— B. S. in Electrical Engineering —

2017–18 Assessment Report

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Contents

1 Introduction

1.1 Program Design and Goals

The Bachelor of Science in Electrical Engineering program at Oregon Institute of Technology (Oregon Tech) aims to impart a thorough grounding in the theory, concepts, and practices of electrical engineering. Emphasis is on practical applications of engineering knowledge. The goal of our program design is to graduate engineers who require minimal on-the-job training while providing them with sufficient theoretical background to enable success in graduate education in engineering.

1.2 Program History

In 2007, Oregon Tech began offering its new Bachelor of Science in Electrical Engineering (BSEE) program at its Klamath Falls campus. In Fall 2012, the BSEE degree started to also be offered at the Portland Metro campus. The BSEE degree is a traditional EE degree that was created to prepare graduates for careers in various fields associated with Electrical Engineering. These include, but are not limited to, analog integrated circuits and systems, digital integrated circuits and microcontroller systems, signal processing, communication systems, control systems, semiconductors, optoelectronics, renewable energy, and biomedical fields as stated in the Oregon Tech catalogs for 2007 through 2017.

The BSEE program prepares graduates to enter careers in the field of electrical engineering in positions such as design engineers, test engineers, characterization engineers, applications engineers, field engineers, hardware engineers, process engineers, control engineers, power engineers, semiconductor-processing engineers, controls and signal-processing engineers, energy system-integration engineers, analog-systems engineers, digital-systems engineers, and embedded-hardware engineers, among others. Graduates of the program will be able to pursue a wide range of career opportunities, not only within the more traditional areas of Electrical Engineering, but also within emerging fields, such as Renewable Energy Engineering and Optical Engineering.

One hundred and twenty-five students have graduated from the BSEE program since it was first launched in 2007. From these, 38 new BSEE students graduated in the Spring term of 2017. Twenty-four of those completed the Senior Exit Survey, with 83% of respondents reporting having found employment in their field, 10% were admitted or planning on attending graduate school, and 7% are looking for employment after graduation. The reported average annual salary of the first group was $60,777.

1.3 Industry Relationships

The BSEE program has strong relationships with industry, particularly through its program-level Industry Advisory Board (IAB), and through its alumni. These relationships with our constituents allow the BSEE program to meet the institutional goal of maintaining the currency of our degree programs.

The IAB has been a mainstay in the development of the EE program since its early roots. The IAB provides advice and counsel to the EE program with respect to curriculum content, instructional resources, career guidance and placement activities, accreditation reviews, and professional-development 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 industry for students and faculty.

1.4 Program Locations

The BSEE program is located at both Oregon Tech campuses (Klamath Falls and Portland Metro), serving a large portion of rural Oregon and California, as well as the Portland metropolitan area. Oregon Tech is the only university offering multiple classical engineering degrees at the Bachelor's (and some at the Master's) level in a region ranging from Corvallis, Oregon, in the north, to Chico, California, in the south, and from the Pacific coast in the west to Boise, Idaho, in the east.

The Klamath Falls campus includes a large solar facility and the Oregon Renewable Energy Center (OREC) with exceptional opportunities for students to gain experience in the subfields of power, energy, and renewable energy. OREC, as stated on its website, "promotes energy conservation and renewable[-]energy use in Oregon and throughout the Northwest through applied research, educational programs, and practical information." These resources give students access to research *and* practical experience in geothermal, solar, wind, biofuel, waste, fuel-cell, and other sources of green energy.

The Portland Metro campus offers excellent access to internships and other technological collaboration with the Silicon Forest (as the semiconductor industry in the Portland metropolitan area is known).

This arrangement satisfies the needs of the state of Oregon by placing a traditional EE program in the southern, rural part of the state to serve that region as well as providing a small-school EE program to students who desire a low student-to-faculty ratio and small classes.

2 Program Mission, Educational Objectives and Outcomes

2.1 Program Mission

The mission of the Electrical Engineering Bachelor of Science degree 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 provide high-quality career-ready candidates for industry as well as teaching and research careers. 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, the Program Educational Objectives for the BSEE program are:

- The graduates of the BSEE program will possess a strong technical background as well as analytical, critical-thinking, and problem-solving skills that enable them to excel as professionals contributing to a variety of engineering roles within the various fields of electrical engineering and the high-tech industry.
- The graduates of the BSEE program are expected to be employed in electrical engineering positions including (but not limited to) design engineers, test engineers, characterization engineers, applications engineers, field engineers, hardware engineers, process engineers, control engineers, and power engineers.
- The graduates of the BSEE program will be committed to professional development and lifelong learning by engaging in professional or graduate education in order to stay current in their field and achieve continued professional growth.
- The graduates of the BSEE program will be working as effective team members possessing excellent oral and written communication skills, and assuming technical and managerial leadership roles throughout their career.

2.3 Relationship between Program Objectives and the Institutional Mission

The Oregon Tech mission statement is as follows. "Oregon Institute of Technology offers innovative and rigorous applied degree programs in the areas of engineering, engineering technologies, health technologies, management, and the arts and sciences. To foster student and graduate success, the university provides an intimate, hands-on learning environment, focusing on application of theory to practice. Oregon Tech offers statewide educational opportunities for the emerging needs of Oregon's citizens and provides information and technical expertise to state, national and international constituents."

The core themes of Oregon Tech are as follows.

- Applied Degree Programs
- Student and Graduate Success

- Statewide Educational Opportunities
- Public Service

The "strong technical background" of PEO 1 corresponds to the rigor required by the institutional mission of Oregon Tech's degree programs.

PEO 2 is aligned with the institution's core themes of both public service and graduate success. The Oregon Tech BSEE program prepares students to take their place in the work force as design engineers, test engineers, characterization engineers, applications engineers, field engineers, hardware engineers, process engineers, control engineers, and power engineers, serving the needs of Oregon, the nation, and the world.

Furthermore, the institution's mission emphasizes graduate success along with student success, and this is where the commitment to lifelong learning (PEO 3) aligns with the mission. Moreover, the mission statement's specification that "[t]o foster student and graduate success, the university provides and intimate, hands-on learning environment, focusing on application of theory to practice" is also in strong alignment with the BSEE program due to the prominence of small classes, the hands-on focus of the program, and faculty-taught laboratories.

2.4 Program Outcomes

To date, the BSEE program outcomes follow ABET's EAC (a)–(k) student outcomes:

(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.

Starting with the 2018-19 academic year, assessment will be done using the new (1)-(7) student outcomes below

(1) an ability to identify, formulate, and solve engineering problems problems by applying principles of engineering, science, and mathematics
(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(3) an ability to communicate effectively with a range of audiences
(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
(6) an ability to develop and conduct appropriate experimentation, interpret data analyze and interpret data, and use engineering judgment to draw conclusions
(7) an ability to acquire and apply new knowledge as needed, using learning appropriate learning strategies

3 Cycle of Assessment for Program Outcomes

3.1 Introduction, Methodology, and the Assessment Cycle

Assessment of the program outcomes is conducted over a three-year cycle. Table 1 shows the outcomes assessed each year. Effective the 2014-15 academic year, the assessment cycle started with the Spring term. At the assessment coordinator's meeting on Oct 15, 2017, it was decided that the assessment cycle should match the academic year and start in the Fall term.

In addition to the outcomes scheduled for a particular year, assessment is also performed for Oregon Tech's Essential Student-Learning Outcomes (ESLOs) that are scheduled for that particular year by the Executive Committee of the Assessment Commission.

current outcomes	new outcomes
(a) & (e)	(1)
(c)	(2)
(g)	(3)
(f) & (h) & (j)	(4)
(d)	(5)
(b)	(6)
(i)	(7)

Starting with academic year 2018-19, assessment will transition to the new ABET student outcomes (1)-(7). These will commence in the fall of 2018 and are shown in Table 2. We have adopted the mapping suggestions approved by the ABET Engineering Area Delegation on October 20, 2017. Specifically, the mapping is outlined in the following table.

This means that we will go from assessing 3–4 outcomes each year to 2–3 outcomes. The current and future mappings are shown in Table 1 and Table 2.

Student Outcome	2015-16	2016-17	2017–18
(a) Fundamentals			•
(b) Experimentation	•	†	
(c) Design			•
(d) Teamwork			•
(e) Problem solving		•	†
(f) Ethics	•	†	
(g) Communication		•	†
(h) Impact	•	†	
(i) Independent learning		•	†
(j) Contemporary issues		†	•
(k) Engineering tools		•	†

Table 1: Current BSEE Outcome Assessment Cycle. Bullets (•) indicate standard assessment cycle, daggers (†) indicates additional assessment done this year.

Student Outcome	2018-19	2019-20	2020–21
(1) Principles			•
(2) Design			•
(3) Communication		•	
(4) Ethics	•		
(5) Teams			•
(6) Experimentation	•		
(7) Learning		•	

Table 2: New BSEE Outcome Assessment Cycle. Bullets (•) indicate standard assessment outcomes.

3.2 Summary of Assessment Activities & Evidence of Student Learning

3.2.1 Introduction

The BSEE faculty conducted formal assessment during the 2017–18 academic year using direct measures, such as designated assignments and evaluation of coursework normally assigned. Additionally, the student outcomes were assessed using indirect measures, primarily results from a graduate exit survey.

3.2.2 Methodology for Assessment of Student Outcomes

At the beginning of the assessment cycle, an assessment plan is generated by the Assessment Coordinator in consultation with the faculty. This plan includes the outcomes to be assessed during that assessment cycle (according to Table 1), as well as the courses and terms where these outcomes will be assessed.

The BSEE mapping process links specific tasks within BSEE course projects and assignments to program outcomes and on to program educational objectives in a systematic way. The program outcomes are evaluated as part of the course curriculum primarily by means of assignments. These assignments typically involve a short project requiring the student to apply math, science, and engineering principles learned in the course to solve a particular problem requiring the use of modern engineering methodology and effectively communicating the results.

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 relevant 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.

A systematic, rubric-based process is then used to assess the level of attainment of a given program outcome, based on a set of performance criteria. The work produced by each student is evaluated according to the different performance criteria, and assigned a level of 1-developing, 2-accomplished, or 3-exemplary. The results for each outcome are then summarized in a table, and reviewed by the faculty at the annual closing-the-loop meeting.

The standard acceptable performance level is to have at least 80% of the students obtain a level of accomplished or exemplary in each of the performance criteria for any given program outcome. It has been accepted in past closing-the-loop meetings that faculty can set a different threshold if required by the type of assignment or outcome, but must do so prior to the assessment.

If any of the direct assessment methods indicates performance below the established level, that triggers the process of continuous improvement where all the direct and indirect assessment measures associated with that outcome are evaluated by the faculty, and based on the evidence, the faculty decides the adequate course of action. The possible courses of action are these:

- Collect more data (if there is insufficient data to reach a conclusion as to whether the outcome is being attained or not); this may be the appropriate course of action when assessment was conducted on a class with low enrollment, and it is recommendable to re-assess the outcome on the following year, even if it is out-of-cycle, in order to obtain more data.
- Make changes to the assessment methodology (if the faculty believe that missing the performance target on a specific outcome may be a result of the way the assessment is being conducted, and a more proper assessment methodology may lead to more accurate numbers); for example, this could be the suggested course of action if an outcome was assessed in a lower-level course, and the faculty decide that the outcome should be assessed in a higher-level course before determining whether curriculum changes are truly needed.
- Implement changes to the curriculum (if the faculty conclude that a curriculum change is needed to improve attainment of a particular outcome). A curriculum change will be the course of action taken when the performance on a given outcome is below the target level, and the evidence indicates that there is sufficient data and an adequate assessment methodology already in place, and therefore there is no reason to question the results obtained.

If the faculty decide to take this last course of action and implement curriculum changes, the data from the direct assessments is analyzed and the faculty come up with a plan for continuous improvement, which specifies what changes will be implemented to the curriculum to improve outcome performance.

In addition to direct assessment measures, indirect assessment of the student outcomes is performed on an annual basis through a senior exit survey.

The results of the direct and indirect assessment, as well as the conclusions of the faculty discussion at the closing-the-loop meeting are included in the annual BSEE assessment report, which is reviewed by the department chair and the director of assessment for the university. The suggested changes to the curriculum are presented and discussed with all the department faculty at the annual convocation meeting in the fall, as well as with the Industry Advisory Board at the following IAB meeting. If approved, these changes are implemented in the curriculum and submitted to the University Graduate Council (if catalog changes are required) for the following academic year.

3.2.3 Targeted Direct Assessment Activities

The sections below describe the 2017–18 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.

3.2.3.1 Outcome (a): Knowledge

An an ability to apply knowledge of mathematics, science and engineering.

A targeted direct assessment of this outcome was done in EE 321 *Electronics I* in Fall of 2017 and Spring of 2018.

<u>Portland Metro, EE 321, Fall 2017, Dr. Mateo Aboy</u>

This outcome was assessed in EE321 — Electronics I in Fall 2017 by means of a lab assignment. The purpose of the assignment was for students to design a regulated power supply. The lab assignment consisted of designing, simulating, implementing, and experimentally testing an AC-to-DC power supply and linear regulator with current boosting to provide an adjustable regulated output voltage with short-circuit/overload protection. Students were provided with a series of design specifications and design constraints. Students were expected to select an initial topology within the given constraints, identify the limitations of this topology and work on improving the design through an iterative process of analyzing and solving technical problems until the given specifications were met. Once the design was finalized (analyzed theoretically) and the simulations indicated the results were met, students were required to physically implement their designs and experimentally test them. This additional step was intended to get students to identify, analyze, and solve an additional set of technical problems related to implementation and measurement of electronic designs. Finally, the students were required to write a record and video demo showing their working design and write a brief (3 page) report documenting their design. The assignment involved the application of fundamentals (i.e., to apply knowledge of mathematics, science and engineering) in order to design the power supply.

Seventeen students were assessed in Fall 2017 in the course EE321 Electronics I using the performance criteria listed in the table 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.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
1. Math	2	15	0	88%
2. Science	3	14	0	82%
3. Engineering	3	13	1	82%

Table 3: EE 321 assessment of Outcome (a): Knowledge.

<u>Klamath Falls, EE 321, Fall 2017, Dr. Andy Sedlock</u>

This outcome was assessed in EE321 — Electronics I in Fall 2017 by means of a lab assignment.

Students were instructed to design a simple low-pass filter (integrator). As part of the design process, students were required to perform basic design, construction and verification of their circuit. They also observed the circuitÕs behavior (output) for both square wave and sinusoidal input signals.

Sixteen students were assessed in Fall 2017 in the course EE321 Electronics I using the performance criteria listed in the table 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.

Specifically the students were able to

1. Apply knowledge of mathematics by identifying math/physical assumptions that allow models to be developed (analysis) by identifying design parameters such as cutoff frequencies and gain values for their filters, combining math principles to formulate models for a system/process in an area of concentration (synthesis) by identifying and performing calculations based on the desired design parameters for their filters, and evaluating validity of math models by comparing solutions to known results (evaluation) by constructing their designed filters and performing measurements to verify correct operation,
2. Apply knowledge of scientific principles by applying scientific principles to an area of concentration (application) by successfully identifying a basic filter structure capable of performing the function of the assigned filter and analyzing modeling results of a system or process using scientific principles (analysis) by verifying the performance of the constructed filter or else by combining scientific principles to develop a model for a system or process (synthesis) by identifying the design methodology for the assigned filter project and correctly implementing them to identify a basic filter structure capable of performing the filter function, creating the filter design and then interpreting the scientific significance of the model predictions (evaluation) by performing measurements of the constructed filter and evaluating the performance of the filter based on those measurements,
3. Apply knowledge of engineering principles by combining engineering principles to develop a model for a system or process (synthesis) by using mathematical principles to create a model of the assigned filter and interpreting the engineering significance of the model predictions (evaluations) by identifying particular values of circuit components and a specific configuration of those components in order to implement the designed circuit as a physical reality.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
1. Math	0	0	16	100%
2. Science	0	5	11	100%
3. Engineering	0	0	16	100%

Table 4: EE 321 assessment of Outcome (a): Knowledge.

3.2.3.2 Outcome (c): Design

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.

A targeted direct assessment of this outcome was done in Klamath Falls in EE 225 and in Portland Metro in three sections of ENGR 465 *Capstone Project*.

Klamath Falls, EE 225, Fall 2017, Dr. Eve Klopf

This outcome was assessed in EE 225 Circuits III. Students were instructed to design an active filter capable of changing a square wave input into a triangle wave output, design a second active filter capable of changing that triangle wave output into a sinusoidal output, and to then observe the cascade of the two filters with the understanding that a cascade of this type in combination with an oscillator input could be considered a very basic function generator. As a part of the design process, students were required to perform basic design, simulation, construction and verification of their circuit(s).

Five students were assessed in Fall 2017 in the course EE321 Electronics I using the performance criteria listed in the table 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.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students $\geq$ 2
1. Need	0	5	0	100%
2. Design	0	5	0	100%
3. Evaluation	0	1	4	100%

Table 5: EE 225 assessment of Outcome (c): Design.

Portland Metro, ENGR 465, Spring 2018, Douglas, Prahl, Scher

This outcome was assessed in the ENGR 465 - Capstone Project, in Spring 2018. The Capstone Project is a year-long (three-term) project that students complete in their senior year, which involves a major design experience. Throughout the year, students are required to complete the definition, design, implementation, and verification of a major engineering design project. During the initial stage, students work under the supervision of their capstone project advisor to select a project of adequate scope and submit a project proposal. The proposal typically includes an explanation of the project relevance, a project definition or specification, a timeline with major milestones, a list of resources needed to complete the project, and a projected cost analysis. Once the proposal is approved by the academic advisor, students go through the different phases of design, implementation, and verification of their project. During this time, students have regular meetings with their project advisor in order to report progress, notify of plan changes if needed, present results, and perform prototype demonstrations. Once the design, implementation, and verification process is completed, and there is a final working prototype, students are required to generate a poster for inclusion in the annual Student Project Symposium, deliver an oral presentation, and submit a formal written report. These three deliverables are used to determine the students' ability to design a system, component, or process to meet desired needs within realistic constraints according to the performance criteria listed in the table below.

A total of sixteen students were assessed in Spring 2018 using the performance criteria listed in the table below. The minimum acceptable performance level was to have above 80% percent of the students performing at the accomplished or exemplary level in all performance criteria. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
1. Need	1	8	7	94%
2. Design	1	9	6	94%
3. Evaluation	0	10	6	100%

Table 6: ENGR 465 assessment of Outcome (c): Design.

3.2.3.3 Outcome (d): Teams

An ability to function effectively on multidisciplinary teams

A targeted direct assessment of this outcome was done in EE 335 *Advanced Microcontrollers*

Portland Metro, EE 335, Winter 2018, Allan Douglas

This outcome was assessed in EE335 - Advanced Microcontrollers in Winter 2018 by means of five lab assignments. At the beginning of the quarter, student teams were created. Each student team consisted of two students. Students were required to work as a team to complete the five lab assignments, covering the design, development, and test of a microcontroller-based robot for final test in an obstacle course. Teams were required to generate and submit lab report for each part of the overall project. Each team was also required to test their robot on an obstacle course. There was a mix of students from different disciplines completing the course (BS EET, BS EE, BS REE).

At total of 31 students were assessed in Winter 2018 using the performance criteria listed in the table 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.

Table 7 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. In fact, 100% of the students assessed showed the required level of proficiency at being able to function in a multidisciplinary team.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
d1. Participation	2	14	15	94%
d2. Decision	1	19	11	97%
d3. Management	5	18	8	84%

Table 7: EE335 assessment of Outcome (d): Teams.

3.2.3.4 **Outcome (e):** an ability to identify, formulate, and solve engineering problems

A targeted direct assessment of this outcome was done in EE 355 *Control Systems Design* and EE 401 *Communication Systems*

Klamath Falls, EE 355, Spring 2018, Dr. Eklas Hossain

This outcome was assessed in EE355 — Control System Design in Spring 2018 by means of a project. The project consisted of analyzing stability of different systems using stability analysis methods. Students were assigned systems including wind turbine, geothermal plants, and operational amplifiers; which they analyzed using methods including Routh-Harwitz criterion, state-space model etc. Finally, they were required to show their study and findings in the form of a presentation. Students were expected to carry out these tasks by themselves, and using any supportive material by abiding by the ethical rules and norms.

Eighteen (18) students were assessed in Spring 2018 using the performance criteria listed in the table 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.

Table 8 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, that is, over 80% of students were able to identify and perform the professional, ethical, and social responsibilities while carrying out their assigned tasks.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
f1. Knowledge	0	0	18	100%
f2. Practice	0	0	18	100%
f3. Behavior	0	0	18	

Table 8: EE 355 assessment of Outcome (f): Problem Solving.

Klamath Falls, EE 401, Spring 2018, Dr. Eve Klopf

This outcome was assessed in EE 401 — Communication Systems in Winter 2018 by means of a lab assignment. Twelve students were assessed using the performance criteria listed in the table 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. Students were instructed to answer a number of questions regarding which of a number of digital signaling methods that had been discussed in class had the lowest probability of error in the presence of white Gaussian noise and with the assumption of the receiver having a matched filter. In answering these questions, students wrote a description of the problem and their solution, including clear descriptions of how they planned to implement their solutions. Students then implemented their analysis using Matlab code and used the results of their code in order to make a determination of relative probability of error of 9 methods of digital signaling. Finally, students developed solutions appropriate for the problem by analyzing their results in order to determine which methods had the lowest probability of error.

Table 9 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 outcome; that is, that over 80% of students were able to identify and define the problem of determining which digital signaling method(s) has the lowest probability of error in the presence of white Gaussian noise and the assumption of the receiver having a matched filter, articulate the problem in engineering terms by developing a model in order to compare the results, and develop solutions appropriate to the problem by assembling their model and drawing conclusions from the results.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
e1. Knowledge	0	0	18	100%
e2. Practice	0	0	18	100%
e3. Behavior	0	0	18	100%

Table 9: EE 472 assessment of Outcome (e): Problem Solving.

3.2.3.5 Outcome (g): Communication

An ability to communicate effectively.

A targeted direct assessment of this outcome was EE355 and EE 430 in three sections of EE 465 *Capstone Project*.

Klamath Falls, EE 355, Spring 2018, Dr. Eklas Hossain

This outcome was assessed in EE355 - Control System Design in Spring 2018 by means of a project. The project consisted of analyzing stability of different systems using stability analysis methods. Students were assigned systems including wind turbine, geothermal plants, and operational amplifiers; which they analyzed using methods including Routh-Harwitz criterion, state-space model etc. Finally, they were required to show their study and findings in the form of a presentation.

Eighteen (18) students were assessed in Spring 2018 using the performance criteria listed in the table 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.

Table 10 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, that is, over 80% of students were able to identify and perform the professional, ethical, and social responsibilities while carrying out their assigned tasks.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
1. Oral	0	0	18	100%
2. Acquisition	0	0	18	100%
3. Written	0	0	18	100%

Table 10: EE 355 assessment of outcome (g): Communication.

Portland Metro, EE 430, Spring 2018, Dr. Mateo Aboy

This outcome was assessed as part of EE430 — Digital Signal Processing in Spring 2018 by means of a lab assignment (Lab 9). Students were required to conduct research on beat detection algorithms for physiologic signals (e.g., QRS and pressure beat detectors) and design an automatic beat detection algorithm using DSP techniques (e.g., FIR filters, IIR filters, spectral analysis). In order to assess Outcome G, students were required to write a brief report (3-4 pages) following the IEEE Transactions Camera-Ready standards.

Seven (7) students were assessed in Winter in the course EE430 — DSP using the performance criteria listed in the table 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.

Table 11 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, that is, over 80% of students were able to apply mathematics, science and engineering fundamentals to design an adjustable power supply with a discrete regulator.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
1. Oral	1	6	18	96%
2. Acquisition	1	6	18	96%
3. Written	1	6	18	96%

Table 11: EE 430 assessment of outcome (g): Communication.

3.2.3.6 Outcome (i): Independent Learning A recognition of the need for, and an ability to engage in, life-long learning.

A targeted direct assessment of this outcome was done in EE 225, EE321, and REE 321.

Klamath Falls, EE 225, Spring 2018, Dr. Eve Klopf

This outcome was assessed in EE 225 — Circuits 3 in Fall 2017 by means of a lab assignment. Four students were assessed in Fall 2017 — Circuits 3 using the performance criteria listed in the table 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. Students were instructed to answer a number of questions regarding human exposure to wireless signals. In answering these questions, students performed independent learning on the topic of human exposure to wireless signals including methods of calculating tissue penetration depth of transmitted signals. Students evaluated their learning options and applied what they learned to select an appropriate method to calculate the penetration depth of signals at two different frequencies into human tissue. They then used their research and calculation results in a technical discussion of radio-frequency (RF) safety.

Table 12 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 outcome; that is, that over 80% of students were able to apply independent learning to a project by conducting independent research on the question of RF safety and methods for calculating tissue penetration depth of transmitted signals, either discuss the meaning of the information that they researched and apply it to a research project (through calculation of tissue penetration depth and analysis of RF safety) or organize the information by categories (such as various frequencies of signals), identify how that information is interrelated (such as by discussing different levels of hazards at different frequencies) and applying that information to actual situations (such as by analyzing which types of technology used those various frequencies and the implications for RF safety in different situations), and by evaluating the learning options available, selecting the best option, and supporting their decision from a technical point of view by selecting resources for self-teaching about RF safety and then answering technical questions based on their research.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
i1. Needed	0	0	4	100%
i2. Gathering	0	1	3	100%
i3. Continuous	0	0	4	100%

Table 12: EE 430 assessment of Outcome (i): Independent learning.

Portland Metro, EE 321, Fall 2017, Dr. Mateo Aboy

This outcome was assessed in EE321 - Electronics I in Fall 2017 by means of lab project. The purpose of the project was for students to independently design and test a regulated power supply.

The lab assignment consisted of designing, simulating, implementing, and experimentally testing an ACâtoâDC power supply and linear regulator with current boosting to provide an adjustable regulated output voltage with shortâcircuit/overload protection. Students were provided with a series of design specifications and design constraints. Students were expected to select an initial topology within the given constraints, identify the limitations of this topology and work on improving the design through an iterative process of analyzing and solving technical problems until the given specifications were met. Once the design was finalized (analyzed theoretically) and the simulations indicated the results were met, students were required to physically implement their designs and experimentally test them. Finally, the students were required to write a record and video demo showing their working design and write a brief (approximately 3 double column pages) report documenting their design. The assignment required students to engage in independent learning (a component of lifelong learning) by researching different types of voltage regulators (not covered in class), learn how they work, and implement their own linear regulator to meet the stated specifications. Additionally, they submitted 3 progress updates documenting their research (independent learning).

Seventeen students were assessed in Fall 2017 in the course EE321 Electronics I using the performance criteria listed in the table 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.

Table 13 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, that is, over 80% of students were able to apply mathematics, science and engineering fundamentals to design an adjustable power supply with a discrete regulator.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
i1. Needed	1	16	0	94%
i2. Gathering	3	14	0	82%
i3. Continuous	3	14	0	82%

Table 13: EE 321 assessment of Outcome (i): Independent learning.

Portland Metro, REE 463, Winter 2018, Dr. Robert Melendy

REE 463 Energy Systems Instrumentation (Winter 2018) ABET Outcome (i) was assessed by means of a laboratory assignment in which students conducted a comprehensive, multidisciplinary experiment. The objective of this experiment was to have the students recognize the need for sensors, actuators, and electronic circuitry in measuring equipment and instrumentation engineering. An equally important objective was to have students recognize the need for Newtonian mechanics and the mechanical properties of materials in the development of electronic instrumentation for energy-related systems.

Two (2) EE majors were assessed using the performance criteria (Table 1). The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria. For outcome i1 (Demonstrates and awareness of what needs to be learned), the minimal acceptance performance criteria was under 80% (50%). For outcome i2 (Identifying, gathering, and analyzing information), the results indicate that the minimum acceptable performance level of 80% was exceeded (100%). Note that these two EE students were in the same course along with eleven (11) REE majors, whose performance criteria for i1 and i2 were 91% and 91%, respectively. So taken altogether, the low performance criteria of 50% for i1 (for this small population of EE majors) is not overly concerning. Conversely, the score of 100% for i2 is not overly optimal (given the small population), however, it is much more reflective of the 90.91% demonstrated by the REE majors for i2.

Overall, the majority of the thirteen (13) students in REE 463, met or exceeded expectations. Students from both REE and EE majors demonstrated their abilities to interface sensors and actuators with various metal test specimens, how sensors and actuators interface with various electronic circuitry to form different types of energy systems instruments, how the different forms of measurements are interrelated with sensors, actuators, and recording instrumentation, and how experimental research is conducted using instruments and components that the researcher designs and builds.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
i1. Needed	1	16	0	50%
i2. Gathering	3	14	0	100%
i3. Continuous	N/A	N/A	N/A	N/A

Table 14: REE 463 assessment of Outcome (i): Independent learning.

3.2.3.7 Outcome (j): Contemporary Issues A knowledge of contemporary issues.

A targeted direct assessment of this outcome was done in EE 401, *Communication Systems*

Klamath Falls, EE 401, Winter 2018, Dr. Eve Klopf

This outcome was assessed in EE 401 — Communication Systems in Winter 2018 by means of a lab assignment. Students were instructed to answer a number of questions involving the development of the 5G network and its likely impact on areas which will and will not have coverage through this network. As our university is located in a rural area of Oregon, students have experience with areas which currently are and are not covered within existing cellphone networks. This topic is also germane because 5G is/will be the next generation of cellphone technology and will enable IoT device communication on a level not currently available; this technology is currently under active development and, consequently, represents a contemporary issue involving communication systems. Additionally, there were a number of articles in the news at that time that this assignment was given discussing the question of whether the federal government or private industry should be in control of the development of the 5G network. As a part of this assignment, students were also asked to give their opinion about whether the federal government or private industry should control development of the 5G network, as well as their reasons for their opinion on this issue.

Twelve students were assessed in Winter 2018 in the course EE 401 — Communication Systems using the performance criteria listed in the table 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.

Table 15 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 outcome; that is, that over 80% of students were above to discuss the impacts on areas having and not having cellphone coverage currently, discuss what the 5G network is/will be and how it is likely to impact communities having and not having this coverage, and additionally give an opinion on whether development of the 5G network should be controlled by the federal government or private industry and provide justification for this opinion.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
j1. Knowledge	0	0	12	100%
j2. Temporal	0	2	10	100%
j3. Context	0	0	12	100%

Table 15: EE 323 assessment of Outcome (j): Contemporary Issues.

Portland Metro, EE 401, Spring 2018, Dr. Aaron Scher

This outcome was assessed by asking students to write a paper that examines the impact of engineering technology solutions in a contemporary societal and global context. Since this outcome was assessed in EE 401 Communication Systems, the general topic of the paper was expected to be related to communication systems. Appropriate areas of inquiry include the debate over net neutrality, the cellphone radiation and health risks, and communication security issues.

A total of 21 BSEE students were assessed in Spring 2018 in the course EE 401 Communication Systems using the performance criteria listed in the table below. Students were not assessed in performance criteria 2) Knowledge of Contemporary Issues (ecosystems).

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
j1. Knowledge	4	10	7	81%
j2. Temporal	7	11	3	67%
j3. Context	8	8	5	62%

Table 16: EE 401 assessment of Outcome (j): Contemporary Issues.

3.2.3.8 Outcome (k): Engineering Tools

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

A targeted direct assessment of this outcome was done in EE 331 *Digital System Design*.

Portland Metro, EE 331, Spring 2018, Dr. Allan Douglas

This outcome was assessed by means of a single lab. Each student was asked to design, build, and test serial UART using a Xilinx FPGA according to design requirements and guidelines. Students then designed their circuit in VHDL, simulated the circuit using industry standard tools, implemented their design in hardware, tested the design, and submitted a complete lab report.

A total of twenty-one students were assessed in Winter 2018 in the course EE 331 Digital System Design w/HDL using the performance criteria listed in the table 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 results indicate that the acceptable performance level was not reached in two of the three performance criteria.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
k1. Proficiency	2	5	14	90%
k2. Hardware	1	10	10	95%
k3. Communication	2	7	12	90%

Table 17: EE 331 assessment of Outcome (k): Engineering tools.

3.2.3.9 Summary of all targeted direct assessments

	Total Students	Number Students ≥ 2	Percentage Students ≥ 2
(a) Knowledge (KF & PM)			
a1. Math	33	31	94%
a2. Science	33	30	91%
a3. Engineering	33	30	91%
(c) Design (KF & PM)			
c1. Need	21	20	95%
c2. Design	21	20	95%
c3. Evaluation	21	21	100%
(d) Teams (KF)			
d1. Participation	36	36	100%
d2. Decision	36	36	100%
d3. Management	36	36	100%
(e) Problem Solving (KF)			
e1. Identify	31	29	94%
e2. Formulate	31	30	97%
e3. Solve	31	26	84%
(g) Communication (KF & PM)			
g1. Oral	43	42	98%
g2. Acquisition	43	42	98%
g3. Written	43	42	98%
(i) Independent Learning (KF & PM)			
i1. Needed	38	36	95%
i2. Gathering	38	32	84%
i3. Continuous	21	18	98%
(j) Contemporary (KF & PM)			
j1. Knowledge	33	29	88%
j2. Temporal	33	26	79%
j3. Context	33	25	76%
(k) Engineering tools (PM)			
k1. Proficiency	21	19	90%
k2. Hardware	21	20	95%
k3. Communication	21	19	90%

Table 18: Overall totals for each assessed outcome during 2017–18. The total number of students assessed, the number of students scoring 2 (accomplished) or 3 (exemplary) and the percentage of students scoring 2 or 3 is shown. (KF = Klamath Falls, PM = Portland Metro

3.2.4 Indirect Assessments

In addition to direct assessment measures, the student outcomes (a) through (k) were indirectly assessed through a senior exit survey. Senior Exit Surveys are conducted every year in the spring term. The 2017–18 data collected in spring 2017 was used in this assessment report, which covers the period of spring 2016 through spring 2017. (The 2015–16 survey covered spring 2015 to winter 2016.)

Twenty-six BSEE graduating seniors completed the Senior Exit Survey out of a total of 39 graduating. Of the twenty-six respondents, 15 were from Portland Metro and 11 were from Klamath Falls. One possible cause for the low response rate was a glitch in the survey software and from March-June surveys were not emailed.

In this survey, question Q BEE 1 asked students, "Please rate your proficiency in the following areas" and listed the ABET Student Outcomes. More than 80% of the respondents rated themselves, upon completion of the BSEE program, they were "Proficient" or "Highly Proficient" in all but one categories. Outcome (j) was self-assessed at 65% in which (18/24) or 75% of the students felt proficient or highly proficient.

These results align with the direct assessment results, where outcome (j) had the lowest attainment levels. Potential changes to improve attainment of this outcome were discussed at the closing-the-loop meeting, and the results are summarized in the next section.

Outcome	Limited Proficiency	Some Proficiency	Proficient	Highly Proficient	Proficient & Highly Proficient
(a) Knowledge	0	2	8	16	92%
(b) Experimentation	0	1	7	18	96%
(c) Design	0	3	11	12	88%
(d) Teamwork	0	2	10	14	92%
(e) Problem solving	0	1	7	18	96%
(f) Ethics	0	4	9	13	81%
(g) Communication	0	0	13	13	100%
(h) Impact	0	4	8	14	85%
(i) Independent learning	0	2	5	19	92%
(j) Contemporary issues	0	9	6	11	65%
(k) Engineering tools	0	1	11	14	96%

Table 19: Results of the indirect assessment of proficiency for ABET outcomes from the Senior Exit Survey (2017–18).

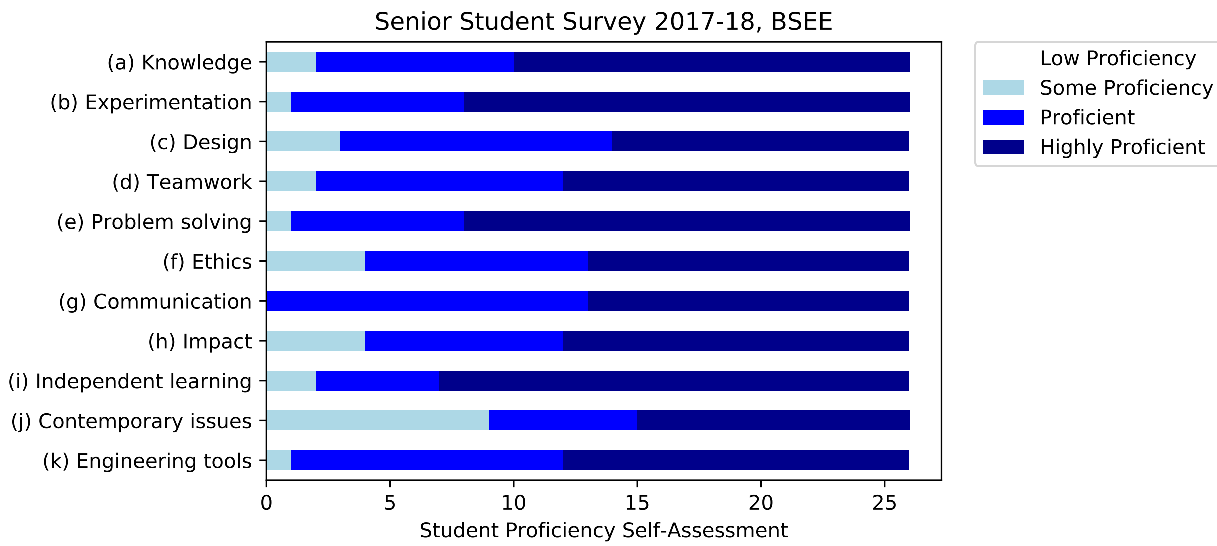

Figure 1: Self-assessment of proficiency at ABET outcomes by the students as reported in the Senior Exit Survey (2017–18).

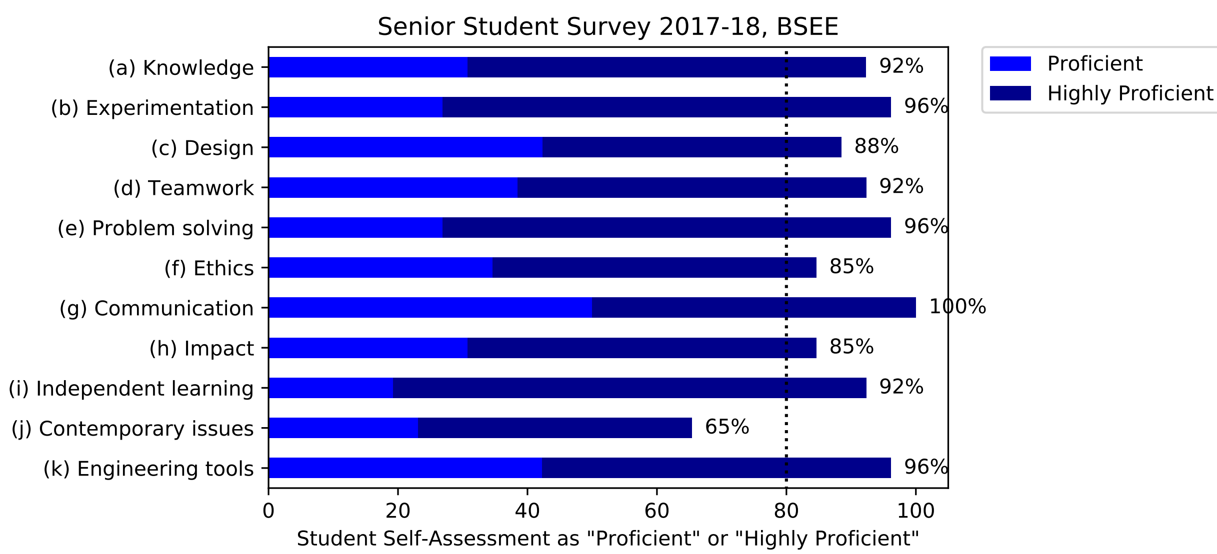

Figure 2: Self-assessment as “Proficient” or “Highly Proficient” for ABET outcomes as reported in the Senior Exit Survey (2017–18).

4 Changes Resulting from Assessment

This section describes the changes resulting from the assessment activities carried out during the academic year 2017–18. 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.

The BSEE faculty met on November 8, 2018 to review the assessment results and determine whether any changes are needed to the BSEE curriculum or assessment methodology based on the results presented in this document. The objective set by the BSEE faculty was to have at least 80% of the students perform at the level of accomplished or exemplary in all performance criteria of the assessed outcomes. Table refsummary provides a summary of the 2017–18 assessment results. Table refhistory shows how these assessments relate to those from previous assessment cycles.

The results of the 2017–18 assessment indicate that the minimum acceptable performance level of 80% was not met on every performance criterion for every assessed outcome. Below is a detailed report of the discussions from the closing-the-loop meeting held on November 8, 2018.

4.1 Outcome (a): Knowledge

Results: The direct and indirect assessment results show that the threshold of attainment of this outcome was exceeded in all performance criteria.

Recommendation: The faculty identified no problem with this outcome, and therefore recommended no changes at this time.

4.2 Outcome (c): Design

Results: The direct and indirect assessment results show that the threshold of attainment of this outcome was exceeded in all performance criteria.

Recommendation: The faculty identified no problem with this outcome, and therefore recommended no changes at this time.

4.3 Outcome (d): Teams

Results: The direct and indirect assessment results show that the threshold of attainment of this outcome was exceeded in all performance criteria.

Recommendation: The faculty identified no problem with this outcome, and therefore recommended no changes at this time.

	2014–15	2015–16	2016–17	2017–18
(a) Knowledge	$N = 34$			$N = 33$
a1. Math	94%			94%
a2. Science	94%			91%
a3. Engineering	94%			91%
(c) Design)	$N = 18$			$N = 21$
c1. Need	83%			95%
c2. Design	94%			95%
c3. Evaluation	50%			100%
(d) Teams	$N = 30$			$N = 31$
d1. Participation	100%			100%
d2. Decision	100%			100%
d3. Management	100%			100%
(e) Problem Solving				
			$N = 50$	$N = 31$
e1. Identify			94%	94%
e2. Formulate			82%	97%
e3. Solve			98%	84%
(g) Communication				
			$N = 22$	$N = 43$
g1. Oral			91%	98%
g2. Acquisition			77%	98%
g3. Written			86%	98%
(i) Independent Learning				
			$N = 6$	$N = 38$
i1. Needed			100%	95%
i2. Gathering			100%	84%
i3. Continuous				98%
(j) Contemporary Issues				
	$N = 36$		$N = 26$	$N = 33$
j1. Knowledge	69%		100%	88
j2. Temporal	67%		100%	79
j3. Context	58%		100%	76
(k) Engineering tools				
			$N = 8$	$N = 21$
k1. Proficiency			75%	90%
k2. Hardware			100%	95%
k3. Communication			75%	90%

Table 20: Comparison of results with those from previous assessment years. The percentage of students scoring 2 (accomplished) or 3 (exemplary) is shown for 2017–18 and the previous assessment year. Sample size and results includes combined total of students for each outcome evaluated within the assessed year.

4.4 Outcome (e): Problem Solving

Results: The direct and indirect assessment results show that the threshold of attainment of this outcome was exceeded in all performance criteria.

Recommendation: The faculty identified no problem with this outcome, and therefore recommended no changes at this time.

4.5 Outcome (g): Communication

Results: The direct and indirect assessment results show that the threshold of attainment of this outcome was exceeded in all performance criteria.

Recommendation: The faculty identified no problem with this outcome, and therefore recommended no changes at this time.

4.6 Outcome (i): Independent Learning

Results: The direct and indirect assessment results show that the threshold of attainment of this outcome was exceeded in all performance criteria.

Recommendation: The faculty identified no problem with this outcome, and therefore recommended no changes at this time.

4.7 Outcome (j): Contemporary Issues

Results: The direct and indirect assessment results show that the threshold of attainment of this outcome was not reached.

Recommendation: The faculty discussed this issue at length. The consensus was that the assignment used to assess this outcome was not taken seriously by the students. Faculty in Kammath Falls and Portland Metro agreed to pool resources to provide students with additional context to increase engagement by the students. This outcome falls under the new student outcome (4) which will be assessed in the next academic year.

4.8 Outcome (k): Engineering Tools

Results: The direct and indirect assessment results show that the threshold of attainment of this outcome was exceeded in all performance criteria.

Recommendation: The faculty identified no problem with this outcome, and therefore recommended no changes at this time.