1997 - 2002 Associate Professor of Chemical Eng. and Mater. Sci. & Eng., NCSU
1992 - 1997 Assistant Professor of Materials Science & Engineering, NCSU

Related experience (teaching, industrial experience, etc.):
1989 -1992 Staff Scientist, Corporate Research Division, Procter & Gamble Co., Cincinnati;
1989 Research Fellow, Institutt for Energiteknikk, Kjeller (Norway);
1988 - 1989 Research Associate, University of Cambridge, Cambridge (United Kingdom);
1983 - 1988 Graduate Student Research Assistant, Lawrence Berkeley Laboratory

Consulting, patents, etc.:
5 issued patents (US and foreign); consulted for 17 chemical companies/law firms.

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
Five publications most closely related to the proposed research (out of 200 peer-reviewed and 232 including book chapters, monographs, etc.):
1. Krishnan, A.S., Roskov, K.E., and Spontak, R.J., "Nanostructured Organogels via Molecular Self-Assembly," *Advanced Nanomaterials* (K.E. Geckeler and H. Nishide, eds.), Wiley-VCH, Weinheim, 2010, pp. 791-834.
2. Shankar, R., Ghosh, T.K., and Spontak, R.J., "Electroactive Nanostructured Polymers as Tunable Actuators," *Adv. Mater.*, **19**, 2218 (2007).
3. Abetz, V., Spontak, R.J., and Talmon, Y., "Determination of Bulk and Solution Morphologies by Electron Microscopy," in *Macromolecular Engineering: Precise Synthesis, Materials Properties, Applications* (K. Matyjaszewski, Y. Gnanou and L. Leibler, eds.), Wiley-VCH, Weinheim, 2007, Vol. 3, Chap. 7, pp. 1649-1685.
4. Hamersky, M.W., Smith, S.D., Gozen, A.O., and Spontak, R.J., "Phase Behavior of Triblock Copolymers Varying in Molecular Asymmetry," *Phys. Rev. Lett.*, **95**, 168306 (2005).
5. Merkel, T.C., Freeman, B.D., Spontak, R.J., He, Z., Pinnau, I., Meakin, P., and Hill, A.J., "Ultrapermeable, Reverse-Selective Nanocomposite Membranes," *Science*, **296**, 519 (2002).

Scientific and professional societies of which you are a member:
American Chemical Society; Microscopy Society of America; Materials Research Society; American Physical Society; American Society for Engineering Education

Honors and awards:
American Chemical Society Chemistry of Thermoplastic Elastomers Award (2008)
University of North Carolina Board of Governors' Award for Excellence in Teaching (2008)
Pennsylvania State University Outstanding Scholar Alumnus Award (2007)
International Network for Engineering Education & Research Recognition Award (2006)
American Chemical Society Cooperative Research Award in Polymer Science (2006)
NC State Alumni Distinguished Undergraduate Professorship (2001-2003; permanent title)

Institutional and professional service in the last five years:
Co-organized and co-chaired symposia at (inter)national American Chemical Society, American Physical Society and Microscopy Society of America meetings. Inducted as a Fellow of the American Physical Society. Served as guest editor for the *Materials Research Society Bulletin* and as expert witness in patent litigations involving international manufacturing companies. Developed and coordinated undergraduate multidisciplinary senior design teams and courses in accord with our NSF Action Agenda Program.

Professional development activities in the last five years:
Editor-in-chief, *Open Colloid Science Journal* (2008-); Editorial Advisory Board, *Langmuir* (2008-2010); *Macromolecules* (2002-2005); *Macromol. Chem. Phys*., *Macromol. Rapid Commun*., *Int. J. Polym. Sci.*; Invited instructor, International Center for Materials Research, UC Santa Barbara (2007); *Prospects for European Integration*, Embassy of the Federal Republic of Germany (2006); Guest co-editor, *Materials Research Society Bulletin* (2006); U.S. DOE Energy Challenge National Competition, 1st Place Prize, Kitty Hawk, NC (2003); Director of Graduate Admissions, Department of Chemical Engineering, NC State (1999-2003); Delegate in German Academic Exchange Program in Physics; Recipient of Humboldt and Tewkesbury fellowships; Reviewer for > 50 journals, such as *Science*, *Nature*, *Nature Mater*., *Adv. Mater.*, *Phys. Rev. Lett.*

Percentage of time available for research or scholarly activities: 40%

Percentage of time committed to the program: 25%

Curriculum Vitae for Joseph B. Tracy

Academic Rank: Assistant Professor

Degrees (fields, institutions, and date):
B.S. (2000) Chemistry, University of California, Santa Barbara
PhD. (2005) Physical Chemistry, MIT

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
2007-Present, Assistant Professor, Department of Materials Science and Engineering, NCSU

Related experience (teaching, industrial experience, etc.):
2005-2007, Postdoctoral Research Associate, Department of Chemistry, University of North Carolina, Chapel Hill
2001-2005, Graduate Research Assistant, Department of Chemistry, MIT
2000-2001, Graduate Teaching Assistant, Department of Chemistry, MIT

Consulting, patents, etc.:
Y.T. Chan, J.P. Zimmer, M.G. Bawendi, J.B. Tracy, N. Insin, Microspheres Including Nanoparticles Patent Cooperation Treaty (PCT), Application Number PCT/US2005/025593, filed July 20, 2005.
2007, The Implementation Group, External review of proposals before submission.

States in which professionally licensed or certified: N/A

Principal publications of the last five years:
1. J. Wang, A.C. Johnston-Peck, J.B. Tracy, "Nickel Phosphide Nanoparticles with Hollow, Solid, and Amorphous Structures" Chemistry of Materials, Articles ASAP.
2. A.C. Johnston-Peck, J. Wang, J.B. Tracy, "Synthesis and Structural and Magnetic Characterization of Ni(core)/NiO(shell) Nanoparticles" ACS Nano 2009, 3, 1077-1084.
3. N. Insin, J.B. Tracy, H. Lee, J.P. Zimmer, R.M. Westervelt, M.G. Bawendi, "Incorporation of Iron Oxide Nanoparticles and Quantum Dots into Silica Microspheres" ACS Nano 2008, 2, 197-202.
4. R.P. Carney, G.A. DeVries, C. Dubois, H. Kim, J.Y. Kim, C. Singh, P.K. Ghorai, J.B. Tracy, R.L. Stiles, R.W. Murray, S.C. Glotzer, F. Stellacci, "Size Limitations for the Formation of Ordered Striped Nanoparticles" Journal of the American Chemical Society 2008, 130, 798-799.
5. J.B. Tracy, M.C. Crowe, J.F. Parker, O. Hampe, C.A. Fields-Zinna, A. Dass, R.W. Murray, "Electrospray Ionization Mass Spectrometry of Uniform and Mixed Monolayer Nanoparticles: Au25[S(CH2)2Ph]18 and Au25[S(CH2)2Ph]18-x(SR)x" Journal of the American Chemical Society 2007, 129, 16209-16215.
6. J.B. Tracy, G. Kalyuzhny, M.C. Crowe, R. Balasubramanian, J.P. Choi, R.W. Murray, "Poly(ethylene glycol) Ligands for High-Resolution Nanoparticle Mass Spectrometry" Journal of the American Chemical Society 2007, 129, 6706-6707.

7. J.B. Tracy, M.G. Bawendi, "Defects in CoO in Oxidized Cobalt Nanoparticles Dominate Exchange Biasing and Exhibit Anomalous Magnetic Properties" Physical Review B 2006, 74, 184434.
8. J.B. Tracy, D.N. Weiss, D.P. Dinega, M.G. Bawendi, "Exchange Biasing and Magnetic Properties of Partially and Fully Oxidized Colloidal Cobalt Nanoparticles" Physical Review B 2005, 72, 064404.

Scientific and professional societies of which you are a member:
American Chemical Society, Materials Research Society, Sigma Xi

Honors and awards:
National Defense Science and Engineering Graduate Fellowship, 2001
National Science Foundation Predoctoral Fellowship, offered and declined, 2001
Outstanding Teaching Award for Chemistry TA, MIT, 2001
Katherine Esau Honor Key, Phi Beta Kappa, 2000
Regents Scholarship, UC Santa Barbara, 1996 2000

Institutional and professional service in the last five years:
2007-2008, Department Vision Committee, Member
2007-2009, Department Curriculum Committee, Member
2009-present, Department Undergraduate Program Committee, Member
2008-present, Department Undergraduate Academic Advisor
Manuscript Reviews for: ACS Nano, Analytical Chemistry, Chemistry of Materials, Journal of the American Chemical Society, Journal of Cluster Science, Journal of Nanoparticle Research, Journal of Experimental Nanoscience, Journal of Physical Chemistry C, Langmuir, Materials Research Society Proceedings, Nanoscale, and Physical Review B.
Co-organizer, Symposium: Multifunctional Nanoparticle Systems: Coupled Behavior and Applications, Spring Meeting of the Materials Research Society, San Francisco, CA, April 5-9, 2010.

Professional development activities in the last five years:
2007 NCSU College of Engineering New Faculty Workshop
2008 NSF Regional Grants Conference, University of Rhode Island

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Curriculum Vitae for Yaroslava G. Yingling

Academic Rank: Assistant Professor

Degrees (fields, institutions, and date):
B.S. Computer Science and Engineering, St. Petersburg State Technical University, 1996
Ph.D. Materials Science and Engineering, Pennsylvania State University, 2002

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
2 years of service, 08/2007 - Assistant Professor

Related experience (teaching, industrial experience, etc.):
Cancer Research Training Award Postdoctoral Fellow, National Cancer Institute, National Institutes of Health, MD, 03/2004-07/2007
Postdoctoral Fellow, Pennsylvania State University, University Park, PA, 10/2002-05/2004

Consulting, patents, etc.:
US Patent, Y. G. Yingling et al, RNA Nanoparticles and Nanotubes , , No. 60/810,283, WO/2008/039254.

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Principal publications of the last five years:

1. V. A. Stupina, A. Meskauskas, J. C. Mccormack, Y. G. Yingling, B. A. Shapiro, J. D. Dinman, A. E. Simon, The 3' Proximal Translational Enhancer of Turnip Crinkle Virus Binds to 60S Ribosomal Subunits, RNA 14 (2008) 2379-2393.
2. J. C. McCormack, X. Yuan, Y. G. Yingling, W. Kasprzak, R. E. Zamora, B. A. Shapiro, A. E. Simon, Structural domains within the 3 UTR of Turnip Crincle Virus, Journal of Virology 82 (2008) 8706-8720 .
3. B. A. Shapiro, E. Bindewald, W. Kasprzak, Y. G. Yingling, Protocols for the In silico Design of RNA Nanostructures in Nanostructure Design Methods and Protocols, Methods in Molecular Biology series, Vol. 474, E. Gazit and R. Nussinov, Eds., (Humana Press, 2008).
4. Bindewald, R. Hayes, Y. G. Yingling, W. Kasprzak, B. A. Shapiro, RNAJunction: A Database of RNA Junctions and Kissing Loops for Three-Dimensional Structural Analysis and Nanodesign, Nucleic Acids Research 36 (2008) D392-D397.
5. Y. G. Yingling, B. A. Shapiro, Computational design of an RNA hexagonal nano-ring and an RNA nanotube, Nano Letters 7 (2007) 2328-2334.

A. Shapiro, Y. G. Yingling, W. Kasprzak, E. Bindewald, Bridging the gap in RNA structure prediction, Current Opinion in Structural Biology 17 (2007) 157-165.

6. Y. G. Yingling, B. A. Shapiro, The Impact of Dyskeratosis Congenita Mutations on Structure and Dynamics of the Telomerase RNA Pseudoknot Domain, Journal of Biomolecular Structure and Dynamics 24 (2007), 303-320.

7. Y. G. Yingling, B. A. Shapiro, The Prediction of the Wild-type Telomerase RNA Pseudoknot Structure and the Pivotal Role of a Bulge in its Formation, Journal of Molecular Graphics and Modelling 25 (2006) 261-274.
8. W. A. Hastings, Y. G. Yingling, G. S. Chirikjian, B. A. Shapiro, Structural and Dynamical Classification of RNA Single-Base Bulges for Nanostructure Design, Journal of Computational and Theoretical Nanoscience 3 (2006) 63-77.
9. Y. G. Yingling, B. A. Shapiro, Dynamic Behavior of the Telomerase RNA Hairpin Structure and Its Relationship to Dyskeratosis Congenita, Journal of Molecular Biology 348 (2005) 27-42.
10. Y. G. Yingling, B. J. Garrison, Coarse-Grained Model of Interaction of Light with Polymeric Material: Onset of Ablation, J. Phys. Chem. B 109 (2005) 16482-16489.
11. Y. G. Yingling, B. J. Garrison, Coarse Grained Chemical Reaction Model, Feature Article in J. Phys. Chem. B 108 (2004) 1815-1821.

Scientific and professional societies of which you are a member:
American Chemical Society, Materials Research Society, Biophysical Society

Honors and awards:
National Cancer Institute Spring Research Festival Best Poster Award (2007); NCI Center for Cancer Research Exceptional Stipend Increase Award (2007);NIH Postdoctoral Cancer Research Training Award (2004-2007); Best Ph.D. Thesis Award from the Materials Research Institute, Penn State University (2003); Braucher Fellowship for Graduate Student Research (2002); Gordon Research Conference Travel Award (2002); PSU Graduate Student Travel Award (2002); Miller Graduate Student Research Award (2001)

Institutional and professional service in the last five years:
Reviewer for Applied Physics Letters, Applied Surface Science, Applied Physics, Proteins, Journal of Biomedical Optics, Journal of Physical Chemistry, Journal of the American Chemical Society; Faculty Advisor for MRS NCSU Student Chapter & Women in MS&E Committee member; Proceedings Editor and Organizer of Invited Session Innovation through Simulations and Modeling in Materials Science IMETI 2009, Orlando, FL; Reviewer for: NSF; Panel member: NASA EPSCoR; Materials High School Camp Instructor/ Planning Committee.

Professional development activities in the last five years:
Cancer Research Training Award Postdoctoral Fellow, National Cancer Institute, National Institutes of Health, MD, 03/2004-07/2007

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Curriculum Vitae for Yuntian T. Zhu

Academic Rank: Professor

Degrees (fields, institutions, and date):
1979-1983 B.S. in Metallurgy, Hefei University of Technology, China
1985-1988 M.S. in Materials Science and Engineering, Institute of Metal Research, Chinese Academy of Sciences
1989-1991 M.S. in Materials Science and Engineering, Oregon Graduate Institute of Science and Technology
1991-1994 Ph.D. in Materials Science and Engineering The University of Texas at Austin

Number of years of service on this faculty including date of original appointment and dates of advancements in rank:
August 2007: appointed as Associate Professor
August 2008: promoted to Full Professor

Related experience (teaching, industrial experience, etc.):
1983-1985 Assistant Engineer, Luoyang Bearing Research Institute, Luoyang, China
1994-1997 Director s Postdoctoral Fellow, Los Alamos National Laboratory, Los Alamos, NM
1997-present Technical Staff Member, Los Alamos National Laboratory
2006-present Affiliated Professor, New Mexico State University.
2006-2007 Team Leader, Nanomaterials, MPA-STC, Los Alamos National Laboratory
2007-2009 Associate Professor, North Carolina State University
2009-present Professor, North Carolina State University

Consulting, patents, etc.:
1. Y.T. Zhu, P.N. Arent, Q.W. Li, X.F. Zhang, Arrays of Long Carbon Nanotubes for Fiber Spinning, in review.
2. P.N. Arent, Y.T. Zhu, I.O. Usov, and R.F. Depaula, Preparation of Array of Long Carbon Nanotubes and Fibers Therefrom, in review.
3. P.N. Arent, Y.T. Zhu, X.F. Zhang, I.O. Usov, Increasing the specific strengths of CNT fibers, Docket # S-109,186.
4. Y.T. Zhu, P.N. Arendt, X.F. Zhang, Q.W. Li, L. Fu, and L.X. Zheng, Spinning Carbon Nanotube Fiber from Wetted Ribbon, in review, Docket No. S-109,040.
5. Y.T. Zhu and C. Sheehan, A Method for High-Speed Fabrication of Aligned Carbon Nanotube Composites, NCSU invention disclosure No. 09-015, in review.

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Principal publications of the last five years: 85 total. Top 36 listed here.
1. X.L. Wu, J. Narayan, Y.T. Zhu, Deformation Twin formed by Self-Thickening, Cross-Slip Mechanism in Nanocrystalline Ni, Appl. Phys. Lett. 93, 031910 (2008).
2. Y.H. Zhao, T. Topping, J.F. Bingert, A.M. Dangelewicz, Y. Li, Y.T. Zhu, Y.Z. Zhou, and E.J. Lavernia, High Tensile Ductility and Strength in Bulk Nanostructured Nickel, Advanced Mater. 20, 3028-3033 (2008).

3. H.S. Peng, D.Y. Chen, J.Y. Huang, S.B. Chikkannanavar, J. H nisch, D.E. Peterson, S.K. Doorn, Y.F. Lu, Y.T. Zhu, and Q.X. Jia, Strong and Ductile Colossal Carbon Tubes with Wall of Rectangular Macropores, Phys. Rev. Lett. 101, 145501 (2008).
4. H.S. Peng, M. Jain, D.E. Peterson, Y.T. Zhu, and Q.X. Jia, Composite Carbon Nanotube/Silica Fibers with Improved Mechanical and Electrical Properties, Small. 4, 1964-1967 (2008).
5. Y.B. Wang, J.C. Ho, X.Z. Liao, H.Q. Li, S.P. Ringer, and Y.T. Zhu, Mechanism of grain growth during severe plastic deformation of a nanocrystalline Ni-Fe alloy, Appl. Phys. Lett. 94, 011908 (2009).
6. Y.B. Wang, J.C. Ho, Y. Cao, X.Z. Liao, H.Q. Li, Y.H. Zhao, E.J. Lavernia, S.P. Ringer, and Y.T. Zhu, Dislocation Density Evolution during High-Pressure Torsion of a Nanocrystalline Ni-Fe Alloy, Appl. Phys. Lett. 94, 091911 (2009).
7. Y.T. Zhu, J. Narayan, J.P. Hirth, S. Mahajan, X.L. Wu and X.Z. Liao, Formation Mechanisms of Single and Multiple Deformation Twins in FCC Materials, Acta Mater. 57, 3763-3770 (2009).
8. Y.T. Zhu, X.L. Wu, X.Z. Liao, J. Narayan, S. N. Mathaudhu, and L. J. Kecsk s, Twinning Partial Multiplication at Grain Boundary in Nanocrystalline fcc Metals, Appl. Phys. Lett. 95, 031909 (2009).
9. H.Q. Li, A. Misra, Z. Horita, C.C. Koch, N.A. Mara, P.O. Dickerson, Y.T. Zhu, Strong and Ductile Nanostuctured Cu-Carbon Composite, Appl. Phys. Lett. 95, 071907 (2009).

Scientific and professional societies of which you are a member:
Tau Beta Pi (Engineering Honor Society); The Minerals, Metals & Materials Society (TMS); The Materials Research Society; ASM International

Honors and awards:
Keynote Presentation, Plasticity 2009, Virgin Island, US, Jan. 3-8, 2009.
Keynote Presentation, Austrian Network on High Performance Bulk Nanocrystalline Materials, Planneralm, Austria, March 4-6, 2009.
Keynote Presentation, BNM-2009, Ufa, Russia, Sept. 22-26, 2009.
Keynote Presentation, The Second Nanotechnology International Forum, Moscow, Russia, Oct. 6-8, 2009.

Institutional and professional service in the last five years:
Invited Guest Editor on a special issue for the Journal of Materials Science on Nanomaterials Science, 2006.
Editorial Board, Journal of Materials Science, 2006-present.
Editorial Board, Materials Science and Engineering A, 2006-present.
Advisory Board, Advanced Engineering Materials, 2006-present
Editorial Board, The Open Applied Physics Journal, 2007-present.

Professional development activities in the last five years: n/a

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

APPENDIX C

Major Instructional and Laboratory Equipment

Purpose	Location	Equipment	Manufacturer and model	Date purchased
Sample preparation	EB1 3053	Fatigue pre-crack machine	Fatigue Dynamics LFE-500	1998
Sample preparation	EB1 3053	Rolling mills (2)	Vigor RM-1000	
Sample preparation	EB1 3049	Spin Coater	Laurell WS-400B	2008
Sample preparation	EB1 3049	Sputtering Deposition System	NCSU Maria-7	2008
Sample preparation	EB1 3049	Carver Press	Carver 3851-0	2008
Sample preparation	EB1 3049	Analytical Balance	Sartorius LA230S	2005
Sample preparation	EB1 3059	Isostatic Press 60,000 psi	Autoclave Engineers	
Metallography	EB1 3057	Cutoff saw	Leco	2010
Metallography	EB1 3057	Belt sander		2010
Metallography	EB1 3057	Mounting press (2)	Leco PR-10	
Metallography	EB1 3057	Variable speed polishing stations (17)	Leco, Buehler Various	
Metallography	EB1 3057	Manual grinding stations	Leco, Buehler	
Metallography	EB1 3057	Surface Grinder		
Heat treating	EB1 3049	Elevator Furnace	Protherm ELV140-8	2008
Heat treating	EB1 3049	Tube Furnace	Protherm PTF 12/75/600	2008
Heat treating	EB1 3049	High temperature furnace	Protherm PLF 150/5	2008
Heat treating	EB1 3059	Fluidized Baths (3)	Tecam SBS-4	
Heat treating	EB1 3059	Heat Treat furnaces (3)	Thermolyne F-1636-1	
Heat treating	EB1 3059	Muffle Furnaces (2)	Thermolyne Type 48000	
Structure characterization	EB1 1031	Reflected and transmitted light microscope with image software, image acquisition and dedicated computer	Olymus BH-2	
Structure characterization	EB1 3049	UV/Vis Spectrometer		2008
Structure characterization	EB1 3051	Fourier transform infrared spectrometer	Varian 640-IR	2008
Structure characterization	EB1 3055	3 Inverted microscopes with image software, image acquisition and dedicated computer	Zeiss Axiovert 40-MAT	2006

Purpose	Location	Equipment	Manufacturer and model	Date purchased
Structure characterization	EB1 3055	Binocular microscope with image software, image acquisition and dedicated computer	Zeiss Stemi 2000-C	2006
Structure characterization	MRC AIF	SEM w/ elemental analysis	Hitachi	
Structure characterization	MRC AIF	AFM		
Structure characterization	EB1 1048	TEM	JEOL	1997
Structure characterization	EB1 1038	X-Ray	Rigaku	
Property measurement	EB1 3051	Contact Angle Goniometer		2010
Property measurement	EB1 3049	Hall measurement system		2010
Property measurement	EB1 3049	4-point probe		2010
Property measurement	EB1 3051	Ferroelectrics tester		2010
Property measurement	EB1 3051	Kiethley Meters (4)	Kiethley	2009
Property measurement	EB1 3053	4 RSL tensile Testers w/control software and dedicated computer	Fracture Diagnostics RSL 25000T	1998
Property measurement	EB1 3053	RSL Bending frame w/control software and dedicated computer	Fracture Diagnostics RSL 1000B	1998
Property measurement	EB1 3053	ATS tensile tester w/control software and dedicated computer	ATS 1105C	
Property measurement	EB1 3053	Impact tester	Satec SI-1D	2007
Property measurement	EB1 3055	Micro hardness tester	Mitutoyo	2010
Property measurement	EB1 3053	Rockwell superficial hardness tester	Wilson 9JS	
Property measurement	EB1 3053	Rockwell hardness tester (2)	Wilson 3JR, 3PR	
Property measurement	EB1 3053	Instron mechanical testing system	Instron	2010
Property measurement	EB1 3049	Dilatometer	Orton 2010 STD	2009
Property measurement	EB1 3051	DTA/TGA/DSC	Exstar TG/DTA/DSC 6200 series module	2010

APPENDIX D

Institutional Summary

Appendix D is contained in a separate document provided by the College of Engineering.