Electrical Engineering
2010–2011 Assessment Report

Department of Electrical Engineering and Renewable Energy

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1 Introduction

1.1 Program Goals and Design

In 2007, the Oregon Institute of Technology (OIT) began offering its new Bachelors of Science in Electrical Engineering (BSEE) at its main campus in Klamath Falls, Oregon. The BSEE degree was created to prepare graduates for careers in various fields associated with electrical engineering. These included, but were not limited to, electronic, communication, power, microcontrollers, and control systems as stated in OIT's 2007–08 catalogue. The BSEE program was a transition from the BSEET that was discontinued in 2007 at the Klamath Falls campus to better serve the needs of industry in the state of Oregon.

We anticipate BSEE graduates will enter electrical engineering careers as analog systems engineers, digital systems engineers, embedded hardware systems engineers, power engineers, semiconductor processing engineers, signal processing and controls engineers, energy-system integration engineers, test engineers, and applications engineers. Graduates of the program will be able to pursue a wide range of career opportunities, not only within the emerging fields of electrical engineering, but within more traditional areas of electrical engineering as well.

1.2 Program History

In 2007, the Oregon Institute of Technology (OIT) began offering its new Bachelors of Science in Electrical Engineering program (BSEE) at its main campus in Klamath Falls, Oregon. The BSEE degree is a traditional EE degree that is being offered to replace the BSEET program in KF, and it was created to prepare graduates for careers in various fields associated with electrical engineering. These included, but were not limited to, analog ICs and systems, digital and microcontroller systems, signal processing, communication systems and control systems as stated in OIT's 2007–2008 catalogue. The first graduating class was June 2010 and had a class size of five. The graduating class of 2011 is expected to be ten students.

1.3 Industry Relationships

The BSEE program has strong relationships with industry, particularly through its program-level Industry Advisory Council (IAC) and EE/EET alumni. These relationships with our constituents allow the BSEE program to meet another institutional mission objective, "5. Develop and maintain partnerships with public and private institutions, business and industry, and government agencies to ensure quality programs that meet the needs of students and the organizations that employ them."

The IAC has been a mainstay in the development of the EE program from its early EET roots. The IAC provides advice and counsel to the EE program with respect to the areas of curriculum content advisement, instructional resources review, career guidance and placement activities, program accreditation reviews, and professional development advisement and assistance. In addition, each advisory committee member serves as a vehicle for public relations information and potentially provides a point of contact for the development of specific opportunities with industries for students and faculty.

1.4 Program Locations

The EE program is currently offered only at the KF campus with a degree completion program in EET at the Portland campus. This arrangement satisfies the needs of the state by placing a traditional EE program in the southern end of the state to serve that region as well as providing a small school EE program to students who desire a small student to faculty ratio and smaller class sizes. The EE program also supports the shift at the institution from four-year technology degrees to the four-year engineering degree. The addition of EE completes the ETM College with CE, EE, ME, and REE Programs in KF.

1.5 Enrollment

Enrollment in the EE program at the Klamath Falls campus has been steady since the inception of the program. Fall Week 4 2010–11 headcount enrollment was 48 students at the Klamath Falls campus. The total program enrollment is given below in Table 1. This data is a total headcount taken at week 4 of the Fall term.

Table 1: Enrollment growth for the Klamath Falls BSEE location, Fall 2007 to Fall 2010

EE DATA: (Week 4, Fall Term)

KF	2003/06	2007*	2008	2009	2010	2011
Full-Time		33				
Part-Time		3				
Headcount		36	38	53	48	52

*2007 includes a class of EET converts *and* EE freshmen.

1.6 Graduates

Graduation rates have been climbing; 15 BSEE students have graduated as of Spring 2011. The first graduating class of 2010 had five students. The BSEE program will have a graduating class at the end of every spring term. Graduate employment status is summarized in the Table 2 for June graduates of 2010 and 2011.

Table 2: BSEE Program Graduates

ID Number	Date of Graduation	Employment Status
1	SP 2010	Graduate School, University of Oregon – Materials Science
2	SP 2010	Graduate School, University of Oregon – Materials Science
3	SP 2010	Graduate School, Florida Atlantic – Ocean Engineering
4	SP 2010	Jeld Wen – Quality-Control Engineer
5	SP 2010	Unknown
6	SP 2011	Graduate School, University of Idaho – Computer Science
7	SP 2011	Graduate School, Colorado School of Mines – Power Engineer
8	SP 2011	Schweitzer Engineering – Analog Engineer
9	SP 2011	Novellus Engineering. – IC-Fab Quality Control
10	SP 2011	Novellus Engineering – IC-Fab Quality Control
11	SP 2011	Novellus Engineering – IC-Fab Quality Control
12	SP 2011	Biotronix – Test Engineer
13	SP 2011	Air Guard, Electronics Communications Engineer
14	SP 2011	Unknown
15	SP 2011	Unknown

2 Program Mission, Educational Objectives and Outcomes

2.1 Program Mission

The mission of the BSEE program is to provide a comprehensive program of instruction that will enable graduates to obtain the knowledge and skills necessary for immediate employment and continued advancement in the field of electrical engineering. The program will be a leader in providing career-ready candidates for electrical engineering fields. Faculty and students will engage in applied research in emerging technologies and provide professional services to their communities.

2.2 Program Educational Objectives

In support of this mission, BSEE graduates will:

1. Excel as engineering professionals in the various fields and disciplines in electrical engineering.

2. Continue to apply principles of mathematics, science, and engineering to solving electrical engineering problems in new and emerging disciplines in the high tech industry.

3. Continue to be known for a commitment to professional development, lifelong learning and social and ethical responsibilities throughout their engineering careers.

4. Excel in areas related to critical thinking, problem-solving, and effective communication as applied to Electrical Engineering career assignments.

2.3 Relationship Between Program Objectives and Institutional Objectives

These program objectives map strongly to two of the six objectives in OIT's institutional mission statement, particularly the central objectives "1. Provide degree programs that enable graduates to obtain the knowledge and skills necessary for immediate employment," and "2. Enable students to be effective communicators, responsible citizens, and lifelong learners by assisting them in the development of critical thinking and problem solving skills, and ethical and cultural awareness."

2.4 Program Outcomes

Graduates of our Bachelor of Science in Electrical Engineering program must 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 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) an ability to engage in independent learning and recognize the need for continual professional development

(j) a knowledge of contemporary issues

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

(l) knowledge of differential and integral calculus and advanced mathematics including differential equations, linear algebra, vector calculus, complex variables, series and sequences, Laplace Transforms, Fourier Transforms, and probability and statistics with appropriate applications.

(m) in addition to mathematics, knowledge of basic sciences, computer science, and engineering sciences necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components, as appropriate to program objectives.

3 Cycle of Assessment for Program Outcomes

3.1 Introduction and Methodology

Table 3 shows the minimum outcomes assessed during each academic year. Assessment of the program outcomes will be conducted over a three-year cycle, following the pattern starting in the 2010–11 academic year. (During the 2009–10 academic year, all outcomes were assessed in order to establish a baseline.) In addition to program assessment, faculty members participate in assessment of Institutional Student Learning Outcomes (ISLOs).

3.2 Assessment Cycle (Program Student Learning Outcomes PSLO)

Table 3 lists the three-year cycle for assessing the PSLOs for the BSEE program. The assessment will be done over a three-year cycle starting in academic year 2007–2008.

Note: In the academic year 2010–2011, the program assessment focused on more than the normal outcomes in preparation for the upcoming ABET EE Program evaluation in Fall 2012.

Table 3: BSEE Outcome-Assessment Cycle

		2007–08	2008–09	2009–10	2010–2011	2011–2012	2012–13
(a)	Fundamentals		**X**		**X**	**X**	
(b)	Experimentation	**X**		**X**	**X**		**X**
(c)	Design within constraints		**X**			**X**	
(d)	Teamwork	**X**	**X**	**X**	**X**		**X**
(e)	Problem-solving	**X**			**X**		
(f)	Ethics			**X**	**X**		**X**
(g)	Communication	**X**			**X**		
(h)	Impacts of engineering			**X**			**X**
(i)	Life-long learning				**X**		
(j)	Contemporary issues			**X**	**X**		**X**
(k)	Engineering tools	**X**			**X**		
(l)	Advanced mathematics		**X**			**X**	
(m)	Basic, computer, and engineering sciences		**X**			**X**	

3.3 Summary of Assessment Activities and Evidence of Student Learning

3.3.1 Introduction

The BSEE faculty have conducted formal assessments since the 2007–08 academic year using direct measures, such as exams, lab projects, and research-paper assignments. Additionally, the program outcomes were assessed using indirect measures, namely results from student evaluations based on methodology developed by the IDEA Center[1] and data from Senior Exit Surveys.

1 The IDEA Center, www.theideacenter.org

3.3.2 Background of Assessment of Program Educational Objectives

Because BSEE graduates have not been in the field for longer than three years, the faculty has not yet conducted assessment of the Program Educational Objectives (PEOs). The BSEE faculty designed the PEOs using broader statements describing career and professional accomplishments that the graduates can expect to achieve.

Assessment of the program objectives will be conducted over a two-year cycle, beginning in the 2012–13 academic year, as shown in Table 4. In 2012–13, all four PEOs will be assessed in order to establish a baseline. Future appendices of the annual EE program assessment report will include detailed alumni and employer's surveys designed to assess these PEOs.

Table 4: BSEE Program Educational Objectives Assessment Cycle

OBJECTIVES	2012–2013	2013–2014	2014–2015	2015–2016
EO1	X	X		X
EO2	X	X		X
EO3	X		X	
E04	X		X	

3.3.3 Methodology for Assessment of Program Outcomes

The BSEE conducts direct and indirect assessments. The direct assessment process using assignments specifically designed to measure ABET-style outcomes. The indirect assessment process derives assessment data from course evaluations and student surveys.

Direct Measure: ABET Assignments

This direct assessment process links specific tasks within engineering course assignments to EE program outcomes and then on to program educational objectives in a systematic way based on EE Program Outcome rubrics and a mapping of PSLOs to the Program Educational Objectives (EO). The program outcomes are evaluated as part of the course curriculum primarily by means of comprehensive assignments some are standard assignments while others are specifically designed to measure program-level outcomes in addition to course-level outcomes. These assignments typically involve a project or lab requiring the student to apply math, science, and engineering principles learned in the course to solve a particular problem requiring the use of modern CAD tools and engineering equipment, working in teams, and writing a project report or giving an oral presentation.

Evaluations of these outcomes are then gathered and accounted in outcome-specific tables, analyzed and then individually summarized. Summaries for all outcomes are then compiled into a comprehensive program outcome summary for each course. The outcome summary is then evaluated for relevance with respect to the program objectives. The summary of outcomes is formatted and organized such that it is suitable for inclusion in an ABET review document.

The mapping process aims to systemize the assessment of engineering coursework, and to provide a mechanism that facilitates the design of engineering assignments that meet the ABET-general (a)–(k) outcomes, particularly those that are more distant from traditional engineering coursework. Rather than considering how the outcomes match the assignment, the assignment is designed to map to the program outcomes.

Indirect Measure: KSU IDEA Evaluations

At OIT, course evaluations are conducted using the course evaluation form developed by the IDEA Center[2], an organization originating from Kansas State University. From collected student evaluation forms, an IDEA Center diagnostic report is generated and returned to the instructor.

Methodology for this indirect assessment is detailed in Criteria 3 of the 2009–10 BSEE ABET Self-Study. The faculty are considering implementing this indirect assessment in 2012–13.

Indirect Measure: Senior Exit Survey (Under Development)

A senior exit survey is being developed for this indirect measure when the program has more graduates (2011–12).

3.3.4 2010–11 Targeted Assessment Activities

The sections below describe the 2010–11 targeted assessment activities and detail the performance of students for each of the assessed outcomes. Unless otherwise noted, the tables report the percentage of students performing at a developing level, accomplished level, and exemplary level for each performance criteria, as well as the percentage of students performing at an accomplished level or above.

The minimum acceptable performance level for all outcomes was to have 80% or above of the students performing at the accomplished or exemplary level for all performance criteria. The summary data presented in this section represent cumulative averages for multiple course-specific evaluation criteria, not percentages of students. The percentages of students meeting course-specific criteria may be found in course notebooks.

Currently the faculty use performance criteria rubrics on class and lab assignments as direct measures. This is a new program with the second class of graduates expected in 2010–11. The following is a set of tables for the outcomes being assessed for the 2010–11 collection year, outcomes (a), (d), (e), (f), (g), (i), (j), and (k). An additional assessment assignment was prepared for outcome (h) as part of the continuous improvement recommended during the 2009–10 assessment cycle. The assessment timeline for this year and next has been accelerated to prepare for the initial site visit in 2012–13. Each table is a summary of the various course assignments used to assess the outcomes using the performance criteria rubric for the outcome. The percentage of students performing at a level of 2 or higher (levels 1, 2 or 3) is given for each assignment.

[2] The IDEA Center, www.theideacenter.org

Targeted Assessment of Outcome (a)

An ability to apply knowledge of mathematics, science and engineering

Performance Criteria:

A1	Apply Mathematical Knowledge
A2	Apply Scientific Knowledge
A3	Apply Engineering Knowledge

Assessment (a) 1: REE 451 – Geothermal Energy and GSHP, Fall 2010 (Zipay)

This outcome was assessed using two final-exam questions. The class had a mix of EE and REE students. The students were required to demonstrate mastery of applying basic principles of science (fluids) and engineering (heat transfer) to solve for the flash point in a specified geothermal reservoir. The only EE student was somewhat weaker in the science behind fluid flow.

The table below summarizes the results of this targeted assessment. The results indicate that the performance level higher than 80% was met on one performance criterion for this program outcome but not on the other, nonetheless demonstrating that the majority of the students in the evaluated class have the ability to apply math and science to solve engineering problems. The shortcoming (small sample size) was that the REE students had a better understanding of fluid flow than the single EE student (who had had no class in fluid dynamics).

Table 5: Targeted Assessment for Outcome (a)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(a) An ability to apply knowledge of mathematics, science and engineering				
A1: Apply mathematical knowledge				100%
A2: Apply scientific knowledge				67%

STRENGTHS: The students showed a strong ability to apply basic math to solving complex reservoir-design problems such as establishing a flash point in the geothermal well given a set of parameters.

WEAKNESSES: The student without the background in fluid dynamics did not understand the science behind fluid flow in the well.

RECOMMENDATIONS: None for this outcome except be sure students have some background in fluids which can be accomplished by enforcing the prerequisite of MECH 318.

<u>Assessment (a) 2: REE 412 – Photovoltaic Systems, Winter 2011 (Zipay)</u>

This outcome was assessed using two final-exam questions regarding solar parameters (science) and site analysis (engineering and math). The students performed very well on all criteria. It should be noted that this is new material, and coverage did not rely on prerequisites.

Seven students were assessed (two were EE majors) in Winter 2010 in the course using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria. The summary data presented below represents cumulative averages for multiple course-specific criteria, not percentages of students. Percentages of students meeting course-specific criteria may be found in the course notebook.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Students generally met or exceeded expectations, although several groups formed weak conclusions on the site analysis. The test responses clearly demonstrated the students' ability to apply math, science, and engineering.

Table 6: Targeted Assessment for Outcome (a)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(a) an ability to apply knowledge of math, science and engineering				
A1: Apply mathematical knowledge				100%
A2: Apply scientific knowledge				100%
A3: Apply engineering knowledge				100%

RECOMMENDATIONS: None for this outcome.

Targeted Assessment of Outcome (b)

An ability to design and conduct experiments as well as to analyze and interpret data

Performance Criteria:

B1	Conduct an experiment
B2	Analyze, interpret data
B3	Design an experiment

<u>Assessment (b) 1: EE 325 – Electronics III, Spring 2010 (Barnes)</u>

The planned direct assessment in EE 325 was administered as an indirect assessment and the results are not included in this report.

RECOMMENDATIONS: Collection error; will be assessed in the next cycle in an upper-division lab class.

Targeted Assessment of Outcome (d)

An ability to function on multi-disciplinary teams

Performance Criteria:

D1	Team participation, communication
D2	Reaching a group consensus
D3	Management of team, delegation of responsibilities

Assessment (d) 1: EE 421 – Analog IC Design, Winter 2011 (Zipay)

The outcome was assessed using a final group laboratory project in a senior-level analog IC-design class. The students were given a choice of two defined projects (op-amp design or Gilbert Cell design using transistors) or a student-defined project. The students needed to work in teams of two and set up the project design between the team. There was no defined project lead—decisions were made by the group. The students had a variety of design and simulation tasks that would require a great deal of teamwork with a tight time schedule. Moreover, this was an experimental project with use of a variety of lab equipment.

The class was divided into five teams and overall six students were assessed (out of ten in the class) using the performance criteria listed below. The group and individual effort were evaluated based on report and group presentation. The group projects were evaluated for the following: identifying and defining an engineering problem (e.g., selection of problem and partition design), management of team and delegation of responsibilities (e.g., division of task within team), and developing solutions appropriate for the problem (e.g., adaptation of methods, development of novel procedures), (total 60%); final report (40%).

The table below summarizes the results of this targeted assessment. The results indicate that the performance level higher than 80% was met on both performance criteria for this program outcome, demonstrating that the students in the evaluated class have the ability to function on teams.

Table 8: Targeted Assessment for Outcome (d)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(d) an ability to function on multi-disciplinary teams				
d1: team participation by members				85%
d2: Reach a group consensus				100%

RECOMMENDATIONS: None for this outcome.

Targeted Assessment of Outcome (e)

An ability to identify, formulate, and solve engineering problems

Performance Criteria:

E1	Identify and define an engineering problem
E2	Articulate the problem in engineering terms
E3	Develop solutions appropriate for the problem

Assessment (e) 1: REE 412 – PV Systems, Winter 2011 (Zipay)

The outcome was assessed using a homework design project in a class of ten students (some EE). The students were given a set of specifications and parameters for available components (PV arrays, batteries, inverters etc). Using the specifications and locations the students were to design a grid-tied PV system. Students needed to analyze site information (NREL insolation data) and PV-module specs, and then develop a design solution and justify their choices.

Many solutions were incomplete, but the design approach was sound for most projects. There were numerous errors in the final solution and some faulty assumptions. Overall the engineering design approach was sound (some results were not completely correct).

The table below summarizes the results of this targeted assessment. The results indicate that the performance level higher than 80% was met on both performance criteria for this program outcome, demonstrating that the students in the evaluated class have the ability to identify, formulate, and solve engineering problems.

Table 9: Targeted Assessment for Outcome (e)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(e) an ability to identify, formulate, and solve engineering problems				
e3: Develop engineering solutions, and adapt methods				100%
e2: Solve conceptual and numerical engineering problem				100%

RECOMMENDATIONS: None for this outcome.

Targeted Assessment of Outcome (f)

An understanding of professional and ethical responsibility

Performance Criteria:

F1	Knowledge of a code of ethics (IEEE)
F2	Evaluate ethical dimensions of engineering practice
F3	Exhibit professional behavior

Assessment (f) 1: EE 341 – Electromagnetics, Fall 2011 (Vurkaç)

This outcome was assessed in a junior-level course on Electromagnetics using a special case study on ethics paper assignment. For the most part, students analyzed the high-level specialized research papers quite well. (They each picked one of several IEEE-published papers on semiconductor manufacturing selected by the instructor.) They successfully decoded the technical contents. Some consulted additional sources. They reviewed the papers in terms of delivery, organization, and to a small extent, technical quality. Some students were more thorough in their critique than others were.

There is some concern over that the assignment focus was more on impacts of solutions and not so much on ethics, therefore the data from this assessment has been moved to outcome (h) in this report. Assessment of outcome (f) needs to be repeated during the next cycle (2011–12).

Assessment (f) 2: EE 419 – Power Electronics, Fall 2011 (Barnes)

This outcome was assessed in a senior-level course on Power Electronics using a written paper assignment:

Elements of the assignment:

1. Read the Wikipedia section on Engineering Ethics at http://en.wikipedia.org/wiki/Engineering_ethics
2. Pick a topic that **you have in some experience with or interest in** that has an ethical question to it (for example wind farms and environmental degradation due to noise pollution and lights flashing at night). Present a **short discussion** of the issue from the perspective of a low-level (but not inconsequential) member of a design team of engineers responsible for its implementation. Give short descriptions of the issue and the arguments on both (or all) sides of the issue using a variety of high-quality sources. Comment: **Compromise** is necessary in most ethical issues.

The table below summarizes the results of this targeted assessment, though there is some concern as with the assessment in EE 341 that the focus was on solution impacts rather than ethics. The results indicate that the minimum acceptable performance level of 80% was not met on any of the three performance criteria for this program outcome.

Table 11: Targeted Assessment for Outcome (f)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(f) an understanding of professional and ethical responsibility				
F1: Knowledge of codes of ethics (IEEE)				69%
F2: Evaluate dimensions of ethical practice				62%
F3: Understand professional behavior				NA

RECOMMENDATIONS: None at this time due to questions about the assignment focus being on impacts and not on ethics. This will be reassessed in the next cycle (2011–12).

Targeted Assessment of Outcome (g)

An ability to communicate effectively

Performance Criteria:

G1	Oral communication
G2	Written communication
G3	Acquisition and application of information sources

The Communications ISLO assessed during the 2010–11 academic year aligns with program outcome (g). The outcome was assessed using an institution-prescribed assignment and rubric.

Assessment (g) 1: EE 321 – Electronics I, Winter 2011 (Vurkaç)

This outcome was assessed in a junior-level course on Electromagnetics using a special case study on ethics paper assignment. For the most part, students analyzed the high-level specialized research papers quite well. (They each picked one of several IEEE-published papers on semiconductor manufacturing selected by the instructor.) They successfully decoded the technical contents. Some consulted additional sources. They reviewed the papers in terms of delivery, organization, and to a small extent, technical quality. Some students were more thorough in their critique than others were.

The written portion of the assignment had three components: technical summary of the contents, the student's view of the quality of delivery of the original paper, and the student's writing quality (for which, they had the option of turning in one or two drafts for instructor's review before the final version. Some turned in one such draft.)

The oral-communication aspect was evidenced and assessed through 15-minute presentations, again featuring both explanations of the technical material and the students' critique of its delivery (positive and negative).

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on two of the three performance criteria for this program outcome. Students generally met or exceeded expectations, although several students were uncomfortably nervous presenting their projects to the class. The presentations and papers clearly demonstrated the students' abilities to communicate effectively.

Table 12: Targeted Assessment for Outcome (g)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(g) an ability to communicate effectively				
G1: Oral communication				83%
G2: Written communication				67%
G3: Acquisition and application of information sources				83%

STRENGTHS:

Some students consulted external sources—not just on the Web—for clarification of foreign concepts in the papers they reviewed. Most of the summaries were informative to the rest of the class as well as the instructor.

WEAKNESSES:

In a few cases, students admitted not understanding a concept from the paper they presented on, and did not seek other sources to learn about it. In one such case, one of the concepts was explained superbly by the student, but another was simply left out.

RECOMMENDATIONS:

Due to limited data collection, the faculty suggest reassessing this outcome with more detailed performance criteria.

Targeted Assessment of Outcome (h)

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

Performance Criteria:

H1	Identify impacts of engineering solutions
H2	Understand impacts in various contexts

<u>Assessment (h) 1: EE 341 – Electromagnetics, Fall 2010 (Vurkaç)</u>

The outcome was assessed using a special assignment in a junior class in electromagnetic taken by 14 EE juniors and seniors in Fall 2010 using a special case study on engineering practices and their ethical, social, or health impacts (paper assignment). Students were asked to search for topics relevant to Electromagnetism that had a controversial aspect (health, military, political, etc.)

Once each topic was approved by the instructor (in order to avoid duplication), students were encouraged to research *multiple* pro and *multiple* con arguments for the technology or application in question, and synthesize their findings into a position paper (with technical content).

Most students found unusual and interesting topics of great significance. Quite a few balanced the presentation of various views along with their own approach and conclusion. Several students, looking into different topics, independently found a discrepancy in the engineering code of ethics as engineering might commonly be practiced.

The assessment was originally intended for outcome (f), but the assignment and the way it was assessed was later seen as better suited to outcome (h). The relevant portion of the results were ported over to the present entry.

The table below summarizes the results of this targeted assessment. The results indicate that the performance level higher than 80% was met on two of the three performance criteria for this program outcome.

A recommendation for next time this outcome is evaluated is to have an in-class discussion of the essays submitted by the students, to allow the youngest ones or those with no work experience to be exposed to different ideas in the context of lifelong learning. A broader recommendation is to expose students earlier in the program to professional societies and to encourage them to think about their professional paths in every class they take.

Table 13: Targeted Assessment for Outcome (h)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic…				
H1: Identify impacts				93%
H2: Understand impacts				93%

STRENGTHS:

Most students demonstrated that the engineering field requires that a continuous learning paradigm be established to keep current in emerging fields. This requires the ability to research information and gather appropriate data as required for various research papers.

WEAKNESSES:

Although the students understand the need for independent learning, they lacked an understanding of how to implement the continuous process.

RECOMMENDATIONS:

On next normal cycle offer more explanation on the assignment and have students discuss an approach as well as perform the tasks.

Targeted Assessment of Outcome (i)[3]

An ability to engage in independent learning and recognize the need for continual professional development

Performance Criteria:

I1	Demonstrate an awareness that knowledge must be gained
I2	Identify, gather and analyze information
I3	Recognize the acquisition of knowledge is a continuous process

Assessment (i) 1: EE 341 – Electromagnetics, Fall 2010 (Vurkaç)

The outcome was assessed using a special assignment in a junior class in electromagnetics taken by thirteen EE juniors and seniors. The assignment was a short paper that targeted aspects of lifelong learning by asking students to identify and discuss the concept, professional societies, and credentials for certification.

The table below summarizes the results of this targeted assessment. The results indicate that the performance level higher than 80% was met on two of the three performance criteria.

A recommendation for next time this outcome is evaluated is to have an in-class discussion of the essays submitted by the students, to allow the youngest ones or those with no work experience to be exposed to different ideas in the context of lifelong learning. A broader recommendation is to expose students earlier in the program to professional societies and to encourage them to think about their professional paths in every class they take.

Table 14: Targeted Assessment for Outcome (i)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 2
(i) a recognition of the need for, and an ability to engage in life-long learning				
I1: Demonstrate an awareness that knowledge must be gained				100%
I2: Identify, gather and analyze information				86%
I3: Recognize the acquisition of knowledge is a continuous process				50%

STRENGTHS:

Most students demonstrated that the engineering field requires that a continuous-learning paradigm be established to keep current in emerging fields. This requires the ability to research information and gather appropriate data as required for various research papers.

WEAKNESSES:

Although the students understand the need for independent learning, they lacked an understanding of how to implement the continuous process.

[3] The wording of outcome (i) was changed by the EERE faculty in Fall 2010

RECOMMENDATIONS:

Offer more explanation on the assignment and provide the students with the rubric.

Assessment (i) 2: REE 412 – PV Systems, Winter 2011[4] (Zipay)

This outcome was assessed by means of a research paper in a senior-level PV-systems class taken by REE students and some EE students (an elective). For this assignment students selected a research topic from a list of PV-related topics (or they select an area of their own) and developed a short research paper on this topic. The paper requirements were given as part of the assignment. One requirement was that there be a minimum of three vetted references. This required students to do independent learning beyond the normal scope of the class.

The table below summarizes the assessment results. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria, that is, over 80% of students were able to recognize the need for and display the ability to engage in independent learning.

A recommendation for next time this outcome is evaluated is to have an in-class discussion of the essays submitted by the students, to allow the youngest ones or those with no work experience to be exposed to different ideas in the context of lifelong learning. A broader recommendation is to expose students earlier in the program to professional societies and to encourage them to think about their professional paths in every class they take.

Table 15: Targeted Assessment for Outcome (i).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(i) a recognition of the need for, and an ability to engage in life-long learning				
I1: Demonstrate an awareness that knowledge must be gained				100%
I2: Identify, gather and analyze information				100%
I3: Recognize the acquisition of knowledge is a continuous process				NA

STRENGTHS:

This is a senior-level systems-design class, and most students have been exposed to research-paper assignments that required acquiring of information outside of the traditional class notes. In this assignment students selected a research topic from a list of PV-related topics (or they select an area of their own) and developed a short research paper on this topic. They did well in this area, indicating a strong grasp of these criteria.

WEAKNESSES:

None noted.

[4] This assessment was performed using criteria established for our BSREE program. However, some of the students in the REE 412 course are BSEE students, so the faculty felt it important to include this assessment in our report.

RECOMMENDATIONS:

A recommendation for next time this outcome is evaluated is to have an in-class discussion of the essays submitted by the students, to allow the more junior ones or those with no work experience to be exposed to different ideas in the context of lifelong learning. A broader recommendation is to expose students earlier in the program to professional societies and to encourage them to think about their professional paths in every class they take. Also, add another section to the assignment to assess performance criterion 3.

Targeted Assessment of Outcome (j)

A knowledge of contemporary issues

Performance Criteria:

J1	Demonstrate knowledge of contemporary issues
J2	Recognize the temporal nature of contemporary issues
J3	Recognize the historical pretext of contemporary issues

Assessment (j) 1: EE 407 – Semiconductor Processing, Spring 2011 (Zipay)

This outcome was assessed through a special take-home quiz discussing contemporary issues in the semiconductor industry (J1–J3).

Three students were assessed in Spring 2011 in the course using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on both performance criteria for this program outcome. All students identified a contemporary issue related to the class topic and recognized current factors that contribute to its existence.

Table 16: Targeted Assessment for Outcome (j)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(j) a knowledge of contemporary issues				
J1: Demonstrate knowledge of contemporary issues				100%
J2: Recognize the temporal nature of contemporary issues				100%
J3: Recognize the historical pretext of contemporary issues				NA

RECOMMENDATIONS: None for this outcome.

Targeted Assessment of Outcome (k)

An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Performance Criteria:

K1	Demonstrate proficiency with engineering software: CAD, CAE, programming, data analysis, etc
K2	Demonstrate proficiency with engineering hardware: test/measurement equipment, prototyping, etc
K3	Apply communications tools and skills within engineering practice

<u>Assessment (k) 1: EE 421 – Analog IC Design, Winter 2011[5] (Zipay)</u>

This outcome was assessed by means of a final design lab project in a senior-level analog IC design course. This project involved the use of LTSpice for simulation and schematic capture of the design. It also required extensive use of design partitioning, testing, and final integration using prototyping and test instruments.

The outcome was assessed using a final group laboratory project in a senior-level analog IC-design class. The students were given a choice of two defined projects (op-amp design or Gilbert Cell design using transistors) or a student-defined project. The students needed to work in teams of two and set up the project design between the team. There was no defined project lead but decisions were made by the group. The students had a variety of design and simulation tasks that would require a great deal of teamwork with a tight time schedule. Moreover, this was an experimental project with use of a variety of lab equipment and CAE tools.

The class was divided into five teams, and overall six students were assessed (out of ten in the class) using the performance criteria listed below. The group and individual effort were evaluated based on report and group work during the lab time. The group projects were evaluated for the following: Identify and define an engineering problem; management of team, delegation of responsibilities (e.g., division of task within team); develop solutions appropriate for the problem (e.g., adaptation of methods, development of novel procedures, use of CAE tools, and partition and test actual hardware), (max. 60%); and final report (max. 40%).

The table below summarizes the assessment results. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria, that is, over 80% of students were able use various skills, techniques and tools to design, build and test a final Analog IC project.

Table 17: Targeted Assessment for Outcome (k)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(k) an ability to use the techniques, skills and modern engineering tools necessary for eng. practice				
K1: Proficient with software tools (CAD/CAE)				100%
K2: Proficient with engineering HW (prototypes/instruments)				100%
K3: Proficient with communication tools (Powerpoint etc.)				NA

STRENGTHS:

This is a senior-level analog IC-design class, most students have been exposed to various design projects in previous classes, and they are currently in the design phase of the capstone senior project so proficiency is expected here.

WEAKNESSES:

None noted.

RECOMMENDATIONS:

Add another section to the assignment to assess performance criterion 3.

<u>Assessment (k) 2: EE 321 – Electronics I, Winter 2011 (Vurkaç)</u>

This outcome was assessed in a lab assignment in a junior-level Electronics class using LTSpice circuit simulation tools. This was a Winter 2011 out of sequence class of six students.

A few students in EE 321 had sufficient skills with LTSpice to support their prototyping and design work. It was observed that some students seemed to be unfamiliar with writing proper experimental conclusions: Rather than uncontrollable experimental conditions, fixable mistakes were sometimes listed as “errors”.

In the case of EE 321, targeting an assignment specifically for this outcome, or presenting the outcome’s relevance to students (perhaps along with the rubric) to increase their awareness of what is expected may lead to better assessment (more meaningful, relevant results).

The table below summarizes the assessment results. The results indicate that the minimum acceptable performance level of 80% was not met on any performance criteria, that is, very few students could demonstrate usage of CAE tools at a junior class level.

Table 18: Targeted Assessment for Outcome (k)

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students > 1
(k) an ability to use the techniques, skills and modern engineering tools necessary for eng. practice				
K1: Proficient with software tools (CAD/CAE)				33%
K2: Proficient with engineering HW (prototypes/instruments)				67%
K3: Proficient with communication tools (Powerpoint etc.)				NA

STRENGTHS:

None noted.

WEAKNESSES

It was noted a weakness in using tools that may indicate a lack of exposure in circuit classes in the sophomore year.

RECOMMENDATIONS:

Investigate how much exposure students receive in LTSpice in the sophomore Circuits Lab sequence and determine if more exposure is needed and how to achieve this goal.

Add another section to the assignment to assess performance criterion 3.

Summary of Direct-Measure Assessment for 2010–11

OVERALL:

Strengths
Outcomes (a), (d), (e), (g), (j), and (k) (normal cycle)

Weaknesses
Outcomes (b), (f), and (i) need to be redone in 2011–12 (continuous improvement)

Recommendations
Outcome (b): Reassess with the instructor rating student performance.

Outcome (f): Need to discuss the assignments used and how assessment was done with the instructors. Reassess in 2011–12.

Outcome (i): Need to reassess.

Outcome (k): Not a reassess, but there is a need to investigate how well tools are being used in the EE sophomore Circuits sequence.

Outcome-Specific Strengths, Weaknesses and Recommendations

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

Strengths
Overall students show a strong ability to apply math, science, or engineering to problems.

Weaknesses
Slight one in one assignment but was a small sample.

Recommendations
None at this time.

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

Recommendations
Invalid data collection need to reassess next cycle

(d) an ability to function on multi-disciplinary teams

Strengths
Students have had good exposure to teamwork in most upper-division lab sections, and a later course on group speech, so this is a strength.

Weaknesses
None noted.

Recommendations
None at this time, next cycle look at capstone senior projects.

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

Strengths
Reinforced throughout the program.

Weaknesses
None noted.

Recommendations
None at this time.

(f) an understanding of professional and ethical responsibility

Recommendations
The faculty will reassess in the next cycle, as the assignment lacked focus on ethical issues.

(g) an ability to communicate effectively

Strengths
Students receive strong background in both writing assignments (research papers) and class/lab presentations so they are strong here.

Weaknesses
Need a bit more exposure on gathering proper vetted information from sources.

Recommendations
Define more specific performance criteria next time this outcome is assessed.

(i) An ability to engage in independent learning and recognize the need for continual professional development

Strengths
Students have been doing research type of assignments in various upper-division core classes and do well in learning material outside the scope of the normal class.

Weaknesses
There is a lack of understanding of the continuous-improvement process and how to implement it.

Recommendations
Develop a special assignment and reassess in the next cycle.

(j) a knowledge of contemporary issues

Strengths

Not actually a strength, but satisfactory considering the small amount of reinforcement in previous classes.

Weaknesses

Students had trouble defining contemporary issues and drifted towards a comfort zone of solution impacts.

Recommendations

Work on a tailored assignment for the next normal cycle and work with the institutional assessment of this outcome.

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

Strengths

Lab skills are a strength of the program in most courses.

Weaknesses

None noted.

Recommendations

None at this time except to add an assignment to test use of communication tools. One assignment suggested that the sophomore circuit sequence is not providing adequate exposure to the use of CAE tools in lab.

4. Changes Resulting from Assessment

This section describes the changes resulting from the assessment activities carried out during the 2010-11 academic year. It includes any changes that have been implemented based on assessment in previous assessment cycles, from this or last year, as well as considerations for the next assessment cycle.

4.1 Changes to Assessment Methodology Resulting from the 2010–2011 Assessment

During the 2010–11 academic year an attempt was made to assess many of the (a)-through-(m) Program Outcomes. This was done in order to build a solid body of assessment for ABET review and program improvement. Upon completion of the assessment activities, the faculty decided that targeting specific outcomes each year (e.g. a subset of outcomes not exceeding ten program outcomes) would result in improved assessment data and decisions over the three-year cycle of assessment. Following this decision, during the 2011–2012 academic year we will target needed program outcomes for assessment.

During Convocation in Fall 2010, the EERE faculty agreed to change outcome (i). Previously, the faculty had adopted the outcome (i) developed by ABET: "a recognition of the need for, and an ability to engage in life-long learning". The faculty felt that the outcome was difficult to assess given the "life-long" nature of the outcome, and could only truly be assessed by querying our alumni. The long-term nature of the burden of proof requires assessment more typical of a PEO rather than that of a program outcome; a characteristic exhibited by our alumni rather than one exhibited by our recent graduates.

By recasting the outcome in terms of shorter-term criteria, the assessment becomes measurable within the time frame of a class or senior project while still revealing the same desired values, particularly independent learning and professional development. The faculty agreed that the EE outcome (i) achieves the same goal as the ABET outcome (i); encourage the faculty to develop curricula that cause BSEE students to recognize the need for continuous professional development and independent learning.

The assessments conducted during the 2010-2011 academic year revealed the following areas of improvement:

1. There is a need for better coordination among the faculty to define outcomes and methods for performing relevant outcome evaluations. This need is especially important for new faculty joining so we can ensure consistency in our evaluation approach.
2. Where there are not enough assessments available to draw clear conclusions, assessments could be broadened to other classes and assessment methods and need better participation by program faculty.

3. Assessment of several of the outcomes and outcome performance criteria should be broadened to different classes and different instructors. This approach will net us larger assessment samples and result in variation in methods. Consequently, the assessment results should be more representative of how the ABET outcomes are likely to be applied in professional practice.

4. There is a distinction between the "hard" and "soft" skills represented by the several ABET outcomes. We need to find methods to assess both types of skills in a range of courses, rather than just concentrate soft skills assessments in project-based classes and assessments of hard skills in classes that emphasize engineering fundamentals and problem solving that students will encounter in industry. There is an attitude among some students, although it might not be universal, that calculations and technical problems are the primary focus of working engineers. Although it is certainly true that engineers are singularly qualified to deal with technology problems, some students discount the need to develop communication, teamwork, and other "soft skills", which are essential for successful careers. Many of the "soft skill" assessments may require a special assignment and some focused instruction in the course.

5. It would be helpful for faculty to reinforce the kinds of circumstances and performance expectations

6. To emphasize the mechanics and processes of teamwork, we need to find ways to make all team members accountable. Perhaps SPE 321 should be a prerequisite for any course that requires teamwork, since teamwork is the hallmark of many of our upper-division courses. This may require a sequence change and limit assessment to senior-level classes or the capstone project.

7. To address the need for using information sources, it is important to educate students on the array of sources available for the kinds of information they are expected to locate, and to instruct them on how to go about identifying and validating useful information. This can be done as part of the research paper assignment and have this done in more courses (especially upper-division).

8. Assessments should be emphasized later on in the program, in upper-division classes – more so than in the lower-divisions classes – after students have had ample opportunity to learn and develop knowledge and capabilities that demonstrate competence with the program outcomes.

9. To address the apparent disparity between the students early in the program and those in upper-division status, it is important that the faculty concur what kind of assessment is most appropriate and what to expect of students at different levels.

10. Consider tighter integration of software tools within the curriculum, identifying which software tools should be recommended or used as standard. For example, a CAE course is not required in the EE curriculum, yet students are expected to use CAE in some courses, and CAE software packages are fundamental tools for design and technical documentation. This needs to be added to lower-division courses as some "training-type" labs based on using the tool and reinforced later.

11. There is a need for better resolution in assessing the skills and abilities that apply to outcome (g), *an ability to communicate effectively*. In future assessments, we will identify more appropriate performance criteria to separate assessment of writing, speaking, presentation, and intra-team communication skills. To accomplish this change, we can take advantage of the separate rubrics developed by our Communication Department, at http://www.oit.edu/faculty-staff/provost/assessment/rubrics.

12. Given the wide variation in the types of communications required by the assessments, such as memos, lab reports, senior project, design documentation, presentations, proposals, and so on, one recommendation is to identify written documentation requirements more explicitly, perhaps using examples or templates so students have a better idea of the structure, organization, and content of such written documentation.

13. For a more focused assessment of outcome (d) *an ability to function on multi-disciplinary teams*, we will adapt the Communication Department's teamwork rubric and tools available at: http://www.oit.edu/faculty-staff/provost/institutional-student-learning-outcomes/tools.

4.2 Changes Resulting from the 2009–2010 Assessment (Continuous Improvement)

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

Assessment from the 2009–10 cycle:

Perf. Criteria	Courses					
	EE421	EE419				AVE PC
Identify Impacts	33.3%	100%				68%
Understand Impacts	NA	100%				100%
Sample Size	9	10				
Assign. Type	Exam 2	Final Exam				
Term	W10	F09				
Faculty	Zipay	Zipay				

This outcome was assessed in two senior-level classes (EE 419 Power Electronics and EE 421 Analog IC Design). The two classes had a similar student (not identical) cohort and focused mostly on special test questions geared towards analyzing engineering impacts.

STRENGTHS:

In the one course, a final-exam question was used to compare engineering solutions with regard to both function and cost. The students did well here this approach has been used with other classes to present students with some questions that are more qualitative than quantitative in focus. The other test question was broader in scope and the students expressed concern over what was being asked.

WEAKNESSES:

When asked to analyze a solution and identify broad impacts the students did not do well.

RECOMMENDATIONS:

Reassess in the 2010–11 cycle and focus on broad impacts, add some discussion to the class to support this approach.

Assessment in 2010–11 Cycle

The following data was collected as part of the 2010–11 collection cycle to reassess this outcome from the 2009–10 collection cycle.

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

Perf. Criteria	Courses					
	REE451					AVE PC
Identify Impacts	100%					
Understand Impacts	100%					
Sample Size						
Assign. Type	Final Ex.					
Term	F10					
Faculty	Zipay					

This outcome was assessed in a senior-level class (REE 451 Geothermal Systems) that had a mix of REE and EE seniors. The class assessment was focused mostly on special test questions geared towards analyzing engineering impacts. The concept of impacts was discussed throughout the class.

STRENGTHS:

When the students had classroom discussions regarding the various impacts of different solutions they were better able to defend a solution choice.

WEAKNESSES:

None noted.

RECOMMENDATIONS:

Continue this approach and assess outcome in classes that have a focus on engineering solution impacts.

Appendix A - Mapping Between SLOs and the BSEE Curriculum

(This table will be redone in 2011–12 cycle.)

Table 19: Mapping between BSEE engineering courses and the Program Outcomes. The number (1) indicates the faculty have identified the outcome as assessable in a particular class. The number (2) indicates the outcome is assigned for assessment in that particular course (to be done in 2011–12 Cycle).

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
ENGR101/2	1	1		1		1	1							
EE131/133	1	1												
EE 221	2	1			1									
EE 223	1	1			1									
EE 225	2	1			1							2		
EE 321	1	1			1	1	1				1			
EE 323	1	2	1	1	1	1	1				1			
EE 325	1	1	1	1	1	1	1				1			
EE 331	1	1	1	1	1	1	1				1		1	
EE 333	1	1		1	1	1	1				1			
EE 335	1	1	1	1	1	1	1				1		1	
EE 341	1				1	1	1					2		
EE 343	1				1	1	1					1		
EE 311	1	1			1		1					1		
EE 411	1	1	1	1	1	1	1	1	1	1	1		1	
EE 412	1	1	1	1	1	1	1	1	1	1	1		2	
EE 413	1	1	1	1	1	1	1	1	1	1	1		1	
EE 401	1	1	1	1	1	1	1	1	1	1	1	1	1	
EE 431	2	1	1		1	1	1	1	1	1		1	1	
EE 425	1	1	1	1	1	1	1	1	1	1	1		1	