BS Renewable Energy Engineering

2019-20 Assessment Report

Eklas Hossain

Electrical Engineering and Renewable Energy Department

Contents

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.

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 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.

1.4 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 Portland-metro campus allows students to leverage their classroom experience within internships at the Northwest's world-class energy and power companies. 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.

2 Program Mission, Educational Objectives and Outcomes

2.1 Program Mission

The mission of the 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. The department will be a leader in providing career ready engineering graduates for various renewable energy engineering fields. Faculty and students will engage in applied research in emerging technologies and provide professional services to their communities.

2.2 Program Educational Objectives

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:

- BSREE graduates will excel as professionals in the various fields of energy engineering.
- BSREE graduates will be known for their commitment to lifelong learning, social responsibility, and professional and ethical responsibilities in implementing sustainable engineering solutions.
- BSREE graduates will excel in critical thinking, problem solving and effective communication.

2.3 Relationship between Program Objectives and Institutional Objectives

These program educational objectives map to the Oregon Tech's institutional mission statement and core themes by offering statewide educational opportunity in an innovative and rigorous applied degree program in engineering oriented toward graduate success and an appreciation for the role of the engineer in public service.

2.4 Program Outcomes

The BSREE program outcomes include ABET's EAC *a* - *k*. All of these are listed below:

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

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

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

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

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

(f) An understanding of professional and ethical responsibility

(g) An ability to communicate effectively

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

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

(j) A knowledge of contemporary issues

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

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

New ABET outcomes:

1. An ability to identify, formulate, and solve complex engineering 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, analyze and interpret data, and use engineering judgment to draw conclusions

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

We will be assessing (1) - (7) from now on. Basically

(1) covers the old ABET outcomes (a) and (e)
(2) covers the old ABET outcomes (c)
(3) covers the old ABET outcomes (g)
(4) covers the old ABET outcomes (f), (h), and (j)
(5) covers the old ABET outcomes (d)
(6) covers the old ABET outcomes (b)
(7) covers the old ABET outcomes (i)
(1), (2) and (6) covers the old ABET outcomes (k)

The modified rubric based on the new outcomes are represented as follows:

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

Students must demonstrate the following Program Outcome

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
IDENTIFY AND DEFINE PROBLEMS BY COLLECTING DATA AND INFORMATION	Identify the known/unknown for a problem and indicates where information is needed (comprehension). Describe a problem to be solved and define resources needed (know).	Identifies where and improvement can be made after analyzing variable limits for a basic model (analysis.) Develops, conducts and uses resources to collect information. (application) Develops possible alternative solutions to a given solution (application)	Combines data, facts and engg. knowledge to build variables, resources and limits into a problem statement and new solution (synthesis) Evaluate resources and information to assess problem statement with regard to objectivity, relevance and validity and the effectiveness of solution (evaluation)	
MODEL AND DESIGN THE EXPERIMENT BY APPLYING KNOWLEDGE OF MATHEMATICS/SCIENCE	Explains the role of mathematics/science and understands the importance of experiments as a tool in modeling a system or process (comprehension). Discuss the types of applicable model (knowledge) Determines the appropriate experimental methods for the problem (comprehension)	Applies mathematical/scientific principles to formulate a model with the appropriate level and scope (application) Designs and conducts an experiment to obtain problem information (application) Investigates functional relationships of a model for validity and analyzes the result to draw conclusions for the problem (analysis)	Identifies math/physical assumptions that allow models to be developed and determine if model data supports hypothesized relationships (analysis.) Combines principles to formulate models for a system/process in an area of concentration and to extend knowledge of the problem (synthesis). Evaluate validity of engg. models by comparing solutions to known results (evaluation).	
APPLYING KNOWLEDGE OF SCIENTIFIC AND ENGINEERING PRINCIPLES TO INTERPRET RESULT AND	Describes the fundamental sci/engg principles of a system or process to list possible solutions and criteria (knowledge). Identifies the fundamental sci/eng principles that describe implementation	Checks solutions for accuracy and ranks best solution (application) Applies manage/team skills by communication (oral/written) to implement and recommend solutions (application)	Apprises effectiveness of techniques by identifying errors and comparing solutions with a set of criteria (analysis) Combines sci/eng principles and management/team solutions to	

IMPLEMENT SOLUTION	process and documentation and define the performance of a system or process (comprehension).	Analyzes modeling results of a system or process using sci/eng principles (analysis.) Reveiws/critiques documentation by others to problem at hand (analysis.)	draw and support conclusion (synthesis.) Interprets the sci/eng significance of model predictions with respect to impact factors (evaluation)	

Table 2. 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

Students must demonstrate the following Program Outcome 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
RECOGNITION OF NEED TO DEFINE THE DESIGN PROBLEM	Describes the methods used to define needs and design (knowledge) Carries out steps in a method to define needs and design (comprehension)	Analyzes perceived needs to isolate most relevant to problem definition (analysis) Selects and performs appropriate methods at correct stage of a design project (application)	Produce a well-defined needs assessment for guiding a design project (synthesis). Evaluate consistency of needs statement with client needs (evaluation).	
DEVELOP A DESIGN STRATEGY	Names steps in a design process (knowledge). Carries out steps of a design process (comprehension).	Selects and performs appropriate design steps for a project (application). Analyzes design progress and makes revisions (analysis.).	Evaluates the design progress against the design plan (evaluation).	
GATHER DESIGN INFORMATION AND EMPLOYS MODELS IN DESIGN DECISIONS	Lists steps for gathering information and modeling and simulation methods available (knowledge). Describes differences between methods to gather information and to model and simulate (comprehension).	Recognizes the need for information and uses a modeling or simulation tool effectively (application). Selects appropriate model or simulation for design decisions (application)	Analyzes outputs from a model or simulation of design (analysis.) Utilizes information collected and incorporates model results into a design (synthesis.) Judges information quality and relevance (evaluation)	

EVALUATES RELATIVE VALUE OF A FEASIBLE SOLUTION AND IMPLEMENT THE BEST DESIGN	Describes evaluation methods and makes choice given a set of alternatives (comprehension.). Names methods and applicability (knowledge)	Selects and applies the best method to evaluate a solution (application). Analyzes results of an evaluation with other alternatives (analysis.).	Ranks results of an evaluation, select appropriate alternative and proceed with the design (synthesis). Judges quality of the evaluation (evaluation).	
COMMUNICATION AND DOCUMENTATION	Describes methods available (DR, reports), (knowledge).	Prepares proper documentation for a review as needed in design process (app). Analyzes results from presentation methods and adjusts designs (analysis.)	Performs effective reviews and evaluates potential quality (eval).	

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

Students must demonstrate the following Program Outcomes EAC-3: an ability to communicate effectively with a range of audiences				
CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
ORALLY COMMUNICATE INFORMATION	Presentation disorganized, lacks a cohesive flow; missing requirements. Questions unanswered. No visual aids; reads report; little audience contact, weak delivery.	All requirements met; organized but does not flow well. Answers most questions. Some visual aids, good presentation techniques and delivery.	Plans, prepares and delivers a well-organized presentation with all requirements met; analyzes and answers all questions. Good visual aids, good presentation techniques, good audience contact (eye contact, voice).	
ACQUIRING INFORMATION FROM VARIOUS SOURCES	Few sources, mostly Web sources; inadequate application and usage of information.	Various sources; tests credibility; good application and usage.	State of the art information from many sources; analyzes information; tests credibility; applies and uses information well.	

WRITTEN COMMUNICATION	Poor organization; missing basic components. Many grammatical and mechanical errors. Conclusion: just a summary.	Organized, possesses a style; good grammar and writing mechanics. Conclusions: summarizes and classifies.	Well-organized and developed; good abstract; selects appropriate style, form and tone; with good grammar and writing mechanics, good use of elements of writing processes. Conclusions: analyzes and critiques effectively.	

Table 4: 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

Students must demonstrate the following Program Outcome EAC-4). An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which m consider the impact of engineering solutions in global, economic, environmental, and societal contexts				
CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
DEMONSTRATING A KNOWLEDGE OF PROFESSIONAL CODES OF ETHICS AND ETHICAL PRACTICES	Aware of ethical codes that guide practice (knowledge) Can recognize the cost, time and risk components of a given situation (knowledge)	Discuss the professional code of ethics in a given field (comprehension.) Aware of ethical codes that guide practice (knowledge) Explain the consequences of ethical components with regards to professional code of ethics used in practice (cost, time and risk) (application)	General knowledge of the potential impact of code of ethics, public safety risks (comprehension.) Applies relevant aspects of a professional code when considering alternative decisions (application) Uses knowledge, information and perspectives of others to evaluate the impacts of an ethical decision (evaluation)	
EVALUATING THE ETHICAL DIMENSIONS OF A PROFESSIONAL ENGINEERING PRACTICE	Can identify some ethical issues that can impact individual customer problems (knowledge)	Describes ethical issues and the effects on individual customer problems (comprehension.) Can identify some ethical issues that can impact individual customer problems (knowledge).	Analyzes the costs, time and risk parameters in ethical terms when evaluating engineering practices (analysis.) Describes ethical issues and the effects on individual customer problems (comprehension.) Can identify some ethical issues that can impact individual customer problems (knowledge)	

KNOWLEDGE OF CONTEMPORARY ISSUES	List and discuss socio-econ, political and environment issues (knowledge) Summarizes the focus of issues and list harmful effects of technology on the environment (comprehension.)	Interprets specific scenarios relative to contemporary issues (comprehension.) Defend the impact of a particular group or party (environmental/political/societal/economic) (knowledge)	Analyze issue at the system level by breaking down an issue (analysis.) Design performs experiments with models to draw conclusions about an issue decisions (application) Evaluate solution in regards to contemporary issues, and device alternate solutions to mitigate impact (evaluation)	
IDENTIFYING SOCIAL AND GLOBAL IMPACT OF ENGINEERING SOLUTION	List basic impacts and describe key features of individual and universal perspective (knowledge)	Can describe the role of science and technology from different perspective (knowledge) Can interpret the potential impacts of a given engg. solution and failure (knowledge) State and classify the societal, global, along with environmental, economic and political impact a solution could have (comprehension.)	Interprets the impacts of an engineering solution from different perspective (application) Identify and analyze the way alternative solutions achieve the same goal (analysis) Predicts and evaluate potential impact of a solution (evaluation)	

Table 5: 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

Students must demonstrate the following program outcome. 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
TEAM PARTICIPATION AND COMMUNICATION	Can describe what an individual does to contribute to a team (comprehension). Understands active listening and constructive feedback (knowledge).	Supports other team members in their team roles (application). Demonstrates commitment to team goals (application). Summarizes main points of a team discussion (application). Applies balanced arguments in a team discussion (application).	Develops a plan to improve team participation (synthesis). Encourages other members to actively participate in the work of the team (synthesis). Incorporates feedback from others for improvement (synthesis).	

DEVELOPS A GROUP CONSENSUS	Understands techniques for generating ideas (knowledge). Participates in the development of ideas (application).	Polls team members for varying opinions (application). Considers alternative solutions after a group discussion (analysis). Integrates information and ideas from other sources (synthesis).	Develops alternative solutions based on group discussions (synthesis). Evaluates the pros and cons of solutions (evaluation). Supports ideas and viewpoints of others (val.).	
MANAGES A TEAM EFFECTIVELY	Describes how to use management tools (Gantt charts, etc.) effectively (comprehension).	Manages a meeting well with respect to time, discussions, etc. (application). Conducts an effective meeting (application).	Develops action items from a meeting and develops timetables (synthesis).	

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

Students must demonstrate the following Program Outcome 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
DEVELOPING AN EXPERIMENTING	Recognizes analytical models, simulators and testing equipment for an experiment (knowledge). Understand the need for proper units (Knowledge). Discusses lab procedures needed (knowledge). Select the variables for the experiment (comprehension).	Identifies constraints, limits and assumptions for an experiment (comprehension). Selects appropriate equipment and models for performance (comprehension). Applies constraints in the experiment design (application). Justifies the assumptions for a given test condition (application). Uses existing experiments to design a new one (application)	Predicts experimental errors (analysis). Determines the appropriate data to collect (application). Combines information/data from multiple sources for an experiment (Synthesis).	

CONDUCTING AN EXPERIMENT	Understands the use of equipment and models in an experiment (knowledge). Recognizes appropriate safety procedures (knowledge). Selects the appropriate test equipment/models to use in an exp. (comprehension)	Aware of measurement errors and uncertainty in an exp. (comprehension). Explains the operation test equip/models for an experiment (comprehension.). Uses appropriate measurement techniques to collect data (Application). Document collection procedures use for exp. Repeatability (application).	Anticipates and minimizes data errors (Application). Develop alternative approaches to an exp (Application).	
ANALYZING EXPERIMENTAL DATA	Select and explain different methods of data analysis (comprehension). Uses appropriate tools to analyze data (Application).	Explain the level of analysis required (comprehension). Uses appropriate graphs and formats for data (Application).	Prepares an analysis so that results can be duplicated (Application). Uses appropriate statistical analysis procedures (Analysis). Organize data into useful categories for analysis (synthesis).	
INTERPRETING EXPERIMENTAL DATA	Understands the need of interpreting data results (knowledge). Explain methods used to interpret results (comprehension).	Explain how results vary from model data (comprehension). Verifies/validates exp. Results using eng. tools (Application). Relates connections between results and variables (Analysis). Presents results in useful format (Synthesis).	Considers extension of results to other experiments (Evaluation). Interprets results with original hypothesis (Evaluation).	
ENGINEERING JUDGMENT	Understand information in a data sheet (knowledge). Use data sheets to define measurements in an experiment (comprehension).	Characterize a system based on data results (analysis). Use data sheets to develop a test setup for an experiment (Application).	Recommend system changes from a characterization test (Evaluation). Combine results from multiple tests to characterize a system (Synthesis).	

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

Students must demonstrate the following Program Outcome EAC-7). an ability to acquire and apply new knowledge as needed, using appropriate learning strategies				
CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
DEMONSTRATES AN AWARENESS OF WHAT NEEDS TO BE LEARNED	Identifies the tools needed to conduct research and improve skills.	Explain how what has been learned will improve research; Develop independent learning skills.	Applies what has been learned to a project; Independent research conducted.	
IDENTIFYING, GATHERING AND ANALYZING INFORMATION.	Memorizes new information; Recalls some old information.	Discusses the meaning of the information; Converts new information for use in an application or project.	Organizes information by categories; Identifies how information is interrelated; Applies information to actual situations.	

Each of the rubric has a predefined scorecard for grading, marked each criteria as Performance Criteria (PC). The scorecards for each outcome (1)-(7) is represented as follows:

ASSESSMENT SCORE CARD				
COURSE			TERM	
INSTRUCTOR			STUDENTS	
PROGRAM	BSREE		OUTCOME	1
Student	PC1	PC2	PC3	
1 - Developing	0	0	0	
2 - Accomplished	0	0	0	
3 - Exemplary	0	0	0	
TOTAL	0	0	0	
TOTAL > 1	0	0	0	
PERCENT > 1	#DIV/0!	#DIV/0!	#DIV/0!	

Figure 1: Scorecard for Outcome (1) containing 3 performance criteria

ASSESSMENT SCORE CARD					
COURSE			TERM		
INSTRUCTOR			STUDENTS		
PROGRAM	BSREE		OUTCOME	2	
Student	PC1	PC2	PC3	PC4	PC5
1 - Developing	0	0	0	0	0
2 - Accomplished	0	0	0	0	0
3 - Exemplary	0	0	0	0	0
TOTAL	0	0	0	0	0
TOTAL > 1	0	0	0	0	0
PERCENT > 1	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Figure 2: Scorecard for Outcome (2) containing 5 performance criteria

ASSESSMENT SCORE CARD				
COURSE			TERM	
INSTRUCTOR			STUDENTS	
PROGRAM	BSREE		OUTCOME	3
Student	PC1	PC2	PC3	
1 - Developing	0	0	0	
2 - Accomplished	0	0	0	
3 - Exemplary	0	0	0	
TOTAL	0	0	0	
TOTAL > 1	0	0	0	
PERCENT > 1	#DIV/0!	#DIV/0!	#DIV/0!	

Figure 3: Scorecard for Outcome (3) containing 3 performance criteria

ASSESSMENT SCORE CARD				
COURSE			TERM	
INSTRUCTOR			STUDENTS	
PROGRAM	BSREE		OUTCOME	4
Student	PC1	PC2	PC3	PC4
1 - Developing	0	0	0	0
2 - Accomplished	0	0	0	0
3 - Exemplary	0	0	0	0
TOTAL	0	0	0	0
TOTAL > 1	0	0	0	0
PERCENT > 1	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Figure 4: Scorecard for Outcome (4) containing 4 performance criteria

ASSESSMENT SCORE CARD				
COURSE			TERM	
INSTRUCTOR			STUDENTS	
PROGRAM	BSREE		OUTCOME	5
Student	PC1	PC2	PC3	
1 - Developing	0	0	0	
2 - Accomplished	0	0	0	
3 - Exemplary	0	0	0	
TOTAL	0	0	0	
TOTAL > 1	0	0	0	
PERCENT > 1	#DIV/0!	#DIV/0!	#DIV/0!	

Figure 5: Scorecard for Outcome (5) containing 3 performance criteria

ASSESSMENT SCORE CARD					
COURSE			TERM		
INSTRUCTOR			STUDENTS		
PROGRAM	BSREE		OUTCOME	6	
Student	PC1	PC2	PC3	PC4	PC5
1 - Developing	0	0	0	0	0
2 - Accomplished	0	0	0	0	0
3 - Exemplary	0	0	0	0	0
TOTAL	0	0	0	0	0
TOTAL > 1	0	0	0	0	0
PERCENT > 1	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Figure 6: Scorecard for Outcome (6) containing 5 performance criteria

ASSESSMENT SCORE CARD				
COURSE			TERM	
INSTRUCTOR			STUDENTS	
PROGRAM	BSREE		OUTCOME	7
Student	PC1	PC2		
1 - Developing	0	0		
2 - Accomplished	0	0		
3 - Exemplary	0	0		
TOTAL	0	0		
TOTAL > 1	0	0		
PERCENT > 1	#DIV/0!	#DIV/0!		

Figure 7: Scorecard for Outcome (7) containing 2 performance criteria

3 Cycle of Assessment for Program Outcomes

3.1 Introduction and Methodology

Assessment of the program outcomes is conducted over a three year-cycle. The assessment cycle was changed during the 2014-15 assessment year. This change was implemented at an assessment coordination meeting on February 2, 2014. At this meeting, assessment coordinators representing each program within the Electrical Engineering and Renewable Energy (EERE) Department aligned their assessment cycles so that each program assesses similar outcomes on the same years. The intention for this change is to better organize the assessment process and produce more meaningful data for comparison between different programs in the EERE Department. Table 8 shows the minimum outcomes assessed in each cycle.

Effective from the 2016-17 academic year, the assessment cycle begins in the Fall. In 2015-16 academic year, the assessment cycle started in the Spring. This change reflects a shift on an institutional level to begin data collection in the Fall term. In 2016-17 the Assessment Commission Executive Committee began recommending that programs begin data collection during Fall term, and generate the assessment report at the beginning of the next academic year.

3.2 Assessment Cycle

Table 8 – Old BSREE Outcome Assessment Cycle

Student Outcome	**2015-16**	**2016-17**	**2017-18**
a) Fundamentals			EE321, REE377 k
b) Experimentation	EE419, REE33X		
c) Design			EE355 k, ENGR465
d) Teamwork			REE412
e) Problem solving		REE337, EE419	REE337 w
f) Ethics	REE463, REE469		
g) Communication		EE355, REE348	
h) Impact	REE412, REE346		
i) Independent learning		REE454, REE463	REE463
j) Contemporary Issues			REE412 w, REE469 k, REE407 k, REE455 w
k) Engineering tools		ENGR355, REE455w, REE413k	
k – Assessed at Klamath Falls campus only, w – Assessed at Wilsonville campus only, if none is specified then it is applicable for both campuses.			

Table 9 – New BSREE Outcome Assessment Cycle

Student Outcome	**2018-19**	**2019-20**	**2020–21**
(1) Principles		REE337pm, EE461k	
(2) Design			EE461k, REE412pm
(3) Communication	REE407k	REE337pm	
(4) Ethics	REE454k		REE463pm
(5) Teams	REE253k, ENGR465k		REE413pm
(6) Experimentation	EE355k	REE413k	EE419pm
(7) Learning			REE337 pm,REE453 k
k – Assessed at Klamath Falls campus only, pm – Assessed at Portland Metro campus (formerly known as Wilsonville campus) only, if none is specified then it is applicable for both campuses.			

Table 10 – Detailed New BSREE Outcome Assessment Cycle

Student Outcome	2018-19	2019-20	2020–21
(1) Principles		REE337pm (Fall; Dr. TorresGaribay), EE461k (Winter, Dr. Hossain)	
(2) Design			EE461k (Spring, Dr. Hossain), REE412pm (Winter; Dr. Petrovic)
(3) Communication	REE407k (Spring, Dr. Shi, Winter, Dr. Dobzhanskyi)	REE337pm (Fall, Dr. TorresGaribay)	
(4) Ethics	REE454k (Winter, Dr. Hossain)		REE463pm (Winter, Dr. Melendy)
(5) Teams	REE253k (Fall, Dr. Dobzhanskyi), ENGR465k (Spring, Dr. Shi)		REE413pm (Spring, Dr. Venugopal)
(6) Experimentation	EE355k (Spring, Dr. Hossain)	REE413k (Winter, Dr. Hossain)	EE419pm (Winter, Dr. Venugopal)
(7) Learning			REE337 pm (Fall, Dr. Corsair), REE453 k (Fall, Dr. Hossain)
k – Assessed at Klamath Falls campus only, pm – Assessed at Portland Metro campus (formerly known as Wilsonville campus) only, if none is specified then it is applicable for both campuses.			

3.3 Summary of Assessment Activities & Evidence of Student Learning

3.3.1 Introduction

The BSREE faculty conducted formal assessment during the 2019-20 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.

3.3.2 Methods for Assessment of Program 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 8), 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.

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 BSREE 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 Fall, as well as with the Industry Advisory Council (IAC) at the following IAC meeting. If approved, these changes are implemented in the curriculum and submitted to the Curriculum Planning Commission (if catalog changes are required) for the following academic year.

3.3.3 2019-20 Targeted Direct Assessment Activities

The sections below describe the 2019-20 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 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.

3.3.4 Targeted Assessment for Outcome (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

This outcome was assessed in EE 461 – Control System Engineering – Winter 2020

Outcome (1) : EE 461, Winter 2020, Dr. Eklas Hossain

The outcome focuses on students' capability to detect, formulate, and solve involved engineering problems using the principles of their engineering contexts that are taught during their classes. To assess the students, the final examination for the EE 461 Control System Engineering course is chosen, which consists of analytical and multiple choice questions related to the theoretical and real-world problems of the control system engineering. The exam was a take-home test, where they were allowed to use books or class notes for the exam without taking any in-person help. Since the test was timed and there were no room for diversion, students were able to demonstrate their analytical skills to solve complex problems by applying engineering, scientific, and mathematical knowledge. Two analytical questions were provided to determine the root locus diagram and to assess a given step response by showing their full analytical works. Twenty-five (25) multiple choice questions were provided with the space to perform rough calculations to pick the correct choice from four given options.

Eight (8) students were assessed in Winter 2020 term using the performance criteria listed below. The minimum acceptable performance level was to have 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. Students met or exceeded expectations; they demonstrated their abilities to function on multi-disciplinary teams. It is observed that student team work was improved significantly through senior capstone project.

Table 11 - Outcome (1): EE 461, Winter 2020, Dr. Eklas Hossain

Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >1
1: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics				
Identify and Define Problems by collecting data and information	1	3	4	87.50%
Model and design the experiment by applying knowledge of mathematics/science	0	3	5	100%
Applying knowledge of scientific and engineering principles to interpret result and implement solution	1	3	4	87.50%

3.3.5 Targeted Assessment for Outcome (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

This outcome was assessed in REE 337 Materials for Renewable Energy Applications, Fall 2019

Outcome (1) : REE 377, Fall 2019, Dr. Claudia Torres Garibay

The outcome was assessed using three questions in the final exam of REE 337 in Fall 2019. These questions assessed the students' ability to provide an engineering material solution, first by identifying information required to address the constraints that determine a complete solution, and second by presenting solutions to open-ended situations based on materials properties. In the first question, students were asked to decide on a polymer for solar panels among three choices based on the data provided in a stress-strain diagram. Students were also asked to mention the reasons for their selection, what mechanical properties are relevant for this application, and what other information is needed to be able to make a selection. In the second question, students were asked to describe the property parameters and constraints involved in the selection of a material for a safety application, how such parameters and constraints would be tested, and how would the materials be used in the application. The third question students were presented with an inaccurate statement comparing the efficiency of coal and solar panels. Students were required to weight of the accuracy of the statement, provide an explanation on how solar panels work, and reword the statement. For the assignment, performance criteria two and three were considered similar for which same scores of criterion three were utilized in criterion two. Part of the first question and the third question assessed students' ability to identify and define problems by collecting data and information. The other part of the first question and the second question assessed

students' ability to apply knowledge of scientific and engineering principles to interpret results and implement a solution.

Eleven students were assessed in Fall 2019 using the performance criteria listed below. Each one of the questions (or portion of them) are graded as developing (1), accomplished (2), or exemplary (3). A developing performance level is considered when students' answers in one or more questions are incomplete, incorrect, or unjustified. An accomplished performance level is considered when students provide solid justifications for the correct selection of materials in the three questions. An exemplary performance level is considered when students responses are all correct, complete, and provide ample justification for their choices and answers. The average of both questions, rounding down, is considered the performance level. The minimum acceptable performance level is defined as 80% of the students or more performing at the accomplished or exemplary level in all performance criteria.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. The work of most students was deemed at an accomplished or exemplary performance level.

Table 12 – Outcome (1): REE 377, Fall 2019, Dr. Claudia Torres Garibay

Performance Criteria	**1-Developing**	**2-Accomplished**	**3-Exemplary**	**% student >1**
1: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics				
Identify and define Problems by collecting data and information	2	9	0	81.82%
Model and design the experiment by applying knowledge of mathematics/science	1	5	5	90.91%
Applying knowledge of scientific and engineering principles to interpret results an implement solutions	1	5	5	90.91%

3.3.6 Targeted Assessment for Outcome (3) an ability to communicate effectively with a range of audiences

This outcome was assessed in REE 337 Materials for Renewable Energy Applications, Fall 2019

Outcome (3) : REE 377, Fall 2019, Dr. Claudia Torres Garibay

The outcome was assessed via a term paper in REE 337 in Fall 2019. The assignment consisted of researching and writing a paper on a material of the student interest that is used in a renewable energy application. The topic and content of the document should address the questions generated by each student utilizing the Question Formulation Technique, a methodology that teaches students how to formulate, work with, improve, and use their own questions. Students were instructed to follow general formatting guidelines priorly studied in their technical writing courses. There were check points throughout the term, but the assessment is based on the final deliverable. Students were assessed on their ability to acquire information from various sources, and their ability to communicate a technical topic in oral and written form to acquiring information. Performance criteria one and two in this assignment were correlated, for which the scores for acquiring information in criterion two were used to assess the oral communication skill in criterion one.

Eleven students were assessed in Fall 2019 using the performance criteria listed below. A developing performance level is considered when students' sources are limited, not appropriately utilized, and/or the information in the paper is poorly organized, key information is missing or inappropriately interpreted. An accomplished performance level is considered when the variety and quality of sources is appropriate, and the information is correctly presented. An exemplary performance level is considered when several sources are used, the information is properly analyzed, and the topic is well developed throughout the document. The minimum acceptable performance level is defined as 80% of the students or more performing at the accomplished or exemplary level in all performance criteria.

Table 13 below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Most students demonstrated an accomplished or exemplary used of sources, and all students demonstrated an accomplished or exemplary performance in terms of their written communication.

Table 13 – Outcome (3): REE 377, Fall 2019, Dr. Claudia Torres Garibay

Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >1
3: an ability to communicate effectively with a range of audiences.				
Orally Communicate information	1	3	7	90.91%
Acquiring information from various sources	1	3	7	90.91%
Written Communication	0	3	8	100%

3.3.7 Targeted Assessment for Outcome (6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

This outcome was assessed in REE 413 Electric Power Conversion System - Winter 2020

Outcome (6) : REE 413, Winter 2020, Dr. Eklas Hossain

The outcome focused on the students' capability to develop and perform experimentations, by conducting adequate hardware and software simulation as per required, analyzing the data with useful tools, and utilize their insights from their engineering lessons to interpret the outcomes and draw conclusions. For assessing the outcome, REE 413 in Winter 2020 is used. The experiment required the students to design a full rectifier circuit using required apparatus and Simulink software. By demonstrating the output waveform of the full wave rectifier, the students were required to determine the parameters such as voltages, currents, powers, ripple factor, efficiency, and percentage of regulations. The students were organized in a group of two-three students to develop and conduct the experiment using the hardware components, simulate the behavior in Simulink, analyzing the data in a tabulated form, interpret those data to perform additional calculations using their engineering judgment.

16 senior students were assessed in term Winter 2020 using the performance criteria listed below. The minimum acceptable performance level was to have 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 14 below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Students met or exceeded expectations; they demonstrated their abilities to function on multi-disciplinary teams. It is observed that student team work was improved significantly through senior capstone project.

Table 14 – Outcome (6): REE 413, Winter 2020, Dr. Eklas Hossain

Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >1
6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions				
Developing an experimenting	0	15	4	100%
Conducting an experiment	2	6	11	89.47%
Analyzing experimental data	0	0	19	100%
Interpreting experimental data	0	10	9	100%
Engineering judgment	2	10	7	89.47%

3.3.8 2019-20 Indirect Assessments

In addition to direct assessment measures, the student outcomes were indirectly assessed through a senior exit survey conducted every year in the spring term. Question BREE 1 in the survey asked students "Program Student Learning Outcomes for Renewable Energy Engineering B.S. Please rate your proficiency in the following areas."

Figure 8 show the results of the indirect assessment of the BSREE student outcomes for the 2019-20 graduating class, as the new outcomes (1)-(7) have been mapped from previous outcomes (a) to (k).

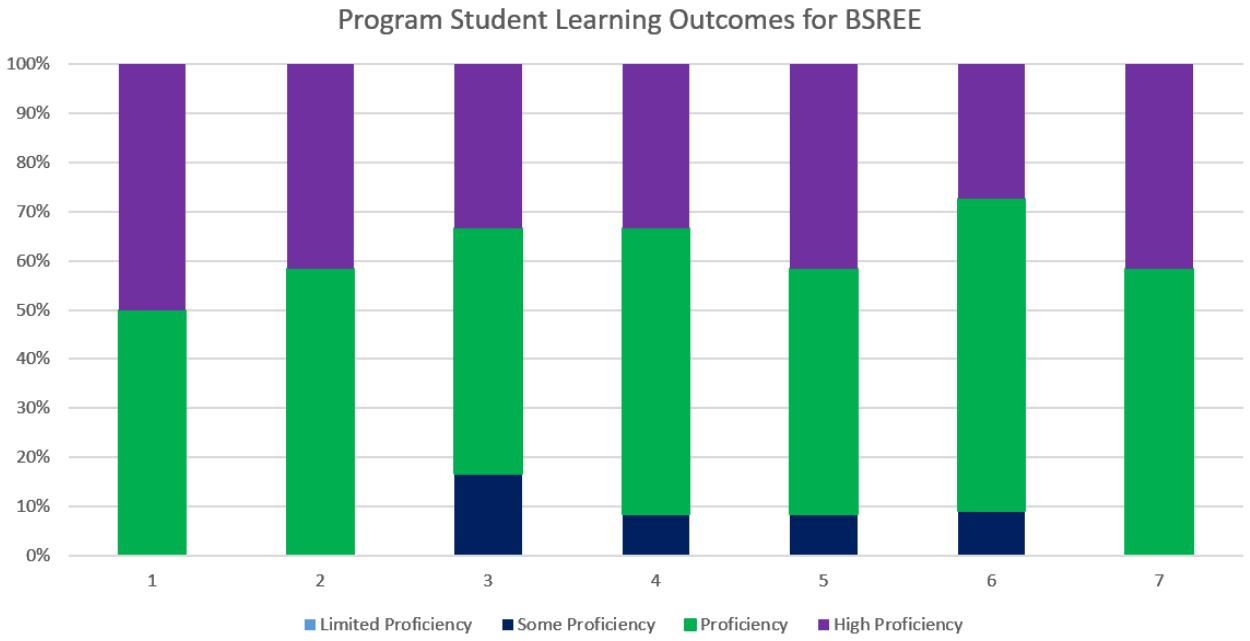

Figure 8 - Graph of results of the indirect assessment for the BSREE Student Outcomes as reported in the Senior Exit Survey (2019-20)

The previous Senior Exit Survey questions have been changed to the following questions which will be effected from 2019-20 sessions for BSREE programs

1. An ability to identify, formulate, and solve complex engineering 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, analyze and interpret data, and use engineering judgment to draw conclusions

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Table 15 show the results of the indirect assessment of the BSREE student outcomes for the 2019-20 graduating class. Twelve (12) BSREE graduating seniors completed the survey, with respondents indicating that as a result of completing the BSREE program they feel proficient or highly proficient in each of the student outcomes. More than 80% of the respondents rated themselves, upon completion of the BSEE program, they were "Proficient" or "Highly Proficient" in all categories.

Table 15 - Results of the indirect assessment for the BSREE Student Outcomes as reported in the Senior Exit Survey (2019-20)

#	Question	High proficiency		Proficiency		Some proficiency		Limited proficiency		Total
1	1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	50.00%	6	50.00%	6	0.00%	0	0.00%	0	12
2	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	41.67%	5	58.33%	7	0.00%	0	0.00%	0	12
3	3. An ability to communicate effectively with a range of audiences	33.33%	4	50.00%	6	16.67%	2	0.00%	0	12
4	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,	33.33%	4	58.33%	7	8.33%	1	0.00%	0	12

	environmental, and societal contexts									
5	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	41.67%	5	50.00%	6	8.33%	1	0.00%	0	12
6	6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	27.27%	3	63.63%	7	9.09%	1	0.00%	0	11
7	7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	41.67%	5	58.33%	7	0.00%	0	0.00%	0	12

These results suggest that the BSREE graduating students feel they have attained the BSREE student outcomes, and agree with the direct assessment results.

4. Changes Resulting from Assessment

This section describes the changes resulting from the assessment activities carried out during the year 2019-20. 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 BSREE faculty met on 22 October, 2020 to review the assessment results and determine whether any changes are needed to the BSREE curriculum or assessment methodology based on the results presented in this document. The objective set by the BSREE 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 16 provides a summary of the 2019-20 assessment results for the outcomes which were directly assessed.

Table 16 - Summary of BSREE direct assessment for 2019-20

	Total Students	Students >= 2	% Students >=2
Outcome (1): (EE 461, Winter 2020, Dr. Eklas Hossain)			

1. **Identify and Define Problems by collecting data and information**	8	7	87.50%
2. **Model and design the experiment by applying knowledge of mathematics/science**	8	8	100%
3. **Applying knowledge of scientific and engineering principles to interpret result and implement solution**	8	7	87.50%
Outcome (1): (REE 377, Fall 2019, Dr. Claudia Torres Garibay)			
1. **Identify and Define Problems by collecting data and information**	11	9	81.82%
2. **Model and design the experiment by applying knowledge of mathematics/science**	11	10	90.91%
3. **Applying knowledge of scientific and engineering principles to interpret result and implement solution**	11	10	90.91%
Outcome (3): (REE 377, Fall 2019, Dr. Claudia Torres Garibay)			
1. **Orally Communicate Information**	11	10	90.91%
2. **Acquiring information from various sources**	11	10	90.91%
3. **Written Communication**	11	11	100%
Outcome (6): (REE 413, Winter 2020, Dr. Eklas Hossain)			
1. **Developing an experimenting**	19	19	100%
2. **Conducting an experiment**	19	17	89.47%
3. **Analyzing experimental data**	19	19	100%
4. **Interpreting experimental data**	19	19	100%
5. **Engineering judgment**	19	17	89.47%

4.1 Changes Resulting from the 2019-20 Assessment

The results of the 2019-20 Assessment indicate that the minimum acceptable performance level of 80% was met on all performance criteria for all assessed outcomes. Areas of improvement to the curriculum were discussed during the Closing the Loop Meeting in October 22, 2020 with respect to these results. These areas include:

- **Outcome (1):**
  - **Results:** The 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.
- **Outcome (3):**
  - **Results:** The 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.

- **Outcome (6):**
  - **Results:** The 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.