— B. S. in Electrical Engineering —

2018–19 Assessment Report

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Contents

1 Introduction

1.1 Program Design and Goals

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

1.2 Program History

In 2007, Oregon Tech began offering its new Bachelor of Science in Electrical Engineering (BSEE) program at its Klamath Falls campus. In Fall 2012, the BSEE degree started to also be offered at the Portland Metro campus. The BSEE degree is a traditional EE degree that was created to prepare graduates for careers in various fields associated with Electrical Engineering. These include, but are not limited to, analog integrated circuits and systems, digital integrated circuits and microcontroller systems, signal processing, communication systems, control systems, semiconductors, optoelectronics, renewable energy, and biomedical fields as stated in the Oregon Tech catalogs for 2007 through 2019.

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

1.3 Program Enrollment and Graduation Data

One hundred and seventy-four students have graduated from the BSEE program since it was first launched in 2007. From these, 49 BSEE students graduated in academic year 2018–19. Seventeen of those completed the Senior Exit Survey, with 88% of respondents reporting having found employment in their field, 11% were admitted or planning on attending graduate school, and 1% is looking for employment after graduation. The reported average annual salary of the first group was $62,400.

	2014	2015	2016	2017	2018
Klamath Falls	27	66	82	75	90
Portland Metro	74	98	115	118	104
Total	146	164	197	193	194

Table 1: Electrical engineering enrollment (headcount of both full and part-time students in the fourth week of the fall term) for the last five years.

	2014-15	2015-16	2016-17	2017-18	2018-19
Klamath Falls	8	13	7	16	17
Portland Metro	3	4	10	10	20
Total	11	17	17	26	37

Table 2: BSEE degrees awarded for the last five academic years.

1.4 Industry Relationships

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

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

1.5 Program Locations

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

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

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

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

2 Program Mission, Educational Objectives and Outcomes

2.1 Program Mission

The mission of the Electrical Engineering Bachelor of Science degree program is to provide a comprehensive program of instruction that will enable graduates to obtain the knowledge and skills necessary for immediate employment and continued advancement in the field of electrical engineering. The program will provide high-quality career-ready candidates for industry as well as teaching and research careers. Faculty and students will engage in applied research in emerging technologies and provide professional services to their communities.

2.2 Program Educational Objectives

In support of this mission, the Program Educational Objectives for the BSEE program are:

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

- The graduates of the BSEE program will be working as effective team members possessing excellent oral and written communication skills, and assuming technical and managerial leadership roles throughout their career.

2.3 Relationship between Program Objectives and the Institutional Mission

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

The core themes of Oregon Tech are as follows.

- Applied Degree Programs
- Student and Graduate Success
- Statewide Educational Opportunities
- Public Service

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

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

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

2.4 Program Outcomes

Starting with the 2018-19 academic year, the faculty decided at Convocation on 19 September 2018 that we will begin assessing using the new (1)-(7) ABET student outcomes below.

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

(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(3) an ability to communicate effectively with a range of audiences

(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

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

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

3 Cycle of Assessment for Program Outcomes

3.1 Introduction, Methodology, and the Assessment Cycle

Starting with this academic year, assessment transitioned to the new ABET student outcomes (1)-(7) and are shown in Table 1. Assessment of program outcomes is conducted over a three-year cycle.

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

Student Outcome	2018-19	2019-20	2020–21	2021-22
(1) Principles			•	
(2) Design			•	
(3) Communication		•		
(4) Ethics	•			•
(5) Teams			•	
(6) Experimentation	•			•
(7) Learning		•		

Table 3: BSEE Outcome Assessment Cycle. Bullets (•) indicate standard assessment outcomes.

3.2 Summary of Assessment Activities & Evidence of Student Learning

3.2.1 Introduction

The BSEE faculty conducted formal assessment during the 2018–19 academic year using direct measures, such as designated assignments and evaluation of coursework normally assigned. Additionally, the student outcomes were assessed using indirect measures, primarily results from a graduate exit survey.

3.2.2 Methodology for Assessment of Student Outcomes

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

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

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

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

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

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

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

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

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

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

3.2.3 Targeted Direct Assessment Activities

The sections below describe the 2018–19 targeted assessment activities and detail the performance of students for each of the assessed outcomes. Unless otherwise noted, the tables report the percentage of students performing at a developing level, accomplished level, and exemplary level for each performance criteria, as well as the percentage of students performing at an accomplished level or above.

3.2.3.1 Outcome (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.

Portland Metro, EE 401, Summer 2019, Dr. Aaron Scher

A targeted direct assessment of this outcome was done in EE 401 *Communications*. Twelve students were assessed.

The assignment was to write a paper on the impact of 5G to society. Students were required to include at least five quality peer-reviewed references in their paper and to use IEEE Style.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
1. Recognize	0	6	6	100%
2. Identify	2	8	2	83%
3. Judge	2	7	3	83%

Table 4: EE 401 assessment of Outcome (4): Ethics.

3.2.3.2 Outcome (6) Experimentation

An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

Portland Metro, EE 225, EE 461, Spring 2019, Dr. Robert Melendy

This outcome was assessed in EE 461 — *Control Engineering I*. The assignment was a final, comprehensive simulation experiment. The objective of this experimental-based project was to have the students first develop a lumped-parameter state-space model for an engine-cam system using the methods they learned in this course involving second-order systems. The students' subsequent task was to examine this model in the frequency domain followed by the design of a proportional-integral-derivative (PID) controller for the purpose of optimizing stable, cam control motion. An equally important objective was to have students recognize the need for Newtonian mechanics and the in the development of an electromechanical motion controller.

Seventeen students were assessed in Spring 2019 using the performance criteria listed in the table below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Criteria	1 Developing	2 Accomplished	3 Exemplary	Students ≥ 2
Develop and Conduct	3	0	14	82%
Analyze and Interpret	3	4	10	82%
Engineering Judgement	3	2	12	82%

Table 5: EE 461 assessment of Outcome (6) Experimentation: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

3.2.3.3 Summary of all targeted direct assessments

3.2.4 Indirect Assessments

In addition to direct assessment measures, the student outcomes (1) through (7) were indirectly assessed through a senior exit survey. Senior Exit Surveys are conducted every year in the spring term. The 2018–19 data collected in spring of 2019 was used in this assessment report, which covers the period of fall 2018 through spring 2019.

Twenty-five BSEE graduating seniors completed the Senior Exit Survey out of a total of 49 graduating. Of the 25 respondents, 11 were from Portland Metro and 14 were from Klamath Falls. Only 18 respondents completed the set of questions matching the ABET student outcomes.

In this survey, question Q BEE 1 asked students, "Please rate your proficiency in the following areas" and listed the ABET Student Outcomes.

1. an ability to identify, formulate, and solve engineering problems problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

	Total Students	Number Students ≥ 2	Percentage Students ≥ 2
(4) Ethics (PM)			
4.1 Recognize	12	12	100%
4.2 Identify	12	10	83%
4.3 Judge	12	10	83%
(6) Experimentation (PM)			
6.1 Design and Conduct	17	14	82%
6.2 Analyze and Interpret	17	14	82%
6.3 Engineering Judgement	17	14	82%

Table 6: Overall totals for each assessed outcome during 2018–19. The total number of students assessed, the number of students scoring 2 (accomplished) or 3 (exemplary) and the percentage of students scoring 2 or 3 is shown. (KF = Klamath Falls, PM = Portland Metro)

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, interpret data analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using learning appropriate learning strategies

More than 80% of the respondents rated themselves, upon completion of the BSEE program, they were “Proficient” or “Highly Proficient” in all categories.

These results align with the direct assessment results.

Outcome	Limited Proficiency	Some Proficiency	Proficient	Highly Proficient	Proficient & Highly Proficient
(1) Principles	0	0	2	16	100%
(2) Design	0	2	6	10	89%
(3) Communication	0	1	6	11	94%
(4) Ethics	0	0	10	8	100%
(5) Teams	0	0	7	11	100%
(6) Experimentation	0	0	5	13	100%
(7) Learning	0	0	5	13	100%

Table 7: Results of the indirect assessment of proficiency for ABET outcomes from the Senior Exit Survey (2018–19).

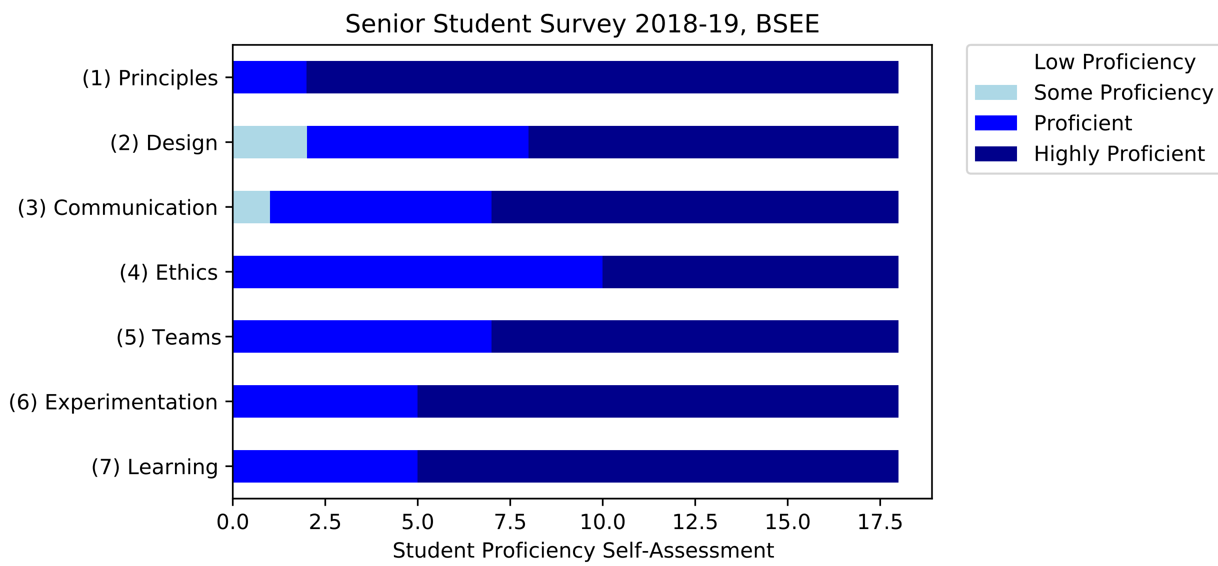

Figure 1: Self-assessment as "Proficient" or "Highly Proficient" for ABET outcomes as reported in the Senior Exit Survey (2018–19).

4 Evaluation and Continuous Improvement

This section describes the changes resulting from the assessment activities carried out during the academic year 2018–19. It includes any changes that have been implemented based on assessment in previous assessment cycles, from this or last year, as well as considerations for the next assessment cycle.

The BSEE faculty met on September 18, 2020 to review the assessment results and determine whether any changes are needed to the BSEE curriculum or assessment methodology based on the results presented in this document. The Closing-the-Loop meeting provides faculty a chance to reflect and assess data and trends with regards to continuous improvement.

The objective set by the BSEE faculty was to have at least 80% of the students perform at the level of accomplished or exemplary in all performance criteria of the assessed outcomes. Table 6 provides a summary of the 2018–19 assessment results. Table 8 shows how these assessments relate to those from previous assessment cycles.

	2015–16	**2016–17**	**2017–18**	**2018–19**
(4) Ethics	$N = 18$	$N = 5$		$N = 12$
	outcome (f)	*outcome (f)*		
Recognize	94%	100%		100%
Identify	80%	100%		83%
Judge	—	—		83%
(6) Experimentation	$N = 56$	$N = 8$		$N = 17$
	outcome (b)	*outcome (b)*		
Design and Conduct	71% or 84%	100%		82%
Analyze and Interpret	64%	100%		82%
Engineering Judgement	—	—		82%

Table 8: Comparison of results with those from previous assessment years. The percentage of students scoring 2 (accomplished) or 3 (exemplary) is shown for 2018–19 and the previous assessment year. Sample size and results includes combined total of students for each outcome evaluated within the assessed year. In prior years, ABET outcomes (f) and (b) were matched to (4) and (6) respectively.

The results of the 2018–19 assessment indicate that the minimum acceptable performance level of 80% was met on every performance criterion for every assessed outcome. Below is a detailed report of the discussions from the closing-the-loop meeting held on September 18, 2020.

Faculty noted that the Klamath Falls campus was not assessed in the 2018–19 report. This oversight will be addressed in the next academic year: outcomes 4 & 6 will be assessed in Klamath Falls in addition to the regularly scheduled assessments.

4.1 Outcome (4): Ethics

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

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

4.2 Outcome (6): Experimentation

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

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

5 Rubrics

EAC RUBRIC: OUTCOME (4) – ETHICS

Outcome (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.	

EAC RUBRIC: OUTCOME (6) – EXPERIMENTATION

Outcome (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.	