7. MATERIALS SCIENCE AND ENGINEERING

Program Outcomes and Assessment

7.1 Program Outcomes and Relationship ABET & TMS Outcomes

Indicated in parentheses are the ABET outcomes and The Minerals, Metals & Materials Society (TMS) program outcomes that are covered by the MS&E program outcomes.

Outcomes of the MS&E undergraduate program:

1 - an ability to apply knowledge of mathematics, the sciences and engineering principles to problems in materials science and engineering (ABET:a) (TMS:a)

2 - an ability to understand and apply fundamental scientific and engineering principles to engineering problems in the context of the interrelationships between structure, properties, processing, and performance of all classes of materials and materials systems (ABET:a) (TMS:b)

3 - an ability to design, conduct, analyse, and interpret results of laboratory experiments that involve the behavior of materials in engineering applications, including the use of statistical and computational methods (ABET:b ABET:c) (TMS:d)

4 - familiarity and experience with modern techniques, instrumentation and other tools require for experimental and engineering design, data collection, and data analysis in the practice of materials science and engineering (ABET:k, ABET:b) (TMS:d)

5 - an ability to work in and provide leadership for diverse teams in the solution of engineering problems (ABET:d)

6 - an ability to identify, formulate and solve engineering problems which involve application and selection of materials (ABET:e) (TMS:c)

7 - an understanding of professional and ethical responsibilities and their implications (ABET:f)

8 - an ability to communicate effectively through written reports and oral presentations, including preparation of professional-quality visual aids (ABET:g)

9 - the broad education necessary to understand the impact of materials engineering problems and solutions in a global/societal context (ABET:h)

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

11 - a knowledge of contemporary issues in the context of engineering problems in materials science and engineering (ABET:j)

These are clearly consistent with the ABET a through k outcomes set out in EC2000 criteria 3.

7.2 Relationship of Program Outcomes to Program Objectives

For reference, the program objectives are:

1. To provide students with a strong educational foundation in materials science and engineering, with emphasis on the fundamental scientific and engineering principles which underlie the application of knowledge of structure, properties, processing and performance of all classes of materials to engineered systems.

2. To teach students all levels of design which relate to materials (electronic, atomistic, molecular, microstructural, mesoscopic, macroscopic), as well as the design of engineering processes and systems.

3. To prepare students for a broad range of career opportunities by providing ample flexibility within the program of study for educational experimentation.

4. To provide students with opportunities to work in teams, solve open-ended problems, develop skills for critical thinking, and communicate effectively with others orally, in writing, and by listening.

5. To provide students with an awareness and understanding of professional, ethical, and legal responsibilities as an integral part of an engineering education

The following chart maps each program outcome onto the appropriate program objective.

Table: Relationship of Program Outcomes to Program Educational Objectives

		Program Outcomes										
Program Educational **Objectives**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
	1	■	■	■	■		■					
	2	▒	▒	■	■	▒	■	▒	▒	▒	▒	■
	3	▒	▒	▒	▒		▒		■	■	■	▒
	4			▒	▒	■	▒	▒	■	▒		
	5			▒	▒	▒		■	▒	▒	▒	■

■ = strongly related ▒ = moderately related □ = unrelated

7.3 Assessment process to ensure that students will achieve outcomes upon graduation

The undergraduate program consists of the curriculum and the learning environment that is in place to achieve the program outcomes. The courses in the curriculum collectively satisfy most of the program outcomes (with the exception of lifelong learning which is taught via our professional society activities). The relationship to each course and the program outcomes is shown in the following chart.

Courses											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
MSE 220 Intro. Matls/Manufac.	■	■		■		■			■		▒
MSE 242 Physics of Materials	■	■		■		■					▒
MSE 250 Principles of MS&E	■	■		■		■			■		▒
MSE 350 MS&E Fundamentals	■	■		■		■					▒
MSE 364 Materials Lab I	■	■	■	■	■	■	▒	■			▒
MSE 368 Materials Lab II	■	■	■	■	■	■	▒	■			▒
MSE 402 Electronic Materials.	■	■		■		■					▒
MSE 410 Biomedical Materials	■	■		■		■					▒
MSE 413 Polymers	■	■		■		■					▒
MSE 414 Polymer Processing	■	■		■		■					▒
MSE 420 Mechanical Properties	■	■		■		■					▒
MSE 430 Thermodynamics	■	■		■		■					▒
MSE 435 Transport	■	■		■		■					▒
MSE 442 Ceramics	■	■		■		■					▒
MSE 470 Physical Metallurgy.	■	■		■		■					▒
MSE 482 Capstone Design	■	■	■	■	■	■	▒	■	■		▒
MSE 488 Processing Design	■	■	■	■	■	■	▒	■	■		▒

■ = strongly related ▒ = moderately related □ = unrelated

Assessment tools

A wide variety of assessment tools are used to qualitatively measure the achievement of the program objectives. These include surveys, competency checklists, capstone design reports and video taped presentations, instructor reports, and cognizant faculty reports. Each assessment tool is described below:

Surveys:

Student surveys at the end of each course:

At the end of each course, students are asked to evaluate several aspects of their experience in that class. The department has included several questions on this anonymous survey that relate directly to the program outcomes relevant to that course. This measure permits us to directly assess the student's view of their own achievements of the outcomes.

Senior surveys

A college wide survey of graduating seniors has been collected for the past three terms. This will be a continuing practice. Included in the survey are a variety of questions intended to assess the quality and satisfaction level of our graduating students. Amongst the questions are several designed for assessment of ABET and program outcomes. We have had some problem convincing the graduating seniors to fill out the forms to date. Next term we plan to make the completion of the senior survey a part of the senior audit that the program advisor performs. This measure permits the direct assessment of the graduating senior's view of their outcome achievements.

Alumni surveys

A college wide survey of alumni has been instituted this year and will be a continuing practice. Included in the survey are a variety of questions intended to assess the quality and satisfaction level of our alumni. Amongst the questions are several designed for assessment of ABET and program outcomes. This measure permits the direct assessment of our alumni's view of their outcome achievements.

Competency Checklists:

The undergraduate committee has agreed to present the faculty with a plan to institute competency checklists for a few key courses in our curriculum (the laboratory and design courses). This will be voted on by the faculty early next

term and should be in place by the end of the term. The competency checklist will be a form that the primary instructor of each course will fill out for each student. On it will be a list of the program outcomes related to the course with three options to check. The three options will be; Exemplary achievement, achievement, and insufficient achievement. Each student will be asked to fill out the same form for comparison with the instructor's form. This will NOT be anonymous. These checklists will not be used for a grade. They are intended only as a direct measure of the instructor's opinion of the student's achievement of the particular outcomes associated with the course.

Design project presentations and reports:

The capstone design course represents the final stage of the preparation of our students as engineers. The final report and the presentations include aspects of a majority of the program outcomes. These reports and videotapes of the presentations represent a direct measure of the achievement of these program outcomes. We intend to keep copies of these reports and presentations for use in the summer, during our undergraduate committee's yearly review process. Copies of the design reports and presentations will be available for ABET to review.

Instructor reports:

At the end of each term, the primary instructor is asked to fill out a form on our web-site which asks about the course just completed. This report serves as a post-mortem intended to document those things that went well with the course and those that did not. Included in these reports are questions directly relating to those program outcomes that were associated with the course. These reports represent a direct measure instructor's view of the effectiveness of the course, as a whole, in achieving the program outcomes.

Cognizant faculty reports:

Once the instructor of a course completes the instructor report, they are asked to convene a meeting with the cognizant faculty member committee for that course. Each cognizant faculty member will review the report and discuss it during that meeting. Changes to the course, based on the meeting, will be recommended in a report that the committee will submit to the undergraduate committee. This is intended to be an indirect measure of the effectiveness of the course in achieving the program outcomes.

7.4 Improving the Program with the Results from the Assessment Process

The undergraduate committee reviews the data from the assessments described above once per year (during the summer). If action is warranted, a plan is drafted to improve

the deficiency in the program and forwarded to the faculty for discussion and final approval.

7.5 Demonstration That Graduates Have:

The list below outlines the specific questions that are asked of the students, faculty, and alumni to assess each outcome. The most direct measure of these outcomes will be the competency checklist that the faculty member fills out in each course. The minimal standards for the achievement of any single outcome will be defined by the instructor of the course based on a 60% passing score on the objective based assessment tools used in the class (particular exam questions, a score for writing alone, a score for teamworking ability, etc.). The competency checklist will not be used for giving the student a final grade in the course, nor will it be used to hold a student back from graduation. We intend to use it solely as a diagnostic for improving the program when less than 70% are not achieving a particular outcome in any class.

The student course evaluation questions are reported by asking the student to respond to the statements below by giving one of the following answers:

5 = strongly agree
4 = agree
3 = neutral
2 = disagree
1 = strongly disagree

The results of these surveys are not amenable to simply averaging the scores since they relate closely to the individual courses. These will be available for review during the site visit. Some general observations are worthy of note however. We have conducted these evaluations for two terms to date. Except for two courses where the class was rated poorly in almost every category, every ABET outcome related question received a score higher than 3. One of the most interesting results of the assessment is that even those outcomes that scored poorly in one course was scored highly in at least two other courses. Hence, even if a particular course does not score well, the program outcomes can still be achieved. The undergraduate committee is working to fix the problems with the two courses mentioned above.

The Alumni surveys ask the individual to respond to the following in the table reproduced below: