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1. Program Educational Objectives
Program Educational Objectives

The School of Engineering prepares graduates who will:

1. Be successful as practicing professionals in diverse career paths or in graduate school.
2. Distinguish themselves in breadth of perspective and the ability to solve complex problems.
3. Be effective communicators and team members, with many assuming leadership roles.
4. Be active in their profession and participate in continuing education opportunities to foster personal and organizational growth.
5. Demonstrate a concern for justice, ethical behavior, and societal improvement through participation in professional and civic organizations.

Approved by ACES, November 20, 2009
Reviewed by Faculty, December 4, 2009
Adopted by Faculty, January 15, 2010
Approved by UPEAC, April 23, 2010

Reviewed/Revised Spring 2011
2. School-wide Student Outcomes
School-wide Student Outcomes

Items 1-11(a-k) are the eleven student outcomes listed in the ABET Criteria for Accrediting Engineering Programs, Criterion 3 (a-k). Item number 12 (outcome l) is based on the unique characteristic of our programs in the context of University of Portland.

   a. an ability to apply knowledge of mathematics, science, and engineering;
   b. an ability to design and conduct experiments, as well as to analyze and interpret data;
   c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
   d. an ability to function on 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, economic, environmental, and societal context;
   i. a recognition of the need for, and an ability to engage in life-long learning;
   j. a knowledge of contemporary issues;
   k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice; and
   l. an ability to develop a sense of personal, social, and moral responsibility.

Approved by ACES March 1999
Approved by SEPAC April 1999
Approved by faculty May 1999

Reviewed/Revised Spring 2011
3. Mapping Program Educational Objectives to Student Outcomes
Mapping Program Educational Objectives to Student Outcomes

<table>
<thead>
<tr>
<th>Student Outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) an ability to apply knowledge of mathematics, science, and engineering</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) an ability to design and conduct experiments, as well as to analyze and interpret data</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>d) an ability to function on multi-disciplinary teams</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) an ability to identify, formulate, and solve engineering problems</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) an understanding of professional and ethical responsibility</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>g) an ability to communicate effectively</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>i) a recognition of the need for, and an ability to engage in life-long learning</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>j) a knowledge of contemporary issues</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l) an ability to develop a sense of personal, social, and moral responsibility</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Program Educational Objectives

The School of Engineering prepares graduates who will:

1. Be successful as practicing professionals in diverse career paths or in graduate school.
2. Distinguish themselves in breadth of perspective and the ability to solve complex problems.
3. Be effective communicators and team members, with many assuming leadership roles.
4. Be active in their profession and participate in continuing education opportunities to foster personal and organizational growth.
5. Demonstrate a concern for justice, ethical behavior, and societal improvement through participation in professional and civic organizations.
4. School-wide Assessment Methods
School-wide Assessment Methods

(Approved by Faculty May 6, 2004, Reviewed/Revised Spring 2011)

I. School-wide Assessment Methods for Student Outcomes

A. Direct Assessment Methods

A.1. Course embedded (course-based) assessments. These include projects, assignments, reflective essays, or exam questions that directly link to student outcomes and are scored using established criteria.

A.2. Exams. Locally developed comprehensive exams or nationally standardized exams (FE Exam or Major Field Test).

A.3 Capstone or senior level projects provide evidence of how well students integrate and apply principles, concepts, abilities into a culminating project. They are evaluated by faculty and/or external review teams. This is an effective assessment tool when the student work is evaluated in a standard manner that focuses on student achievement of the outcomes.

B. Indirect Assessment Methods

B.1. Graduating senior exit surveys.

B.2. Alumni surveys.

II. School-wide Assessment Methods for Program Educational Objectives

A. Alumni surveys.

B. Advisory council surveys.

C. Results of assessment of student outcomes from each program (attainment of student outcomes indicates that graduates are prepared to achieve the PEOs).
5. Student Outcomes and Assessment Methods
### Student Outcomes and Assessment Methods

**Common for CE, EE, ME programs**

<table>
<thead>
<tr>
<th>Student Outcomes</th>
<th>Benchmark Course(s)</th>
<th>Senior Design Course</th>
<th>FE or Comp. Exam</th>
<th>Senior Exit Surveys</th>
<th>Alumni Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. An ability to apply knowledge of mathematics, science, and engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. An ability to design and conduct experiments, as well as to analyze and interpret data</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</td>
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<td></td>
<td></td>
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<tr>
<td>d. An ability to function on multi-disciplinary teams</td>
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</tr>
<tr>
<td>e. An ability to identify, formulate, and solve engineering problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. An understanding of professional and ethical responsibility</td>
<td>EGR 110</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>g. An ability to communicate effectively</td>
<td></td>
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</tr>
<tr>
<td>h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context</td>
<td></td>
<td></td>
<td>EGR 351</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. A recognition of the need for, and an ability to engage in life-long learning</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>j. A knowledge of contemporary issues</td>
<td>EGR 351</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>l. An ability to develop a sense of personal, social, and moral responsibility</td>
<td>The University Core Curriculum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Graduating Senior Exit Survey
1. The ABET accreditation guidelines require that we identify outcomes that our graduates should have. We would like to know how well the program prepared you to:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Excellent</th>
<th>Good</th>
<th>Acceptable</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply knowledge of mathematics, science, and engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design and conduct experiments, as well as to analyze and interpret data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design a system, component, or process to meet desired needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function on multi-disciplinary teams</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify, formulate, and solve engineering problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understand professional and ethical responsibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicate effectively</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understand the impact of engineering solutions in a global and societal context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognize the need for, and an ability to engage in life-long learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have knowledge of contemporary issues</td>
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<td></td>
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<tr>
<td>Use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop a sense of personal, social, and moral responsibility</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

2. Briefly comment on the strengths and weaknesses of your education at the University of Portland.

3. Any other comments.

Thank you for filling out this survey.

Program:
- Civil Engineering
- Electrical Engineering
- Engineering Management
- Mechanical Engineering

Name: _____________________________ (Optional)

Reviewed/Revised by ACES Spring 2011
7. Alumni Survey
1. Please evaluate the quality of your education at the University of Portland School of Engineering with respect to the following program educational objectives.

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Acceptable</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Be successful as practicing professionals in diverse career paths or in graduate school.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Distinguish themselves in breadth of perspective and the ability to solve complex problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Be effective communicators and team members, with many assuming leadership roles.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Be active in their profession and participate in continuing education opportunities to foster personal and organizational growth.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Demonstrate a concern with issues of justice and ethical behavior by improving society through professional and civic activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Please rate the appropriateness of the following program educational objectives for the University of Portland School of Engineering.

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Acceptable</th>
<th>Poor</th>
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</thead>
<tbody>
<tr>
<td>1. Be successful as practicing professionals in diverse career paths or in graduate school.</td>
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<tr>
<td>5. Demonstrate a concern with issues of justice and ethical behavior by improving society through professional and civic activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Comments.

Thank you for filling out this survey.

Program:
☐ Civil Engineering        ☐ Engineering Management
☐ Mechanical Engineering   ☐ Electrical Engineering

Name: ___________________________ Year of Graduation: ___________________________

(Optional)

Reviewed/Revised by ACES Spring 2011
8. Employer/Advisory Council Survey
1. Please evaluate the quality of education of UP graduates with respect to the following School of Engineering program educational objectives.

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Acceptable</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Be successful as practicing professionals in diverse career paths or in graduate school.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Distinguish themselves in breadth of perspective and the ability to solve complex problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Be effective communicators and team members, with many assuming leadership roles.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Be active in their profession and participate in continuing education opportunities to foster personal and organizational growth.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Demonstrate a concern with issues of justice and ethical behavior by improving society through professional and civic activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Please rate the appropriateness of the following program educational objectives for the School of Engineering.

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Acceptable</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Be successful as practicing professionals in diverse career paths or in graduate school.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. Distinguish themselves in breadth of perspective and the ability to solve complex problems.</td>
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<td>3. Be effective communicators and team members, with many assuming leadership roles.</td>
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<tr>
<td>4. Be active in their profession and participate in continuing education opportunities to foster personal and organizational growth.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Demonstrate a concern with issues of justice and ethical behavior by improving society through professional and civic activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Comments.

Thank you for filling out this survey.

Reviewed/Revised by ACES Spring 2011
9. Course Embedded Assessment
University of Portland
Donald P. Shiley School of Engineering
Course Embedded Assessment

This document presents a recommended process for course embedded assessment for the School of Engineering programs. This process was first adopted by the school faculty in March 2006. The process was reviewed and revised in the Spring 2011. The following pages present the principles that will guide this assessment process, guidelines for selecting courses and assessing student work, and the role that this process will assume in improving courses and curricula.

The Shiley School of Engineering faculty has agreed that course embedded assessment will be used as a direct assessment method for measuring the degree to which student outcomes have been achieved. The faculty also has agreed that each program will use other direct and indirect methods for assessing student outcomes, and each program will develop a table showing its student outcomes and the courses that will be used to assess them.

Course embedded assessment, as described in this document, is one of the instruments that will be used for measuring the degree to which students attain the student outcomes that have been adopted by the four accredited degree programs.

I. Purpose and Structure of Course Embedded Assessment

As a school, we are committed to using course embedded assessment in all of our programs as a direct assessment method. Course embedded assessment has two primary roles:

- To use student work to assess the achievement of each student outcome and the degree to which each outcome is achieved, and
- To provide data for developing and improving the programs.

The course embedded assessment process will also provide a means of documenting the assessment results and the course and program changes that follow from these results. Not all courses will be involved in course embedded assessment. The choice of courses will be guided by the following principles:

- Each student outcome will be assessed with student work in a course(s), termed “benchmark course(s).”
- Only required (not elective) courses in the program curriculum will be selected as benchmark courses.
- Although a benchmark course will likely address multiple student outcomes, typically one or two of its outcomes will be designated for course embedded assessment.

Course embedded assessment will be administered with the following in mind:
• Assessment of student work will resolve the degree to which student outcomes are being achieved and will provide useful information for making program improvements.

• Within a benchmark course, it is not necessary to use all student work to assess an outcome that has been designated for the course. Some student work will be more appropriate than others for assessing a particular outcome.

• Outcome assessment instruments will be designed so that they are focused and easy to administer and evaluate.

• Outcomes assessment will be based upon student work and will be guided by the grading of that work.

II. Course Embedded Assessment Process

The following procedure will be used for benchmark courses, which are selected for course embedded assessment:

• The program faculty articulates the performance criteria associated with the outcomes. (See Section III and Attachment B.)

• The program faculty identifies the courses that will be used as benchmark courses for addressing each of the twelve outcomes. For each outcome, required course(s) will be identified as benchmark. An example table indicating benchmark courses and other assessment methods is shown in Attachment A.

• Prior to teaching a benchmark course; the instructor identifies the specific instruments (i.e. student work, such as homework assignments, classroom assignments, exams) that will be used to measure achievement of the designated outcome. The instructor also determines the manner in which student work will be used to measure the achievement.

• The instructor applies the performance criteria to the student work. The instructor will review the student work and decide the degree to which the work demonstrates achievement of the designated outcome.

• By the end of the academic year, the instructor documents the results of the assessment of each designated outcome that was assigned to the benchmark course: whether students met the faculty’s expectations for the outcome, whether the course will be modified to improve the program, and whether program faculty action is recommended to improve the curriculum. This documentation is discussed in Section V and a format for documenting the results is shown in Attachment C.

• At the end of the academic year, the program faculty will consider the assessments of all benchmark courses. In combination with other assessment instruments and evaluation measures, the faculty will determine the degree to which student outcomes are being achieved and whether program changes are required. (See the Annual Outcomes Assessment Matrix in Attachment D.)

• As additional input, faculty will consider student course evaluations as to whether course learning objectives have been met. Faculty members will remind the students of course learning objectives while conducting course evaluations.
III. Performance Criteria for Assessing Student Outcomes

Depending on the student outcome being assessed, a variety of performance criteria can be used to assess students’ work. Some examples are given in Attachment B. Under each student outcome, the attachment lists some possible performance criteria. Different performance criteria will likely apply to different programs. Program chairs in conjunction with their faculty are expected to articulate the performance criteria for their programs.

IV. Methods for Course Embedded Assessment

In designing methods for course embedded assessment, final course grades by themselves cannot be used for assessing student outcomes. Grades are usually assigned on the basis of a course’s learning objectives; hence they are not direct measures of student outcomes. Although student outcomes are related to course learning objectives, they are not equivalent. In some cases, grades can be used to directly measure the achievement of a student outcome, provided that the grading scheme directly reflects the degree of achievement of that outcome. In other cases, student work can be used both for grading and for outcomes assessment, but different criteria might be applied for the two purposes. In yet other cases, assessment can be based on aspects of student performance that are not graded.

The following are examples of methods for analyzing student work and assessing the achievement of designated outcomes in a benchmark course.

- Outcome X has been designated for the benchmark course ZE 352. The instructor determines that the following student work will be used for assessing the outcome: homework assignments 5 and 7; the third problem of homework assignment 8; and the fourth question of the final exam. The instructor has also determined that grading of this work is closely aligned with the performance criteria for outcome X. The instructor uses the assigned grades on those problems/questions as a measure of the degree to which outcome X is achieved.

- Same as above, except that grading of homework assignments 5 and 7 primarily addresses only two of the departmental criteria for outcome X. Work in another benchmark course for outcome X addresses the remaining criteria. The instructor uses the assigned grades as a partial measure of the degree to which outcome X is achieved.

- Outcome Y has been designated for benchmark course ZE 372, a laboratory course. The instructor determines that laboratory report number 3 will be used for assessing the outcome. The report grade, however, is based on multiple learning objectives and only partly on outcome Y. After grading report number 3, the instructor selects a representative sample of the students’ reports and analyzes them with respect to the departmental criteria to determine the degree to which outcome Y is achieved.

- Outcome B has been designated for benchmark course ZE 373, another laboratory course. Outcome B is “an ability to design and conduct experiments, as well as to analyze and interpret data.” The departmental criteria address all four of the requirements in this outcome. In regard to “conducting experiments,” the instructor uses laboratory session 7 to determine the degree to which students are able to achieve this requirement. The instructor observes the laboratory sessions and analyzes the students’ ability to conduct the experiment, even though this aspect of the laboratory session is not graded.
Outcome S has been designated for benchmark course ZE 452. Outcome S is “a recognition of the need for, and an ability to engage in life-long learning.” One of the departmental criteria for this outcome is “to engage in self-study to acquire learning beyond that attained in their curriculum.” The instructor assigns individual projects for students, each requiring information that has not been discussed in class. Students are told that they must find the information on their own and cite references when they hand in the project. During grading, the instructor analyzes the projects and citations to determine the extent to which the relevant information was incorporated.

V. Instructor Documentation of Course Embedded Assessment

At the end of a benchmark course, the instructor will assess the student work. The format for documenting the results will be as follows. (An example is shown in Attachment C.)

- A list of outcomes addressed by the course. Designated outcome(s) for which the course is used as a benchmark are highlighted in bold letters.

- A list of the course learning objectives. Those objectives that are directly related to the designated outcome(s) are highlighted.

- An analysis of student work using the performance criteria for the designated student outcome. Although Attachment C is an example, other formats may be appropriate. This involves the following steps:
  - Identify the student work, such as homework, tests, or class assignments that will be used to measure achievement of a particular outcome.
  - Describe the methods that have been used to analyze student work and determine the degree to which the outcome has been achieved. Where appropriate, “grade descriptors” and relative weights of types of student work are to be provided.
  - Apply the analysis to student work and determine the degree to which the designated outcome is achieved. A mapping of course learning objectives to designated outcome(s) is to be provided.
  - Summarize student comments from course evaluations as they pertain to meeting course learning objectives.

- Make suggestions for changes/improvements for the course and/or the program. The faculty member will also discuss the effect of changes from previous annual assessments.

In their end-of-the-academic-year meeting, the program faculty will consider the assessment by the individual faculty member, discuss it, and make recommendations for action, when appropriate.

VI. Program Documentation of Assessment Results

At the end of the academic year, the faculty of each program will meet to assess the degree to which student outcomes have been achieved. The course embedded assessment of benchmark courses will be considered, along with other assessment processes. (See Attachment A.) The program will document this assessment as detailed in the school’s document “Annual Documentation of Program Improvements.”
## Attachment A

**Student Outcomes and Assessment Methods**

**Program:** ______________________

<table>
<thead>
<tr>
<th>Student Outcomes</th>
<th>Benchmark Course(s)</th>
<th>Senior Design Course</th>
<th>Comp. Exam</th>
<th>Senior Exit Surveys</th>
<th>Alumni Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. An ability to apply knowledge of mathematics, science, and engineering</td>
<td></td>
<td></td>
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<td>b. An ability to design and conduct experiments, as well as to analyze and interpret data</td>
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<td>c. An ability to design a system, component, or process to meet desired needs</td>
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<td>d. An ability to function on multi-disciplinary teams</td>
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<td>e. An ability to identify, formulate, and solve engineering problems</td>
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<td>f. An understanding of professional and ethical responsibility</td>
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<td>g. An ability to communicate effectively</td>
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<td>h. The broad education necessary to understand the impact of engineering solutions in a global and societal context</td>
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<td>i. A recognition of the need for, and an ability to engage in life-long learning</td>
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<td>j. A knowledge of contemporary issues</td>
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<td>k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
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<td>l. An ability to develop a sense of personal, social, and moral responsibility</td>
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Attachment B
Examples of Performance Criteria for
Student Outcomes

Student outcome a: An ability to apply knowledge of mathematics, science, and engineering

Students demonstrate that they can:

- Formulate and solve mathematical models describing the behavior and performance of physical, chemical, and biological processes and systems.
- Use basic scientific and engineering principles to analyze the performance of processes and systems.
- Derive an engineering formula from mathematical, scientific, or engineering science principles.
- Determine the appropriate formula for a particular engineering problem.
- Manipulate formulas to find an appropriate answer.
- Solve engineering science problems.
- Apply engineering science concepts to a problem.

Student outcome b: An ability to design and conduct experiments, as well as to analyze and interpret data

Students demonstrate that they can:

- Conduct a laboratory procedure with minimal supervision.
- Design an experiment (i.e., set up experiment, determine the proper models to use, consider the variables and constraints, and consider ethical issues).
- Analyze laboratory data to determine specified quantities.
- Interpret the results for correctness and precision or apply results to a pre-assigned problem.

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

Students demonstrate that they can:

- Identify an engineering problem.
- Apply established design criteria for an engineering system, component, or process within realistic constraints.
- Use appropriate design methods for an engineering system, component, or process.
- Evaluate alternative solutions to select an appropriate solution.

Student outcome d: An ability to function on multi-disciplinary teams

Students demonstrate that they can:

- Collaborate on an assigned task.
- Understand the four dimensions of team work: collaboration, communication, conflict management,
and self-management.

- Organize the delivery of products for an assigned task.
- Collaborate in applying the design process.

**Student outcome e: An ability to identify, formulate, and solve engineering problems**

Students demonstrate that they can:

- Identify a problem by defining the problem expectations.
- Identify a problem by collecting information about the problem and determining which information is important and which information is not.
- Formulate a problem by selecting the appropriate formula and making appropriate assumptions that apply to the problem.
- Formulate a problem by sketching or other graphics, when appropriate.
- Solve a problem by applying appropriate formulas (or principles) and assumptions and by giving appropriate units when applicable.
- Solve a problem by verifying the reasonableness of the result.
- Understand that problem solving process is never complete.

**Student outcome f: An understanding of professional and ethical responsibility**

Students demonstrate that they can:

- Understand their respective professional society’s code of conduct.
- Understand the variety of ethical theories (i.e., virtue ethics, right ethics, duty ethics, and utilitarian ethics).
- Make informed ethical choices.
- Evaluate the ethical dimensions of professional practice.

**Student outcome g: An ability to communicate effectively**

Students demonstrate that they can:

- Organize a written work.
- Provide in writing the purpose of the work and suitable background information related to the work.
- Clearly present results, conclusions, and recommendations related to the work.
- Write clearly and concisely.
- Organize an oral presentation.
- Effectively use visual aids in an oral presentation.
- Deliver an oral presentation clearly and with minimal distractions.

**Student outcome h: The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context**

28
Students demonstrate that they can:

- Understand environmental, political, economical, aesthetics, and social impacts of engineering work.
- Interpret solutions in both societal (a particular community, state or a country), and global (more than one community, nation, or country) contexts.

**Student outcome i: A recognition of the need for, and an ability to engage in life-long learning**

Students demonstrate that they can:

- Articulate the need for continued education and participation in professional activities.
- Recognize problems that require learning beyond that attained in their curriculum.
- Engage in self-study to acquire learning beyond that attained in their curriculum.
- Research a topic and prepare an informed presentation.

**Student outcome j: A knowledge of contemporary issues**

Students demonstrate that they can:

- Understand application of recent hardware and software in their discipline.
- Understand impact of a global engineering environment on their discipline.
- Understand and have in-depth knowledge of non-technical contemporary issues such as socio-economic, political, and environmental.

**Student outcome k: An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice**

Students demonstrate that they can:

- Use specific computer software and simulation packages such as MATLAB, Excel, or PowerPoint.
- Demonstrate the ability to use modern equipment in their discipline.
- Use technical library resources and literature search tools.

**Student outcome l: An ability to develop a sense of personal, social, and moral responsibility**

The University’s core curriculum offers courses to help students:

- Develop the knowledge, skills, and commitments for acting ethically in everyday life.
- Examine faith, its place in one’s own life, and in the lives of others.
- Critically examine the ideas and traditions of western civilization.
- Value the importance of learning and reflection throughout one’s life.
- Learn to live and contribute in a diverse society and an interdependent world.
Attachment C
Sample Course Assessment Summary
Mechanical Engineering

Course Number and Title: ME 312 Mechanics of Fluids II (2 credit hours)
Semester and Year: Spring, 2005
Instructor’s Name: Dr. V. Dakshina Murty

Student Outcomes

<table>
<thead>
<tr>
<th>Student Outcomes</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>i</th>
<th>j</th>
<th>k</th>
<th>l</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 312</td>
<td>x</td>
<td>x</td>
<td>X*</td>
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</tbody>
</table>

Note: The x(s) indicate student outcome(s) addressed by this particular course.
* X (s) (in bold) indicate the outcome(s) for which this course is a benchmark.

Student Outcome a:
Students use their mathematical background to solve pipe flow problems, evaluate drag forces due to friction and pressure on various objects, solve and model compressible flow and CFD equations.

Student Outcome c:
Students apply their theoretical flow analysis techniques to design piping flow problems; also, they design, build, and test a small hydraulic turbine from components supplied.

Student Outcome e:
A substantial part of the course is applied type covering topics in pipe flows, drag, flow measurement, and turbo machinery. Several of the problems in the assignment and tests involve identifying, formulating, and solving engineering problems.

Purpose:
ME 312, Mechanics of Fluids II, is the second course in the thermal sciences stem in the area of fluid mechanics. It is typically taken by the students in the junior year spring semester. Most students would have already been exposed to a semester of elementary courses in fluid mechanics, thermodynamics, and mechanics.

Course Learning Objectives:

By the completion of this course students will be:
- Able to analyze pipe flow problems (outcome e).
- Able to calculate drag on objects (outcome e).
- Able to analyze simple turbo machinery and compressible flow problems (outcome e).
- Familiar with some CFD techniques.

Assessment of Outcome e

1) Tools:
Mid-term examinations 30 pts
Final examination 30 pts
Assignments 15 pts
Project 15 pts

Grading Scale:
A Excellent Understanding and Performance
B Good Understanding and Performance
C Adequate Understanding and Performance
D Poor Understanding and Performance
F Inadequate Understanding and Performance

2) Mapping of Course Learning Objectives to Benchmark Outcome
(Student Outcome e)

Three of the four course learning objectives for this course map into Student Outcome e. All the problems in the mid-term examinations, a majority of the problems on the assignments, and the project enhance the ability of students to identify, formulate, and solve engineering problems.

3) Analysis

From an analysis of the examinations, assignments, class work and project it can be concluded that students are conversant with the importance of making (and stating) engineering assumptions, drawing free body diagrams, using appropriate formulas, giving the answer in correct units, discarding irrelevant/redundant pieces of information. The average grade point on this course was 2.66 on a scale of 4. Students who have successfully completed this course have, in general, met this outcome.

4) Student Evaluation Comments

- Not enough time on applications like turbo machinery
- It would have been nice if there was a lab on minor losses
- Too many derivations

5) Suggested Changes/Improvements for the Course or Program

None.
Attachment D
Annual Outcomes Assessment Matrix

In May of each academic year, the faculty of each ABET accredited program in the Shiley School of Engineering will meet to assess the student outcomes. Using multiple assessment methods for each outcome, they will determine if the outcomes have been achieved, identify actions to be taken as a result of assessment to improve the program, and plan an implementation schedule. This assessment will serve as a comparative reference for the next annual outcomes assessment.

Student Outcome: Ability to identify, formulate, and solve engineering problems

<table>
<thead>
<tr>
<th>Assessment Method</th>
<th>Who Conducted</th>
<th>Action Taken by Program Faculty</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE xyz</td>
<td>Dr. Who 2</td>
<td>The faculty believes there are already too many credit hours required. No new courses will be added.</td>
<td>Dr. Who 2 will look into revising course contents.</td>
</tr>
<tr>
<td>Comprehensive Examination</td>
<td>Drs. Who 3 and Who 4</td>
<td>Agree with Drs. Who 3 and Who 4 recommendation.</td>
<td>No action. Students did extremely well on the topics related to this outcome.</td>
</tr>
<tr>
<td>Senior Exit Survey</td>
<td>Dr. Who 5</td>
<td>Accept recommendation.</td>
<td>No action.</td>
</tr>
</tbody>
</table>

Summary: Describe how the results from the assessment of the above outcome will be used to modify your program (e.g. curriculum changes, offering new courses, changing course sequencing and/or course content, removing courses from curriculum, adding/removing design or engineering science contents, modifying laboratory course content, giving more exposure to students in professional practice, etc.). Describe in detail how this action is likely to improve your program.
10. Annual Documentation of Program Improvements
Annual Documentation of Program Improvements

It is expected that all ABET accredited programs have an assessment process in place, all student outcomes are assessed, and the results are used to further develop and improve the programs. Therefore, it is essential that we review our programs for improvement every year and document the changes made. Documenting the changes made to a particular program (CE, CS, EE, or ME program) will help us better prepare for the next ABET visit scheduled for the fall 2015.

Changes that should be documented include:

- Offering new courses,
- Changing course sequencing,
- Changing course contents,
- Removing courses,
- Modifying design or engineering science contents,
- Adding/dropping laboratory experiments,
- Exposing students to professional practice,
- Etc.

We also need to explain how these changes improve our programs.

In addition to changes based on assessment and evaluation of student outcomes and program educational objectives, there may be other changes identified by program faculty that will result in improvement of their program. The documentation needed for changes based on assessment of student outcomes, as well as documentation for improvements based on other assessment and evaluation measures, is described below.

A. Documentation in Support of Student Outcomes and Assessment (Criterion 3 of ABET)

1. A table similar to the “Student Outcomes and School-wide Assessment Methods” should be used to address the following:
   - Which multiple assessment methods were used to assess each of the student outcomes?

2. A table similar to the “Annual Student Outcomes Assessment Matrix” should be used to address the following:
   - How and when assessment methods were used to assess a particular student outcome?
   - Describe the process used by the program faculty to analyze the results and make recommendations for actions.
   - Summarize the actions taken as a consequence of assessment of student outcome(s).
   - Describe how the program improved, or will improve, as a consequence of the actions taken.
• Provide a schedule of future dates for implementation of each assessment method, the individuals responsible, and outcomes to be assessed, etc.

B. Documentation of Changes Due to Other Assessment and Evaluation Measures

The faculty of each program may identify other improvements above and beyond those resulting from the annual assessment of their student outcomes as required by criterion 3 of ABET.

These improvements could be a result of:

• Alumni surveys,
• Input from industry through program advisory councils,
• Curriculum reviews,
• Individual faculty recommendations,
• Etc.

For each improvement:

• Describe each change,
• Describe how it was decided,
• Describe how it will improve the program,
• State who is responsible for its implementation,
• State when it will be implemented,
• Provide a future schedule to assess the impact of this change.
11. A Sample Outline for Program Annual Reports
A Sample Outline for Program Annual Reports

I. Introduction

II. Assessment Methods for Student Outcomes and Program Educational Objectives

   II.1 Direct Assessment Methods

      II.1.A Course Embedded Assessment

      II.1.B Senior Design as an Assessment Tool

      II.1.C Comprehensive Examination (or FE or Major Field Test)

   II.2 Indirect Assessment Methods

      II.2.A Graduating Senior Exit Surveys

      II.2.B Alumni Surveys

      II.2.C Advisory Council Surveys

III. Results of Assessment and Evaluation

   III. A Course Embedded Assessment

   III. B Senior Design as an Assessment Tool

   III. C Comprehensive Examination

   III. D Graduating Senior Exit Surveys

   III. E Alumni Surveys (if conducted)

   III. F Advisory Council Surveys (if conducted)

IV. Analysis of Past Changes

V. Program Faculty Actions and Changes to be Implemented
VI. Assessment Schedule for the Next Academic Year

VII. References
I. Introduction

In May of each academic year, the faculty of the (CE, CS, EE, ME) program in the Shiley School of Engineering prepares an annual report describing the program improvements the faculty plan to implement for the next academic year. The improvements/changes documented are a result of implementing direct and indirect assessment methods. The direct assessment methods used are:

- Course embedded assessment,
- Senior design, and
- Comprehensive examination (or FE or Major Field Test).

The indirect assessment tools used include:

- Graduating senior exit surveys,
- Alumni surveys (if conducted), and
- Advisory council surveys (if conducted).

This report describes the results of the assessment and evaluation of student outcomes and program objectives and how the results will be used to improve the program. Examples of program improvements include curriculum changes, offering new courses, changing course sequencing, changing course contents, removing courses from the curriculum, adding/removing design or engineering science contents, adding/dropping laboratory experiments, and exposing students to professional practice. The report also describes how these actions will improve the program.

There is no school mandated format for this report. However, the report must clearly address the following:

- For each of the twelve (12) student outcomes (especially the 11 ABET-mandated outcomes), the report must identify assessment methods which were used to collect data for each outcome. A table entitled, “Student Outcomes and Assessment Methods” can be used for this purpose.

- For each assessment method, it should be clear how the data collected measures the respective student outcome.

- To determine if an outcome is achieved, the performance standards/criteria used to make such a conclusion should be clearly stated. What level of achievement of student outcome triggers a decision to make changes/improvements?

- A summary of the changes/improvements to be made as a result of assessment and evaluation of student outcomes and program objectives is provided along with an implementation schedule.

II. Assessment Methods for Student Outcomes and Program Educational Objectives

In the last academic year, the faculty utilized a number of assessment methods to gather data for each outcome. The table on the next page provides a list of student outcomes and the corresponding assessment methods used to gather data for assessment and evaluation. In the sub-sections below, each assessment tool is described along with how the data from a particular assessment method is used to
evaluate student outcomes and program educational objectives, and arrive at decisions that will improve the program.
### Student Outcomes and Assessment Methods

<table>
<thead>
<tr>
<th>Student Outcomes</th>
<th>Benchmark Course(s)</th>
<th>Senior Design</th>
<th>Comp. Exam</th>
<th>Senior Exit Surveys</th>
<th>Alumni Surveys*</th>
<th>Advisory Council Surveys*</th>
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<tbody>
<tr>
<td>a. An ability to apply knowledge of mathematics, science, and engineering</td>
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<td>b. An ability to design and conduct experiments, as well as to analyze and</td>
<td>EGR 360</td>
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<td>interpret data</td>
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<td>f. An understanding of professional and ethical responsibility</td>
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<td>g. An ability to communicate effectively</td>
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<td>h. The broad education necessary to understand the impact of engineering</td>
<td>EGR 351</td>
<td></td>
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<td>solutions in a global, economic, environmental, and societal context</td>
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<td>i. A recognition of the need for, and an ability to engage in life-long</td>
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<td>j. A knowledge of contemporary issues</td>
<td>EGR 351</td>
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<td>l. An ability to develop a sense of personal, social, and moral responsibility</td>
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<td>Curriculum</td>
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* If this method was used.

#### II.1 Direct Assessment Methods

Direct assessment methods provide evidence of student learning. These methods require students to demonstrate their knowledge and skills, and provide data that directly measure achievement of expected outcomes.

#### II.1.A Course Embedded Assessment

The School of Engineering uses a common course embedded assessment process adopted by the school faculty [1]. A brief description of the process is outlined below.
Each student outcome is assessed annually with student work in courses termed “benchmark courses.”

Required courses, preferably upper division, in the program curriculum are selected as benchmark courses.

A benchmark course is used to assess one or two student outcomes, termed the “designated outcomes” for that course.

The faculty member teaching a benchmark course identifies those course learning objectives that are directly related to the designated outcome to be assessed.

The faculty member identifies the student work, such as homework, test problems, or class assignments that will be used to measure achievement of a particular outcome. The faculty member also describes the performance standard/criteria used to make a conclusion about the outcome. Typically a class (or a sample of students) average of 60 to 70 % (C− to C+) on the work directly related to the outcome is considered acceptable and indicates that the particular outcome is achieved. Otherwise, the faculty member makes recommendations for improvements.

Even when the students’ work indicates that the outcome is achieved, the faculty member may suggest changes that would further improve the effectiveness of the course and the program.

II.1.B Senior Design as an Assessment Tool

Capstone or senior design courses address most of the student outcomes. The program faculty review and discuss student performance in the senior design courses and decide on the changes, if any, to be made to improve the program.

II.1.C Comprehensive Examination (or FE or Major Field Test)

The comprehensive examination addresses a number of student outcomes as indicated in the Student Outcomes and Assessment Methods table. The faculty set the acceptable performance standards before administering the examination. The program faculty review and discuss student performance on the comprehensive examination and decide on the changes, if any, to be made to improve the program.

II.2 Indirect Assessment Methods

Indirect assessment methods, such as surveys and interviews, provide reflective data about learning. These methods are likely to suffer from validity and reliability problems as individuals’ perceptions of their actual performances may be difficult to candidly or accurately assess and report. A mix of direct and indirect methods ensures that the results are reliable and we can use the information gathered to further develop and improve our program. The following indirect assessment methods are used to gather data, analyze the data, and use the results to further improve our program.

II.2.A Graduating Senior Exit Surveys [2, 3]

A survey form is used to gather graduating seniors’ perspective on the education they received during their college journey. They are asked to rate how well the program prepared them with
respect to each of the student outcomes. The choices for answers are in the range of poor to excellent. If the responses are at or above acceptable, the faculty considers that the student outcomes are achieved. Otherwise they use the data, along with data from other assessment tools, to make decisions about the future of the program. Students are also asked to comment on the strengths and weaknesses of the program. This data is also analyzed by the faculty to see if changes are in order.

II.2.B Alumni Surveys [2, 3]
Alumni surveys are primarily used to determine how well the program meets its objectives as communicated to the program constituencies through the University Bulletin (catalog). Alumni surveys are used only as a secondary tool to assess the student outcomes and how well they are achieved. These surveys are administered to recent graduates (one to six years after graduation) and are conducted every two to four years. The results are used to further improve and develop the program.

II.2.C Advisory Council Surveys [2, 3]
These surveys are used to obtain industry and the professional engineering communities’ perspectives on our programs. The information gathered is primarily used to determine how well the program meets its objectives. A secondary use is made to determine the achievement of student outcomes. The surveys are conducted every few years. The data collected and analyzed from these surveys are used, along with other assessment and evaluation data, to further develop and improve the program.

III. Results of Assessment and Evaluation
A number of assessment tools are used to collect data on student outcomes and program educational objectives as described before. In sections III.A to III.F, a summary of the results for each assessment method is presented. For each assessment method, the following will be documented:

- The data collected and how the data demonstrates the degree to which an outcome is achieved.
- The action(s) to be considered as a result of evaluating the assessment data.
- Etc.

III.A Course Embedded Assessment

III.B Senior Design as an Assessment Tool

III.C Comprehensive Examination

III.D Graduating Senior Exit Surveys

III.E Alumni Surveys (if conducted)

III.F Advisory Council Surveys (if conducted)
IV. **Analysis of Past Changes**  
Any findings due to implementation of past decisions are summarized here.

V. **Program Faculty Actions and Changes to be Implemented**  
This is an important section of the report. Describe the process used by the faculty to review the assessment data, analyze the results of multiple assessment methods, and summarize the changes that will be made to the program to further develop and improve the program.

VI. **Assessment Schedule for the Next Academic Year**  
Prepare description of the assessment methods you will use next academic year to gather data for the assessment and evaluation of your student outcomes and program educational objectives.

VII. **References**


