BS Renewable Energy Engineering

2022-23 Assessment Report

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1 Introduction

1.1 Program Design and Goals

The Bachelor of Science in Renewable Energy Engineering (BSREE) program at Oregon Institute of Technology (Oregon Tech) has been designed to provide interdisciplinary education in mechanical, electrical, and chemical engineering topics as they apply to renewable energy. Students take coursework in communications, natural sciences, mathematics, and the humanities and social sciences to support their engineering coursework.

The BSREE program goal is to provide graduates for careers in areas of renewable energy engineering including but not limited to: solar, solar thermal, wind power, wave power, geothermal energy, transportation, energy storage, hydroelectric and traditional energy fields such as power systems, smart grid, energy management, energy auditing, energy systems planning, energy economics, energy policy and development, carbon accounting and reduction, and controls and instrumentation. BSREE graduates will enter renewable energy engineering careers as design, site analysis, product, application, test, quality control, and sales engineers.

The BSREE curriculum is designed to match the University's mission to provide hands-on learning in renewable energy engineering topics such as power systems, batteries and photovoltaics. The courses included in the BSREE curriculum provide students with solid fundamentals in the areas of electrical engineering and renewable energy including circuits, power electronics, power systems and protection, grid integration of RE, wind energy and green buildings. Students are provided with the flexibility to choose electives matching their career aspirations. The management, humanities, social science, writing and communication courses are included in the curriculum to cultivate the analytical and critical thinking, communication, broader understanding of socio, economic, and environmental issues in a global context and ethical analysis skills.

The BSREE curriculum focuses on a three-term capstone design project. This year-long project is intended to encompass a major engineering design experience incorporating appropriate engineering standards and multiple constraints, as well as using the knowledge and skills acquired in earlier coursework.

1.2 Program History

In 2005, the Oregon Institute of Technology (Oregon Tech) began offering its new Bachelor of Science degree in Renewable Energy Systems (BSRES) program at its satellite campus in Portland, Oregon. The BSRES degree was the first of its kind in North America, and it was created to prepare graduates for careers in various fields associated with renewable energy. These included, but were not limited to, energy management, energy auditing, energy systems planning, energy economics, energy policy and

development, carbon accounting and reduction, and energy-related research, as stated in Oregon Tech's 2005-06 catalogue.

In 2008, however, the BSRES degree was discontinued and replaced by the Bachelor of Science degree in Renewable Energy Engineering (BSREE). Analysis of the market place and observed growth in career options across the renewable energy fields revealed significant opportunities for graduates with a solid energy engineering education. By design, the original BSRES program was built atop a firm engineering foundation, and the curriculum could generally be described as near engineering-level. But the title of the degree, Renewable Energy Systems, a dearth of 300-level mathematics coursework and the absence of several key engineering fundamentals courses prevented the degree from being considered a full engineering degree program, particularly one that could be accredited as by the Engineering Accreditation Commission of ABET, Inc. By stating engineering as a principle programmatic focus, the career potential for graduates expanded beyond those previously stated to also include engineering-related career paths such as electrochemical systems engineering, energy systems design engineering, building systems engineering and modeling, hydronics engineering, power electronics engineering, HVAC engineering, and power systems engineering.

It is anticipated that BSREE graduates will enter energy engineering careers as power engineers, PV/semiconductor processing engineers, facilities and energy managers, energy system integration engineers, HVAC and hydronics engineers, design and modeling engineers for net-zero energy buildings, LEED accredited professionals (AP), biofuels plant and operations engineers, energy systems control engineers, power electronics engineers, utility program managers, as well as renewable energy planners and policy makers. Graduates of the program will be able to pursue a wide range of career opportunities, not only within the emerging fields of renewable energy, but within more traditional areas of energy engineering as well. Without a mechanism for obtaining professional licensure, these graduates would either not be able to advance in their careers or they would not find employment in these fields to begin with. Our survey of the renewable energy industry cluster in the Pacific Northwest convinced us that an engineering degree, the BSREE degree, was the only suitable option for our students.

1.3 Program Locations

Among the advantages that make Oregon Tech an ideal institution for offering the BSREE program is the benefit of having campuses in two distinctive locations – one in the Portland-metro area in proximity to the Pacific Northwest's energy industry cluster, and the second in Klamath Falls, in the rural Southern Oregon with exceptional natural energy resources.

The Klamath Falls campus is a residential campus located in Klamath Falls, a city of around 40,000 residents in Southern Oregon. Nestled on the eastern slope of the Cascade Mountains, the 190-acre campus

offers spectacular views, an average of 300 days of sunshine per year, and ample opportunities to enjoy the great outdoors. This location also has access to exceptional natural energy resources, such as solar and geothermal. The Oregon Renewable Energy Center (OREC) and the affiliated Geo-Heat center are located here, providing exceptional opportunities for students to gain hands-on experience in the fields of power, energy, and renewable energy. The Klamath Falls campus has unique energy advantages and is already a leading geothermal research facility. In addition, the climate makes it ideally suited to applied research in the field of solar energy.

The Portland Metro campus is an urban non-residential campus located in Wilsonville, on the south of the greater Portland metro area, 15 miles south of downtown Portland. The campus is situated in a wooded business park setting among several technology companies. The Portland-metro campus allows students to leverage their classroom experience within internships at the Northwest's world-class energy and power companies.

1.4 Industry Relationships

The BSREE program has strong relationships with industry, particularly through its program-level Industry Advisory Council (IAC) and REE alumni. The IAC has been instrumental in the success of the BSREE program. Representatives from corporations, government institutions and non-profit organizations comprise the IAC, giving the BSREE a broad constituent audience. The IAC provides advice and counsel to the REE 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.

1.5 Program Enrollment and Graduation Data

Table 1 presents the BSREE program enrollment from Fall 2016 to Fall 2022. Table 2 represents the number of BSREE degrees awarded over the same time span. Based on a rolling average of survey data collected for the BSREE graduating classes of 2017 – 2019, 88% of BSREE graduates are employed and 10% are continuing education after graduation. The median salary of BSREE graduates is reported as $65,000. Current employers of BSREE graduates include PacificCorp, David Evans and Associates, Bonneville Power Administration, Portland General Electric, US Forest Service, Inc.

Table 1: BSREE Program Enrollment Headcounts

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Klamath Falls	78	80	80	74	71	49
Online	--	2	2	0	0	0
Portland-Metro	64	62	59	48	34	32
Total	142	144	142	122	105	81

Table 2: Number of BSREE Degrees Awarded

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Klamath Falls	15	5	12	9	12	11
Portland-Metro	22	8	13	14	14	8
Total	37	13	25	23	26	19

2 Program Mission, Educational Objectives and Outcomes

2.1 Program Mission

The mission of the Bachelor of Science in Renewable Energy Engineering degree program is to prepare students for the challenges of designing, promoting and implementing renewable energy solutions within society's rapidly-changing energy-related industry cluster, particularly within Oregon and the Pacific Northwest. Graduates will have a fundamental understanding of energy engineering and a sense of social responsibility for the implementation of sustainable energy solutions. Faculty and students will engage in applied research in emerging technologies and provide services to their communities.

2.2 Program Educational Objectives

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. The Program Educational Objectives (PEOs) of Oregon Tech's Bachelor of Science in Renewable Energy Engineering program are:

1 BSREE graduates will excel as professionals in the various fields of energy engineering.

2 BSREE graduates will be known for their commitment to lifelong learning, social responsibility, and professional and ethical responsibilities in implementing sustainable engineering solutions.

3 BSREE graduates will excel in critical thinking, problem solving and effective communication.

2.3 Relationship between Program Objectives and Institutional Objectives

The Oregon Tech mission statement is as follows: "Oregon Institute of Technology ("Oregon Tech"), Oregon's public polytechnic university, offers innovative, professionally focused undergraduate and graduate degree programs in the areas of engineering, health, business, technology, and applied arts and sciences. To foster student and graduate success, the university provides a hands-on, project-based learning environment and emphasizes innovation, scholarship, and applied research. With a commitment to diversity and leadership development, Oregon Tech offers statewide educational opportunities and technical expertise to meet current and emerging needs of Oregonians as well as other national and international constituents."

The mission statement was approved by the Oregon Tech Board of Trustees on May 30, 2019 and reviewed by the Higher Education Coordinating Commission (HECC) on August 8, 2019.

The BSREE PEOs are in alignment with the university's mission.

Specifically, PEO1 relates to graduates having a rigorous and relevant preparation that allows them to excel professionally in careers within the energy engineering sector. This links to the university's mission of offering "innovative, professionally focused degree programs" in engineering, with an emphasis on "hands-on education".

PEO2 emphasizes commitment to lifelong learning, which is required to stay current in the rapidly evolving field of energy engineering, as well as social, professional, and ethical responsibility. This PEO is in alignment with the university's mission to meet "current and emerging needs".

PEO3 focuses on graduates being critical thinkers, problem solvers and effective communicators. This is consistent with the university's mission to be committed to leadership development and focused on innovation.

2.4 Program Student Outcomes

Currently, the BSREE SOs follow ABET's EAC (1)-(7) outcomes. The outcomes are published on the BSREE website, as well as the annual BSREE assessment reports (also available on the program website). The BSREE student outcomes are listed below:

(1) (Problem Solving) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

(2) (Design / Broader Factors) 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) (Communication) an ability to communicate effectively with a range of audiences.

(4) (Ethics) 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) (Teamwork) 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) (Experimentation) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

(7) (Independent Learning) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The rubric based on the outcomes are represented in the appendix.

2.5 Relationship between PEOs and SOs

The mission and program educational objectives (PEOs) describe the capabilities of the graduates after they have entered their chosen career. The student outcomes (SOs) are used to develop the necessary foundation of knowledge and skills that a graduate will need to accomplish these objectives as they mature in their disciplines. It is the student outcomes that allow graduates to excel at the educational objectives.

Table 3-2 shows a map of the BSREE student outcomes to the program education objectives. As the table indicates, the student learning outcomes correlate strongly with the education objectives, with each SO mapping to at least one PEO.

Table 3: Mapping between BSREE Student Outcomes (1)–(7) and Program Educational Objectives (PEO1, PEO2, PEO3)

	PEO1	PEO2	PEO3
(1) Problem Solving	X	X	X
(2) Broader Factors	X	X	X
(3) Communication			X
(4) Ethics		X	X
(5) Teamwork	X		X
(6) Experimentation	X		X
(7) Independent Learning		X	X

2.6 Process for Establishment and Revision of PEOs and SOs

The BSREE PEOs and SOs were set in accordance to the current ABET criteria (Criterion 3) for accrediting engineering programs. The BSREE SOs include ABET EAC outcomes (1)-(7), which are the general outcomes for all baccalaureate engineering programs. The PEOs were developed by the program faculty in consultation with the IAC.

The PEOs and SOs are periodically reviewed to ensure their relevance to the curriculum. At the annual EERE Convocation meeting in the Fall, the EERE faculty have an opportunity to review the SOs for each program in light of the results from the assessment activities conducted the previous year (i.e., direct assessments collected in program courses, as well as indirect assessment from senior exit survey), results of graduate surveys provided by Career Services, the input gathered from IAC members and employers during the previous academic year, as well as any changes to the institutional or college mission, or the ABET criteria (if any have occurred). Based on the discussion, the EERE faculty may approve to make no changes to the program SOs or make recommendations for proposed changes. The results are determined

by a simple majority vote.

During the academic year, meetings are held with the IAC (typically in the Spring term). This meeting provide an opportunity for faculty to present program updates, assessment results, etc., as well as gather input from the IAB to inform strategic direction of the program. If changes to the SOs have been proposed by the faculty at the Fall Convocation meeting, these are discussed with the IAC members. The IAC members may approve the changes or propose alternative changes. The results are determined by a simple majority vote.

As part of the assessment cycle, the BSREE program faculty have a Closing-the-Loop meeting. This meeting is typically scheduled in the Fall term, prior to 31 October. At this meeting, the program faculty discuss the results of the assessment activities carried out during the previous academic year and have an opportunity to review the SOs. If any changes to the SOs have been approved by the faculty and the IAC, these are announced at the Closing-the-Loop meeting and included in the annual Assessment Report, which is submitted to the Director of Assessment for the university, and if approved, the new SOs are published on the BSREE program website and submitted for inclusion in the catalog for the following academic year. Table 3-1 summarizes the process for review of the BSREE program student outcomes.

Table 4: BSREE Student Outcomes Review Process

Event	Task
Convocation	• EERE faculty Review PEOs and SOs in light of assessment data and other feedback collected in previous academic year. • Faculty may propose and approve changes to PEOs and SOs
Spring IAC meeting	• If changes to PEOs and SOs have been proposed and approved by EERE faculty, they are presented to IAC for consideration and approval or revision.
BSREE Closing the Loop (CTL) meeting	• If PEO or SO changes have been approved by EERE faculty and IAC, they are announced and included in Assessment Report. • New PEOs and SOs are submitted for update on the website and catalog for following academic year.

2.7 Institutional Assessment and ISLOs

In addition to program-level student outcomes, Oregon Tech has defined and regularly assesses university-wide student outcomes. These are commonly referred to as Essential Student Learning Outcomes (ISLOs) and are linked to the general education requirements which are common to all majors. A description of the ISLOs can be found at https://www.oit.edu/academic-excellence/GEAC/essential-studies/eslo.

Oregon Tech's ISLOs support the university's mission. They reflect the common expectations about the knowledge, skills, and abilities that Oregon Tech students will acquire and are reflected in the General Education requirements that lay the foundation upon which the major curricula build. Engaging in these ISLOs will support Oregon Tech graduates in developing the habits of mind and behaviors of professionals and lifelong learners.

Institutional Student Learning Outcomes: Oregon Tech students will:

- (ISLO1) ***communicate*** effectively orally and in writing;
- (ISLO2) engage in a process of ***inquiry and analysis***;
- (ISLO3) make and defend reasonable ***ethical*** judgments;
- (ISLO4) collaborate effectively in ***teams*** or groups;
- (ISLO5) demonstrate ***quantitative literacy***;
- (ISLO6) explore ***diverse perspectives***.

An initial comparison of the ISLOs to the BSREE SOs reveals good alignment between the two sets of outcomes. Both the program level and institutional level outcomes support and complement each other in a synergistic manner. This also facilitates the coordination of assessment and continuous improvement efforts at the program and institutional level. Table 3-3 shows a tentative map of the BSREE student outcomes to the ISLOs. As the table indicates, the student learning outcomes correlate strongly with the ISLOs, with each SO mapping to at least one ISLO.

Table 5: Mapping between BSREE SOs (1)–(7) and Institutional Student Learning Outcomes (ISLOs)

	ISLO1:communicate effectively orally and in	**ISLO2:** engage in a process of ***inquiry and***	**ISLO3**:make and defend reasonable ***ethical***	**ISLO4**collaborate effectively in ***teams*** or	**ISLO5:**demonstrate ***quantitative literacy***	**ISLO6:**explore ***diverse perspectives***
(1) Problem Solving		X				
(2) Design /Broader Factors						X
(3) Communication	X					
(4) Ethics			X			
(5) Teamwork				X		

(6) Experimentation					X	
(7) Independent Learning		X				

2.8 Mapping of BSREE Curriculum to Student Outcomes

The table below shows the mapping of the BSREE curriculum to the student outcomes (SOs) (1)-(7), as well as the six institutional ISLOs. For each course, the table indicates whether the outcome is covered at the foundational (F), practice (P), or capstone (C) level. In the case of electives, the student outcomes covered are dependent on the specific elective course selected by the student. They have been marked with X.

Table 6: Mapping of BSREE curriculum to SOs and ISLOs

BSREE Student Outcomes	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Institutional Student Learning	ISLO	ISLO	ISLO	ISLO	ISLO	ISLO	ISLO
BSREE Curriculum							
Communication							
SPE 111: Public Speaking	F		F				
SPE 321: Small Group & Team			P		F		
WRI 121: English Composition	F		F				
WRI 227: Technical Report Writing	P		P				
WRI 3xx/4xx: Adv. Writing Elective	P		C				
Math/Science							
MATH 251: Differential Calculus	F					F	
MATH 252: Integral Calculus	P					P	
MATH 254: Vector Calculus I	C					C	
MATH 321: Applied Differential Eq.	C					C	
MATH 341: Linear Algebra I	C					C	
MATH 361: Statistical Methods I	C					C	
CHE 201/4: General Chemistry I &	F				F	F	
CHE 202/5: General Chemistry II &	F	P				P	
CHE 260: Electrochemistry for RE applications					C	P	F
PHY 221: General Physics w/	F				F	F	
PHY 222: General Physics w/	P				F	P	
PHY 223: General Physics w/	C				F	C	
General Education							
ECO 20X: Principle of Economics,				P			F
HIST 35X: HIST 356: A History of			F	P			P

Humanities Electives (varies)	X	X	X	X	X	X	X
Social Science Electives (varies)	X	X	X	X	X	X	X
Electrical Engineering							
EE 221: Circuits I	F		F		F	F	F
EE 223: Circuits II	F		F		F	F	F
EE 225: Circuits III	P		P		P	P	P
EE 321: Electronics I	P	F	P		P	P	P
EE 461: Control Systems Design	F					C	P
EE 419: Power Electronics	C				C	C	C
Engineering Electives (varies)	X	X	X	X	X	X	X
General and Mechanical							
ENGR 211: Engineering Mechanics:	F	F	F				
ENGR 267: Engineering	P					P	
ENGR 355: Thermodynamics	F	F	F				
MECH 318: Fluid Mechanics I	P		F		F	P	
MECH 323: Heat Transfer I	P					F	
Renewable Energy Engineering							
ENGR 101: Intro. to Engineering I	F	F	F	F	F		F
ENGR 102: Intro. to Engineering II	F	F	F	F	F		F
REE 243: Electric Power	F	P	F		F	F	F
REE 253: Electromechanical Energy Conversion	F	P	F		F	F	F
REE 33X: REE 331: Fuel Cells, 333: Batteries or 335: Hydrogen	F		P		F	C	P
REE 337: Materials for RE	P						F
REE 412: Photovoltaic Systems	C	C	F	F	F	C	C
REE 413: Electric Power Conversion Systems	C				C	C	C
REE 463: Energy Systems	C	C	C	C	C	C	
REE 4XX: Senior Sequence I	F	P			F	F	
REE 4XX: Senior Sequence II	F	F		F	C	P	F
REE 4XX: Senior Sequence III	F	F	P	P	F		
Senior Project and Technical							
ENGR465: Capstone Project	C	C	C	C	C	C	C
REE 42X: Global Energy Issues	X	X	X	X	X	X	X
REE XXX: Thermal Energy Elective	X	X	X	X	X	X	X
REE 3XX/4XX: REE Technical	X	X	X	X	X	X	X
REE 3XX: Hydro Energy Elective	X	X	X	X	X	X	X

3 Cycle of Assessment for Program Outcomes

3.1 Introduction

The BSREE faculty conducts periodic assessment of student outcomes. The assessment of the program outcomes is conducted over a three year-cycle, as shown in Table 7. The assessment cycle was last revised in AY2018-19, when the program transitioned from the previous ABET SOs (a)-(k) to the new ABET SOs (1)–(7).

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

The BSREE student outcomes (1) – (7) for the historic, present and future years are presented in table 7. The current year is shown as a shaded column.

The correspondence between programmatic student outcomes (1)-(7) and institutional ISLOs is presented in Table 7. In order to streamline the assessment process, effective 2022-23 the BSEE program assessment will be modified to match the current university ISLO assessment cycle. The last three columns of Table 7 show the new assessment cycle, with the BSEE SO outcome assessment (shown as (•)) overlaps with the ISLO outcome assessment (shown as (x)).

Table 7: BSREE student outcome assessment cycle

Student Outcome	**YEAR 1 (2019/20)**	**YEAR 2 (2020/21)**	**YEAR 3 (2021/22)**	**Year 4 (2022/23)**	**Year 5 (2023/24)**	**Year 6 (2024/25)**
(1) Problem Solving ISLO2 Inquiry & Analysis	●	**x**	● **x**		● **x**	
(2) Design/Broader Aspects ISLO6 Diverse Perspectives	x	●		● **x**		
(3) Communication ISLO1 Communication	●					● **x**
(4) Ethics ISLO3 Ethical Reasoning		●	● **x**			● **x**
(5) Teamwork ISLO4 Teamwork		●	● **x**			● **x**

(6) Experimentation ISLO5 Quantitative Literacy	●	● x	● x		● x	
(7) Independent Learning ISLO2 Inquiry & Analysis		● x			● x	

Bullets (●) indicate BSREE SO (1) – (7) assessment cycle. Crosses (x) indicate ISLO assessment cycle

3.2 Methodology for Assessment of Student Outcomes

At the beginning of the academic year (typically at the Fall Convocation meeting), an assessment plan is generated by the Assessment Coordinator in consultation with the faculty. This plan includes the outcomes to be assessed during the academic year, as well as the courses and terms where these outcomes will be assessed. The BSREE curriculum is mapped to student outcomes and program educational objectives in a systematic way, as described in the previous chapter (Table 6). This facilitates the task of selecting adequate courses to perform assessment of each outcome. The target for EERE programs is to perform at least two direct assessments (one at each campus) for each outcome under assessment, according to the assessment cycle presented in Table 7, as well as one indirect assessment measure for all outcomes (1) – (7) every year (through a senior exit survey).

3.3 Collection of assessment data

Direct assessment of student outcomes are evaluated as part of the course curriculum in course assignments by the faculty members teaching the course. A systematic, rubric based process is used by faculty to assess the level of attainment of the program outcome, based on a set of performance criteria. . The BSREE rubrics were collectively created and are periodically reviewed by the program faculty. For consistency, the same rubric is used for all assessments of a particular outcome. The complete set of rubrics for all SOs are included at the end of every assessment report. The work produced by each student in the assignment assessed is evaluated according to the different performance criteria listed in the rubric, and assigned a level of 1-developing, 2-accomplished, or 3-exemplary. The results are summarized in a document including a description of the assignment and how it relates to the outcome, as well as a summary of the results in tabular form.

Indirect assessment of the student outcomes is performed on an annual basis through a senior exit survey. The survey is sent to graduating seniors in Spring term, and it includes questions where students are asked to indicate their level of preparedness in each of the SOs, as well as their opinion regarding to what extent the program has helped them to attain each of the student outcomes. For each of the outcomes, graduates rate their preparedness on a 3-point scale: “inadequately prepared”, “prepared”, or “highly prepared”.

3.4 Evaluation of Assessment data

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 as well as the courses and terms where these outcomes will be assessed.

The BSREE mapping process links specific tasks within BSREE 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 quickly 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 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.

If any of the direct assessment methods indicates performance below the established level, that triggers the continuous improvement process, 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.

3.5 Degree completion, Retention and Equity Data

Degree completion, retention and equity data are also collected by the university and annually reviewed by the program faculty as part of an initiative to identify and close equity gaps. This is done through the use of the university's dashboards, which all to track the 6-year graduation rates as well as the 1-year retention rates, and sort this data along different demographic categories such as gender, race and socio-economic status. At the closing-the-loop meeting, program faculty review the equity data for their program to identify trends or equity gaps. Potential ways to address these are discussed and appropriate action plans are developed as needed.

3.6 Assessment Report and Curriculum Changes

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 assessment report for the particular program, which is reviewed by the Department Chair and submitted to the Office of Academic Excellence for the university, which also reviews it and subsequently publishes it on the program website. Any suggested changes to the curriculum are presented and discussed with the department faculty as well as with the Industry Advisory Board at the following IAB meeting. If approved, these changes are implemented in the curriculum. For changes that affect the curriculum map, course descriptions, or course pre-requisites, the Program Director submits the necessary paperwork to the university Curriculum Planning Commission (CPC) for final approval. If approved, these changes are reflected in the catalog for the following academic year.

4 Assessment Data

4.1 Assessment of Program Outcomes - Direct Assessment

The following student outcomes were assessed in the 2022-23 academic year in the courses indicated:

- (2) Design/Broader Factors : ENGR 465 Capstone Project (PM and KF)

The sections below describe the targeted assessment activities and detail the performance of students for each of the assessed outcomes. Unless otherwise noted, the tables report the number of students performing at a 1- developing level, 2- accomplished level, and 3- exemplary level for each performance criteria, as well as the percentage of students performing at an accomplished level or above (i.e., assessed level ≥ 2).

The target attainment level for all outcomes is 80% of students at or above a level 2 (Accomplished). All direct assessment was performed using the rubrics in section 6 (Rubrics).

4.1.1 Direct Assessment of Outcome (2) Design/Broader Factors

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

A total of 12 BSREE students were assessed in ENGR 465 (KF: N = 6; PM: N = 6). The results are presented in Table 8.

ENGR 465 – Spring 2023, Feng Shi (Klamath Falls), Slobodan Petrovic (Portland Metro)

This outcome was assessed in ENGR 465 - Capstone Project. 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 includes a background review of the state of art, explanation of the project relevance and problem addressed, a project definition or specification, a proposed design, 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.

Throughout the term, students present status updates of their project to the class and answer questions. Once the design, implementation, and verification process is completed, and there is a final working prototype, students are required to generate and present a poster or slide presentation and submit a formal written report. When appropriate, students must show a working prototype of their project. Students are encouraged to present their project at the annual IdeaFest event in Spring term.

The capstone project requires 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.

Table 8: Results of direct assessment for student outcome (2) Design / Broader Factors

PERFORMANCE CRITERIA	1- DEVELOPING	2- ACCOMPLISHED	3- EXEMPLARY	% STUDENT ≥2	Outcome Attained?
Klamath Falls, ENGR 465, N=6					
2.1	0	0	6	100%	Y
2.2	0	2	4	100%	Y
Portland Metro, ENGR 465, N=6					
2.1	0	0	6	100%	Y
2.2	0	2	4	100%	Y

4.1.2 Indirect Assessment of Program Outcomes

In addition to direct assessment measures, student outcomes (1)-(7) were indirectly assessed through a senior exit survey of graduating students.

The following questions were posed to the BSREE graduating class for each of the outcomes listed above as part of the Senior Exit Survey:

- Q1 Rate your proficiency in the following areas
- Q2 Rate how much your experiences at Oregon Tech contributed to your knowledge, skills, and personal development in these areas

Graduating students are asked to rate their proficiency in each of the program outcomes as well as the contribution of Oregon Tech to their attainment of each outcome on a 4-point scale (0-lowest to 3-highest). The departmental objective is to have at least 80% of participants give a rating of 2 or 3 in both questions.

None of the BSREE graduating students completed the Senior Exit Survey. The no participation rate was due to issues with the survey distribution at the institutional level. How to address this institutional issues and the results were discussed were discussed by the faculty in the closing the loop meeting (see section 5).

4.2 Assessment of ISLOs

The following ISLOs were assessed in the 2022-23 academic year in the courses indicated:

- ISLO6 Diverse Perspectives : ENGR 465 Capstone Project (PM and KF)

The sections below describe the targeted assessment activities and detail the performance of students for each of the assessed ISLOs. The target attainment level for all outcomes is 70% of students at or above a level 3 (Proficiency). All direct assessment was performed using the ISLO rubrics as described in section 6 (Rubrics).

4.2.1 Direct Assessment of ISLO6 Diverse Perspectives

ISLO6 Diverse Perspectives is defined as:

Recognition of diverse perspectives requires the self-awareness, intellectual flexibility, and broad knowledge that enables perception of the world through the eyes of others. This includes but is not limited to the awareness and understanding of the customs, practices, methodologies, and viewpoints of varied cultures, individuals, and identities.

Direct assessment was performed on a sample of 12 BSREE students (KF: N = 6, PM: N = 6). A description of the artefacts used for direct assessment can be found in section 4.1. All direct assessment was performed using the ISLO rubrics in section 6 (Rubrics). The results are presented in Table 10.

The results display the percentage of students showing 1 - limited proficiency, 2 - some proficiency, 3 - proficiency and 4 - high proficiency in each performance criteria, as well as the percentage of students reaching a level of proficiency ≥ 3. The target attainment level for all ISLOs is 70% of students at or above a level 3 (Proficiency).

4.2.2 Indirect Assessment of ISLOs

In addition to direct assessment measures, ISLOs 1-6 are indirectly assessed through a senior exit survey of graduating students.

Students are asked to rate their proficiency in each of the ISLOs on a 4-point scale. The attainment target is to have at least 70% of participants give a rating of 3 or above.

Graduating students are asked to rate their competency in each of the program outcomes on a 4-point scale (0-lowest to 3-highest). The departmental objective is to have at least 80% of participants give a rating of 2 or 3 in both questions.

None of the seniors completed the Senior Exit Survey (0% of the graduating class). The low participation rate was due to issues with the survey distribution at the institutional level. These results and how the institutional issues have been addressed are discussed in the Closing-the-Loop section of the report (see section 5).

The Table 10 shows the direct assessment with the attainment target 70% of scores ≥ 3. Indirect assessment was not included because no student data collected.

Table 9: Results of direct assessment for ISLO6-Diverse Perspectives

PERFORMANCE CRITERIA	1-LIMITED PROFICIENCY	2-SOME PROFICIENCY	3-PROFICIENCY	3- HIGH PROFICIENCY	% STUDENT ≥2	Outcome Attained?
Klamath Falls, ENGR 465, N=6						
Recognize	0	0	1	5	100%	Y
Know	0	0	1	5	100%	Y
Understand	0	0	1	5	100%	Y
Apply	0	0	1	5	100%	Y
Portland Metro, ENGR 465, N=6						
Recognize	0	0	3	3	100%	Y
Know	0	0	3	3	100%	Y
Understand	0	0	2	4	100%	Y
Apply	0	0	2	4	100%	Y

4.3 Degree Completion, Retention and Equity Data

The university has implemented several dashboards to track 6-year graduation data and 1-year retention data to identify and close the equity gaps in different categories such as gender, race and socio-economic status.

Figure 1 shows the 6-year degree completion rates of students starting their degree in Fall 2011 through Fall 2016. Figure 4 shows the 4th term retention rates for students starting at Oregon Tech in Fall 2015 through Fall 2021. Figure 2 shows the 4th term retention rate. The 4th term retention rate represents the proportions of students who were still enrolled at Oregon Tech four terms after their start of the term (excluding the summer term). Both sets of data are presented for three student populations: (1) BSREE students, (2) College of ETM students, and (3) all Oregon Tech students. By overlapping these 3 populations, we can identify whether there are trends that pertain specifically to BSREE students, or whether they follow the overall college or university trend.

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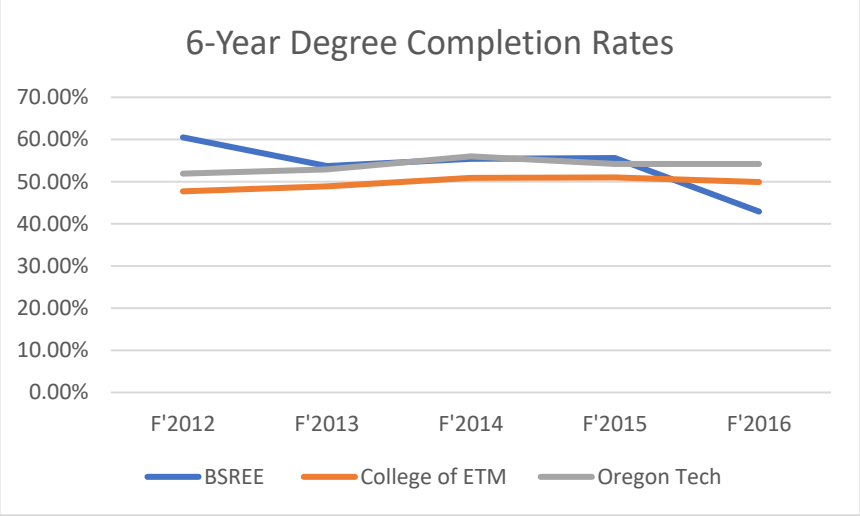

Figure 1: 6- year degree completion rates for students who started at Oregon Tech in Fall 2012 through Fall 2016

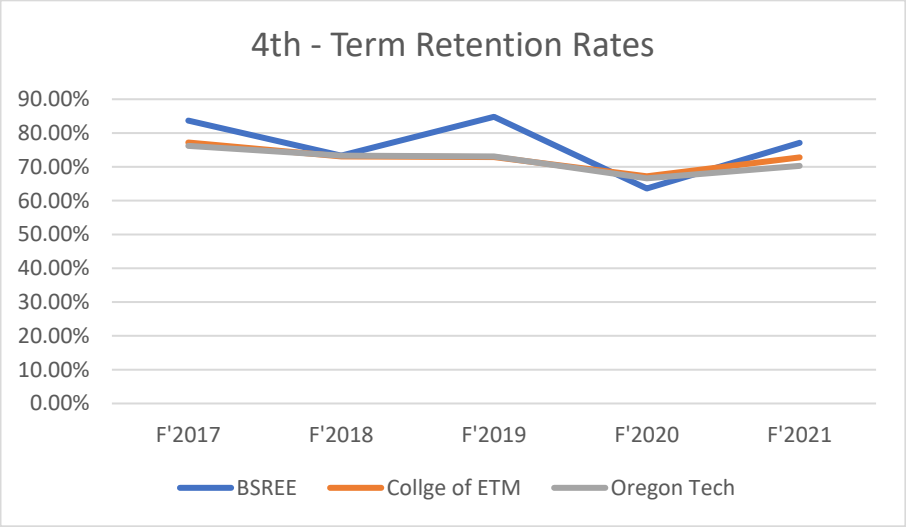

Figure 2: 4th term retention rates for students who started at Oregon Tech in Fall 2017 through Fall 2021

For the 6-year degree completion rate the BSREE program seems was facing a steep decline Fall 2015 with slightly higher value in Fall2012. The 4th- term retention rate has increased slightly in Fall 2021.

Figure 1 shows the 6-year degree completion rates for students starting in Fall 2012 through Fall 2016 (a 5-year window, N = 224). The 6-year degree completion rate for the overall BSREE population (42.9%) is also shown for reference.

Figure 3 shows the 6-Year Degree Completion Rate by Equity Group. Out of the total graduates in Fall 2016, the equity data is derived. The data is presented for different subpopulations of students categorized according to various equity groups (gender, race, etc.).

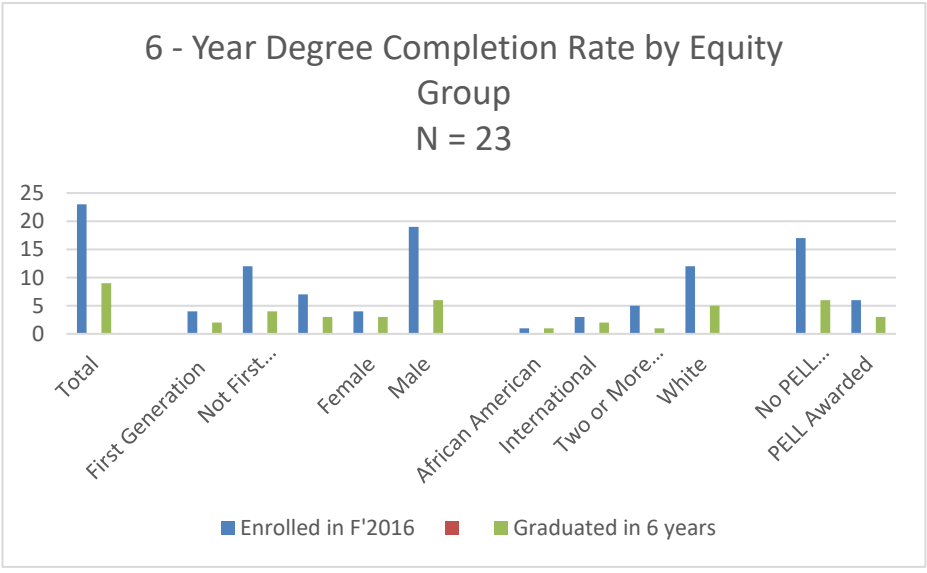

Figure 3: 6-year degree completion rates by Equity Group

5 Continuous Improvement and Closing – the – Loop

5.1 Summary of Assessment Results

Table 13 provides a summary of the 2022-23 assessment results for the outcomes which were directly assessed.

The objective set by BSREE department is at least 80% of the students perform at the level of (2) accomplished or (3) exemplary in all performance criteria of the assessed outcomes.

The changes resulting from the assessment activities carried out during the year 2020-21. 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.

Table 10 - Summary of BSREE direct assessment for 2022-23

Student Outcome	**AY20-21**	**AY22-23**	**Outcome Met?**
(2) Design/Broader Factors **ISLO6 Diverse Perspectives**	N=32	N=12	
2.1 Engineering design	90.92%	100%	Yes
2.2 Broader Factors	93.52	100%	Yes

Table 11 shows a summary and history of results for the direct assessment of outcomes assessed in AY2022-23 compared to AY2020-21. The table shows the percentage of students scoring 2 (accomplished) or 3 (exemplary) in each performance criteria. These results shows the number of students assessed within the year from all campus locations. The objective set by the EERE department is to have at least 80% of the students perform at the level of accomplished or exemplary in all performance criteria.

5.2 Evaluation of Results and Data Driven Action Plans

Below is a summary of the discussion and recommendations made by the BSEE faculty based on the evaluation of the assessment results. The summary of the action plans proposed can be found in Table 12.

1. **Assessment of Program SOs**

Outcome (2) Design/Broader Factors was attained to the desired level, which is consistent with historical trends. No action required at this point.

2. **Assessment of ISLOs**

ISLO 6 Diverse Perspectives was attained to the desired level. No action required.

3. **Indirect Assessment**

In AY2022-23, the university changed its reporting system from FAST to a new reporting application Edify. Due to a clerical error when linking the Student Exit Survey to the new system, only students who graduated in Fall term were able to complete the student exit survey, and therefore the sample size for the indirect assessment this year is too small to be meaningful. Carrie Dickson is working on this and expects this issue to be resolved by Fall 2023. Indirect assessment data collected from previous years shows generally a positive level of attainment of student outcomes.

4. **Program Changes**

The BSREE curriculum map was updated effective Fall 2023 with the aim of having the courses line up in the same terms in K Falls and PM campuses. This should make it easier to run courses remotely if there is a last minute adjunct cancellation, for example. Advisors must also be aware of the changes to the communications courses (course names and credits) implemented last year. BSREE advisors should keep an eye for changes in the terms course are offered and assist students whose academic plans may have been impacted. Any issues with the new curriculum maps should be reported to the BSREE Program Director.

5. **Accreditation**

The final report from the ABET accreditation visit from Fall 2023 was positive for reaccreditation. Two weakness were identified. The first weakness relates to the incorporation of appropriate engineering standards in the capstone projects. The concern relates to low faculty numbers to support the current programs. The department must submit a report describing the corrective actions to address these items by July 1, 2024. A request to ABET for a reaccreditation report evaluation must be made by January 31, 2024.

6. **Enrollment, Retention, Graduation and Equity trends**

BSREE enrollment is -- in Klamath Falls and -- in Portland Metro. Overall enrollment has steadily decreased in the last 5 years, from 144 in AY2018-19 to 81 in AY2022-23. The 4th-term retention rate has improved from 63.6% (Fall 2020) to 73.1% (Fall 2021). This is slightly higher than the retention for the College of ETM (72.8%) and Oregon Tech (70.3%). The 6-year graduation rate has decreased from last year (last year: 55.6%, this year: 42.9%), and is lower than the College of ETM (49.9%) and the university 54.2%).

Figure 4 shows the equity data was collected over a 5-year window to avoid artefacts due to low sample sizes. The PELL awarded is 43.2% whereas no PELL awarded is seen as 52.2%. Major equity gaps (>10%) are observed in all groups as shown in Figure 4. In many cases, the sample sizes in one or more of the subcategories is too small (N< 30), so based on this data there are no equity gaps that can be meaningfully identified.

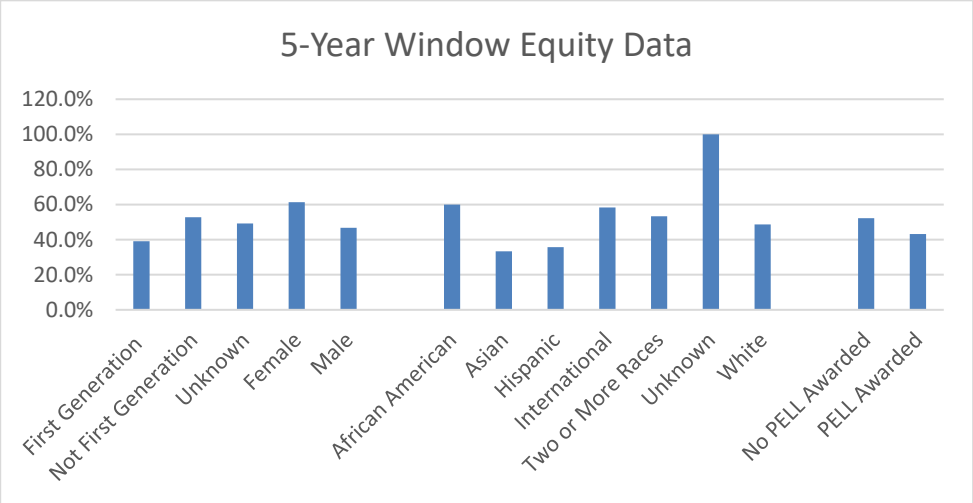

Figure 4: 5-Year Window equity data

Enrollment and retention have been an ongoing issue for a few years, and have been negatively impacted by the COVID-19 pandemic, followed by the high rate of faculty attrition in the last year. The department has been working (and will continue to do so) on stabilizing the situation. A new department chair was brought on board this year, as well as some new faculty hires. In order to improve timely graduation rates and retention, the department will prioritize predictable course scheduling (e.g., ensuring adequate faculty resources to deliver the curriculum at the expected level of quality, minimizing course cancellations). The department chair and BSEE faculty will work with Strategic Enrollment Management and the Admissions office to determine how we can inform and collaborate in recruiting efforts.

The results of the 2022-23 Assessment indicate that the minimum acceptable performance level of 80% was met on all performance criteria for all assessed outcomes except outcome in (1). Areas of improvement to the curriculum were discussed during the Closing the Loop Meeting in October 22, 2022 with respect to these results.

Table 11: Summary of data-driven action plans

Item	**Action**	**Person In Charge**	**Due Date**
SO (2) Design Broader Factors -Outcome met	None	N/A	N/A
ISLO6 Diverse Perspectives -Outcome met	None	N/A	N/A

Indirect Assessment -No participation	Address and correct institutional issues with Student Exit Survey distribution.	C.Dickson	Fall 2023
Program Changes -Updates to BSREE curriculum map effective Fall 2023, and changes to GenEd courses	Updated curriculum maps must be published on the website and advisors should refer to updated versions on EERE website. Any issues that may arise must be reported to BSREE PD and resolved. Catalog should be checked and updated if needed.	N.Korivi, C. Venugopal	Fall 2023
Accreditation – 2 weakness were identified in last ABET visit	A small task force led by M. Aboy will work on determining what changes need to be implemented to address the ABET concern, see that these changes are implemented, and generating the report for ABET describing the corrective action taken.	M. Aboy, N.Korivi, C. Venugopal	Spring 2024
Enrollment, Retention, Graduation and Equity Data	In order to improve timely graduation rates and retention, the department will prioritize predictable course scheduling (e.g., ensuring adequate faculty resources to deliver the curriculum at the expected level of quality, minimizing course cancellations). The department chair and BSREE faculty will work throughout the academic year with Strategic Enrollment	N.Korivi	Spring 2024

	Management and the Admissions office to determine how we can inform and collaborate in recruiting efforts.		
SO(4) Ethics -Outstanding item from last year's report (see Table 13)	SO (4): Faculty proposed to provide students more opportunities to develop their ethical judgement by including some coverage of ethics in other courses throughout the curriculum. An ethics module will be added to EE461	S.Petrovic and F.Shi	Spring 2024

5.3 Review of Previous Year Action Plans

Table 13 shows the status of implementation of recommendations for changes based on prior assessment

Table 12: Status of action plans from prior assessment

Item	**Action**	**Person In Charge**	**Status**
SO (1) Problem Solving	SO(1):The faculty identified a problem with this outcome, and therefore recommends special attention and monitoring of this outcome. If the similar result is obtained in the following year it is recommended that a detailed analysis is performed.	S. Petrovic	In Progress Will be assessed in Winter 2024
SO(5) Teamwork -from last year's report	SO(5): Team forming method will be more formalized to	F.Shi	Completed

	make it uniform for the entire class		
Indirect Assessment	Rephrase categories in Exit Survey as: 1. *Limited Competency* 2. *Some Competency* 3. *Adequate Competency* 4. *High Competency*. • Note: *Competency evaluated against other graduates of ABET accredited engineering programs*. Add comment field: *If you rated any Outcomes at 2 or below, please indicate the reasons*.	M.Aboy, S.Prahl	Completed
Enrollment -Sharp decline in enrollment following COVID-19 pandemic	Continue to monitor enrollment data and collaborate with Admissions on recruiting and registration events.	C.Venugopal, Aaron Scher	In progress
Retention -Decline in retention rates following pandemic, faculty strike, faculty resignations	Request for faculty positions to cover those of faculty who have recently resigned to continue to ensure program quality	Scott Prahl	In Progress (2 faculty was recruited for KF and 1 faculty recruitment is in progress)
Equity Dashboards -Only absolute numbers reported. Provides no meaningful information regarding potential equity gaps.	Cristina Crespo brought this up to the Executive Assessment Commission and will be working with the Director of Institutional Research to update dashboards to report equity data in a way that is informative.	C.Crespo	Completed

5.4 Assessment Plan for AY2023-24

An outline of the planned assessment activities for AY2023-24 is shown in Table 14. The table shows the outcomes that will be assessed (both programmatic SOs and ISLOs), as well as the courses and terms when they will be assessed, and the faculty responsible for collecting the assessment data.

Table 14: Assessment Plan for AY2023-24

Student outcome	Winter 2024	Spring 2024
SO(1) Problem Solving ISLO2 Inquiry & Analysis	REE412 S.Petrovic	ENGR 465 F.Shi, S.Petrovic
SO(6) Experimentation ISLO5 Quantitative Literacy	EE419 C.Venugopal	ENGR465 F.Shi, S.Petrovic
SO(7) Independent Learning ISLO2 Inquiry & Analysis		REE459 C.Venugopal ENGR 465 F.Shi, S.Petrovic

6 Rubrics

The rubrics used by the program faculty for direct assessment of programmatic student outcomes are included below. To promote consistency and reliability of assessment results, all faculty assessing a particular outcome use the same rubric.

The rubrics used for ISLO assessment are provided by the university through the Executive Assessment Committee, and can be found on the Institutional Assessment website.

Appendix:

Table A1: Rubric for EAC-1- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
ABILITY TO IDENTIFY A COMPLEX ENGINEERING PROBLEM	An engineering problem is not identified, or the identification is too vague or unclear.	An engineering problem of reasonable complexity is adequately identified and its significance minimally explained.	A complex engineering problem is properly identified and clearly stated. Its significance is thoroughly explained.	
ABILITY TO FORMULATE A COMPLEX ENGINEERING PROBLEM BY APPLYING PRINCIPLES OF	A complex engineering problem is not properly formulated in engineering, scientific, and/or mathematical terms. Most of the assumptions and specifications are either missing or	A complex engineering problem is adequately formulated in engineering, scientific, and/or mathematical terms, but some of the assumptions and specifications may be missing or not clearly presented.	A complex engineering problem is clearly formulated with a valid and complete set of assumptions and specifications.	

ENGINEERING, SCIENCE AND MATHEMATICS	unclear.			
ABILITY TO SOLVE A COMPLEX ENGINEERING BY APPLYING PRINCIPLES OF ENGINEERING, SCIENCE AND MATHEMATICS	The solution to a complex engineering problem is not developed according to engineering, scientific, and mathematical principles, or it does not follow the original set of assumptions and specifications.	The solution to a complex engineering problem is developed according to engineering, scientific, and mathematical principles. The solution reasonably meets most of the original set of assumptions and specifications.	The solution to a complex engineering problem is very well developed according to engineering, scientific, and mathematical principles. The solution meets or exceeds the original set of assumptions and specifications.	

Table A2. Rubric for EAC-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

CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
ABILITY TO APPLY ENGINEERING DESIGN TO PRODUCE SOLUTIONS THAT MEET SPECIFIED NEEDS	Does not follow the engineering design process, or the designed solution does not meet the specified need(s).	Reasonably follows the engineering design process to produce a solution that adequately meets the specified need(s).	Methodically follows the engineering design process to produce a solution that thoroughly meets the specified need(s).	
ABILITY TO DESIGN SOLUTIONS ACCOUNTING FOR BROADER CONSIDERATIONS, SUCH AS PUBLIC HEALTH, SAFETY, AND WELFARE, AS WELL AS GLOBAL, CULTURAL, SOCIAL,	The solution provided does not take into account broader practical considerations, such as public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	The solution provided takes into account and partially addresses some of the broader practical considerations, such as public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	The solution provided takes into account and thoroughly addresses several of the broader practical considerations, such as public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	

ENVIRONMENTAL, **AND ECONOMIC FACTORS**				

Table A3: Rubric for EAC-3- An ability to communicate effectively with a range of audiences

CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
ABILITY FOR EFFECTIVE ORAL COMMUNICATION	The main ideas are not clearly presented. Low volume or monotonous tone make it hard for audience to engage. Speaker does not transmit any interest or enthusiasm about the topic.	The main ideas are clearly presented. Adequate volume and dynamic tone are used to engage audience. Speaker occasionally transmits interest and enthusiasm about the topic.	Speaker is an excellent communicator. The main ideas are clearly presented. Speaker is eloquent and dynamic, effective at engaging the audience. Speaker displays and transmits a strong interest and enthusiasm about the topic.	
ABILITY FOR EFFECTIVE WRITTEN COMMUNICATION	Content is disorganized, the main ideas are not clearly stated and developed. Writing style is rough or imprecise. Frequent grammar/spelling errors. Document presentation and format rough or inconsistent.	Content is well organized and the main ideas are clearly stated and reasonably developed. Writing style is adequate for purpose and readable. Grammar/spelling mostly correct. Document presentation and format adequate and consistent.	Content is very well organized and easy to follow, main ideas are clearly presented and thoroughly developed. Writing style is adequate for purpose, readable, and tailored to intended audience. Grammar/spelling correct. Work is professionally presented and very well formatted.	

ABILITY FOR EFFECTIVE GRAPHICAL COMMUNICATION	Inadequate use of figures, charts, and/or tables to display data. Figures are not well placed, many figures, charts, and tables missing key formatting elements, such as titles, labels, units, captions, etc. Overall, figures do not contribute to a better understanding of key ideas or results.	Adequate use of figures, charts, and tables to display data. Figures are well placed, most figures, charts, and tables are properly labeled and formatted. Figures moderately contribute to a better understanding of key ideas or results.	Excellent use of figures, charts, and tables to display data. All figures, charts, and tables properly labeled and formatted, easy to read and interpret. Figures substantially and effectively contribute to a better understanding of key ideas or results.	
ABILITY TO ADDRESS A RANGE OF AUDIENCES	Does not address target audience. Content is too technical or too superficial to be understood by and of interest to a wide range of audiences.	Adequately addresses the target audience. Content has a reasonable balance of technical and non-technical information to be understood by and of interest to a wide range of audiences.	Effectively addresses the target audience. Content has the right balance of technical and non-technical information to be understood by and of interest to a wide range of audiences.	

Table A4: Rubric for EAC-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

CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
ABILITY TO RECOGNIZE ETHICAL AND PROFESSIONAL RESPONSIBILITIES IN ENGINEERING SITUATIONS	Description of ethical and professional responsibilities is limited or rudimentary.	Description of ethical and professional responsibilities is substantive.	Description of ethical and professional responsibilities is complete and thorough.	
ABILITY TO IDENTIFY GLOBAL, ECONOMIC, ENVIRONMENTAL, AND SOCIETAL CONTEXTS IN ENGINEERING SITUATIONS	Identifies a single context area relevant in an engineering situation. Explanation of the context is rudimentary.	Identifies most context areas relevant in an engineering situation. Explanation of the contexts is substantive.	Identifies all context areas relevant in an engineering situation. Explanation of contexts is complete and thorough.	
ABILITY TO JUDGE THE IMPACT OF ENGINEERING SOLUTIONS ON GLOBAL, ECONOMIC, ENVIRONMENTAL, AND SOCIETAL CONTEXTS	Analysis and judgement of the impact of engineering solutions on contexts is rudimentary.	Analysis and judgement of the impact of engineering solutions on contexts is substantive.	Analysis and judgement of the impact of engineering solutions on contexts is complete and thorough.	

Table A5: Rubric for EAC-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

CRITERIA	1—DEVELOPING	2—ACCOMPLISHED	3—EXEMPLARY	SCORE
ABILITY TO PROVIDE TEAM LEADERSHIP	Lacks adequate ability to resolve problems and conflicts. Lacks ability to provide adequate leadership in decision making, planning, and goal setting. Does not show appreciation for other team members' contributions. Exhibits poor team communication skills (e.g., interrupts others, gets defensive, does not ask questions, gets distracted). Does not motivate others or lead by example.	Capable of resolving problems and conflicts. Demonstrates adequate leadership ability in decision making, planning, and goal setting. Occasionally shows appreciation for other team members' contributions. Exhibits reasonable team communication skills. Capable of motivating others. Willing to share problems and progress. Mainly does assigned work instead of willingly taking on additional responsibilities.	Proficient in resolving problems and conflicts and exhibits proficient leadership ability in decision making, planning, and goal setting. Appropriately recognizes and shows appreciation for other team members' contributions. Exhibits proficient team communication skills including good body language and active listening. Transparent about expectations and objectives. Motivates others and leads by example. Willing to share problems and take on additional responsibilities and help others when necessary.	
ABILITY TO CREATE A COLLABORATIVE AND INCLUSIVE	Rarely uses respectful language or show cooperative communication skills. Does not demonstrate mutual	Generally, uses respectful language and shows cooperative communication skills. Does not disrespect other group members or	Uses respectful language and shows cooperative communication skills. Actively demonstrates mutual respect and welcomes others' unique	

ENVIRONMENT AS A TEAM MEMBER	respect and tends to dismiss others' unique perspectives, opinions, or ideas. Does not demonstrate ability and willingness to compromise with other group members.	dismiss their unique perspectives, opinions, or ideas. Demonstrates adequate ability and willingness to compromise with other group members. Does not dismiss the sharing of ideas.	perspectives. Demonstrates high ability and willingness to compromise with other group members. Makes other group members feel safe and valued through openly encouraging the sharing of ideas.	
ABILITY TO ESTABLISH GOALS, PLAN TASKS, AND MEET OBJECTIVES AS A TEAM MEMBER	Lacks basic awareness of team duties and responsibilities. Lacks basic awareness of the links between project goals and tasks. Fails to identify risks to meet project deadlines.	Capable of performing most team duties and responsibilities. Capable of establishing goals and performing necessary talks on time to meet project deadlines and identifies most issues impacting project success.	Proficient execution of all team duties and responsibilities. Proficient in establishing goals and performing necessary tasks on time to meet project deadlines and identifies issues impacting projects success.	

Table A6: Rubric for EAC-6- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
ABILITY TO DEVELOP AND CONDUCT AN EXPERIMENT	Demonstrates inadequate knowledge and abilities for conducting experiments with standard test and measurement equipment to collect experimental data. May not observe lab safety and procedures.	Demonstrates adequate knowledge and abilities for conducting experiments. Able to use standard test and measurement equipment to collect experimental data. Reasonably capable of troubleshooting to overcome measurement problems. May require supervision and steering in the right direction. Overall, observes lab safety plan and procedures.	Demonstrates comprehensive knowledge, exceptional abilities, and resourcefulness for conducting experiments. Selects appropriate equipment and measuring devices and methodology for conducting experiments. Demonstrates a proficient ability to troubleshoot, predict and overcome measurement problems. Observes established lab safety plan and procedures. Proposes improvements as necessary.	
ABILITY TO ANALYZE AND INTERPRET DATA	Demonstrates inadequate knowledge and abilities for analyzing and interpreting experimental results. Reporting methods are unsatisfactory.	Demonstrates adequate abilities for experimental data analysis, interpretation, and visualization. Able to draw some reasonable conclusions based on experimental results. Demonstrates an awareness for measurement error. Reporting methods are satisfactorily organized, logical, and complete	Demonstrates exceptional ability for experimental data analysis, interpretation, and visualization. Able to draw insightful conclusions based on experimental results. Analyzes and interprets data using appropriate theory, accounts for measurement error into analysis and interpretation, reporting methods are well-organized, logical, and complete.	
ABILITY TO USE ENGINEERING JUDGEMENT TO DRAW CONCLUSIONS	Lacks the ability and awareness for interpreting experimental data to draw meaningful conclusions, decide, act, and/or communicate suggestive actions using of appropriate scientific/engineering principles, standards, and practices. Not adept at navigating complexity, open ended problems, or ambiguous data.	Adequately capable of interpreting experimental data to draw meaningful conclusions, decide, act, and/or communicate suggestive actions based upon the use of appropriate scientific/engineering principles, standards, and practices. May require significant guidance in the face of complexity, open ended problems, or ambiguous data.	Proficient in interpreting experimental data to draw meaningful conclusions, decide, act, and/or communicate suggestive actions based upon the use of appropriate scientific/engineering principles, standards, and practices. Able to make quality engineering decisions/conclusions, especially in the face of complexity, open-ended problems, or ambiguous data.	

Table A7: Rubric for EAC-7- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
ABILITY TO ACQUIRE NEW KNOWLEDGE USING APPROPRIATE LEARNING STRATEGIES	Shows poor ability and little openness to acquire new knowledge and diagnosing their learning needs. Does not identify proper opportunities or resources to expand knowledge and skills. Unable or uninterested to find new information without significant guidance and prompting. Lacks awareness at one's current knowledge and skills for identifying basic gaps in understanding. Lacks the strategies and motivation necessary for self-directed learning.	Shows sufficient ability and openness to acquire new knowledge and diagnosing their learning needs. Able to identify some opportunities or resources to expand knowledge and skills. Able and interested to find new information, perhaps with some prompting. Uses current knowledge and skills to identify basic gaps in understanding. Exhibits adequate strategies and motivation necessary for self-directed learning.	Demonstrates proficient ability and openness to acquire new knowledge and diagnosing their learning needs. Independently identifies and uses a diverse range of resources to expand knowledge and skills. Able and interested to find new information with minimal prompting. Uses current knowledge and skills to identify key gaps in understanding. Exhibits exemplary strategies and motivation necessary for self-directed learning.	

ABILITY TO APPLY NEW KNOWLEDGE AS NEEDED	Inadequately unmotivated and skilled at applying new knowledge as needed for decision making, completing tasks, drawing conclusions, and/or understanding a topic in more depth. Insufficiently understands and determines the significance or relevance of the learned information needed for the task.	Adequately motivated and skilled at applying new knowledge as needed for decision making, completing tasks, drawing conclusions, and/or understanding a topic in more depth. Partially understands and determines the significance or relevance of the learned information needed for the task.	Proficiently skilled and motivated at applying new knowledge as needed for decision making, completing tasks, drawing conclusions, and/or understanding a topic in more depth. Understands and determines the significance or relevance of the learned information needed for the task.	