جامعة قطر
QATAR UNIVERSITY

مكتب التخطيط الأكاديمي وضمان الجودة
Academic Planning and Quality Assurance (APQA) Office

# Annual Assessment Report (AAR)

| | |
|---|---|
| **College** | [Engineering] |
| **Department** | Electrical Engineering |
| **Program** | [BS. In Electrical Engineering] |
| **Head of Department** | Dr. M. Al-Hitmi |
| **Program Coordinator** | Dr. Muhammad Chowdhury |
| **Assessment Coordinator** | Dr. Muhammad Chowdhury |
| **Email** | mchowdhury@qu.edu.qa |
| **Submission Date** | 10 September 2023 |
| **Academic Year** | 2022-2023 |
| **Assessment Cycle** | Cycle VIII |

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# Part 1

## 1 INTRODUCTION

The summary of adopted improvement actions as per received comments from the previous annual assessment report is presented in Table 1-1.

***Table 1-1 Summary of Adopted Improvement Actions based on previous AARR* Comments/Feedback***

| Suggested Improvement Action Statement/Description for Previous AARR* | Action Taken | Comments |
|---|---|---|
| Establish consistency between the report and the OAS:<br>• The appropriate assessment tools should be uploaded on the OAS.<br>• Individual student work (rather than student scores on the rubrics) should be uploaded on the OAS.<br>• For the uploaded group student work on the OAS, it is not clear what the individual student contribution is. | In OAS, all the assessment tools as well as student work each students are uploaded. In the uploaded group student work, a contribution table is included to show the individual contribution of each student for the corresponding student outcome. | The same practice will be continued to be done. |
| The uses of group student work and homework are not good practices to assess SOs. This may jeopardize the reliability and validity of the assessment methods, results, and suggested improvement actions | All the assessments are conducted based on individual student work (Final exam, quiz, Lab exam). For the senior design project courses, the individual contribution of each student for the corresponding student outcome is included in the report and is used for the outcome assessment. | Homeworks were not considered in any of the assessment in the last cycle. |
| There is no evidence of faculty contribution to the analysis of assessment results. | | The analysis is done by the curriculum committee and the adopted actions are presented to the board for the final approval. Therefore, all faculty have been involved in the assessment process. The meeting minutes will be included in the current assessment report. |
| Only one assessment tool (Term Project for assessment of SO1 in ELEC 341) has been included in Appendix A. All the adopted assessment tools should be added as appendices | All the assessment tools are included in the current assessment report. | The same practice will be continued to be done. |
| Some sections of the report are not in line with the template provided by the Academic Planning and Quality Assurance Office. For example, the tables in Section 3.2, Section 4, and Section 5.1 should focus on the academic year 2021-2022 rather than the assessment cycle. The results, in section 6, should be first analyzed only for the academic year 2021- | | This will be considered for the assessment plan in the next academic year. |

| | | |
|---|---|---|
| 2022 under the subheading "6.1. Activity level analysis for the actual academic year". Then, a second subsection should be devoted to the analysis of the cumulative results under the subheading "6.2. Program level analysis based on cumulative results." | | |

* *AARR: Annual Assessment Report Review*

# 2 PROGRAM SPECIFICATIONS

## Mission Statement of the Department of Electrical Engineering

The Department of Electrical Engineering supports the mission of the College of Engineering and that of Qatar University through high-quality teaching, research, and services that benefit the Electrical and Mechatronics Engineering students and the State of Qatar. The department produces graduates with strong engineering skills necessary for contemporary areas of electrical engineering and who are well prepared for successful engineering careers or for pursuing graduate studies.

## Program Educational Objectives

Graduates of the EE Program will:

- PEO 1. Contribute to the advancement of the electrical engineering profession in ethical and professional manners
- PEO 2. Apply effectively their technical, communication, teamwork, and leadership skills in a modern and diverse work environment as well as while pursuing graduate studies.
- PEO 3. Adapt to emerging technologies, social development, and contemporary issues and experience an entrepreneurial mind-set.

## Student Learning Outcomes

The SOs encompass the exact (1) to (7) SOs as listed by the Engineering Accreditation Commission (EAC) of ABET.

***By the time of graduation, students will have demonstrated the following student 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.

## Curriculum Map

The curriculum map for the current assessment cycle is presented in Table 2-1.

***Table 2-1: Curriculum map for the current assessment cycle.***

| | | **Student Outcomes** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **GENG Required Courses** | | | | | | | | |
| Computer Programming | GENG 106 | I | | | | I | | |
| Engineering Skills & Ethics | GENG 107 | I | I | I | I | I | | I |
| Probability & Statistics for Engineers | GENG 200 | I | | | | | I | |
| Numerical Methods | GENG 300 | I | | | | I | | |
| Engineering Economics | GENG 360 | I | | | I | | | |
| Math for Electrical Engineering | MATH 285 | I | | | | | | |
| Electric Circuits | ELEC 201 | I | | | | | I | |
| **Major Required Courses** | | | | | | | | |
| Digital Systems Design | ELEC 261 | D | D | | | | | |
| Digital Systems Design Lab | ELEC 262 | | D | D | | | D | |
| Electric Circuits II | ELEC 202 | I | | | | | | |
| Electric Circuits II Lab | ELEC 203 | | | D | | | I | |
| Fundamentals of Electronics | ELEC 231 | D | I | | | D | D | |
| Embedded Systems | ELEC 366 | D | D | | | | | |
| Embedded Systems Lab | ELEC 367 | | D | | | | M | |
| Electric Machines | ELEC 312 | D | | | | | | |
| Electric Machines Lab | ELEC 313 | | | D | | | M | |
| Power Electronics | ELEC 325 | M | D | | D | | | D |
| Signals and Systems | ELEC 351 | D | | | | | D | |
| Sensors and Instrumentation | ELEC 371 | M | M | | | | M | |
| Signal Analysis & Filtering | ELEC 353 | M | D | | M | | | D |
| Electromagnetics | ELEC 311 | M | | | D | | | |
| Power Systems Analysis | ELEC 321 | M | | | | | | |
| Control Systems | ELEC 352 | D | D | | | | D | |
| Communications Engineering | ELEC 341 | M | D | | D | | | |
| Communications Engineering Lab | ELEC 342 | | D | | | | M | |
| Electrical Engineering Design | ELEC 428 | M | M | M | M | M | M | M |
| Practical Training | ELEC 399 | | | M | M | | | M |
| Senior Design Project I | ELEC 498 | M | M | M | M | M | | M |
| Senior Design Project II | ELEC 499 | M | M | M | M | M | M | M |
| **Major Elective Courses** | | | | | | | | |

| | | Student Outcomes | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| Renewable Energy Sources | ELEC 420 | M | M | | | | | M |
| Solar Electricity System Design | ELEC 421 | | M | | M | | | |
| Electric Power Distribution Systems | ELEC 423 | M | M | | | | | |
| Operation of Power Systems | ELEC 424 | M | | | | | | |
| Protection of Power Systems | ELEC 426 | M | | M | | | | M |
| Transportation Electrical Systems | ELEC 427 | M | M | | M | | | M |
| Selected Topics in Electric Machines and Drives | ELEC 429 | M | M | | M | | M | |
| Selected Topics in Electronics | ELEC 438 | M | M | | M | | M | M |
| Fundamentals of Secure Communications | ELEC 441 | M | M | | | | M | M |
| Satellite Communications | ELEC 442 | M | M | | | | | M |
| Selected Topics in Communication Engineering | ELEC 446 | M | M | | M | | M | |
| Digital wireless communication | ELEC 448 | M | M | | | | M | |
| Optimization and Machine Learning | ELEC 449 | M | | | | | | M |
| Advanced Control Systems | ELEC 453 | M | M | | | | | |
| Selected Topics in Signal Processing | ELEC 455 | M | M | M | M | | | M |
| Communication Networks and Applications | ELEC 469 | M | M | | M | M | M | M |
| Biomedical Instrumentation | ELEC 473 | | M | | M | | M | |
| Optical Electronics in Modern Comm. | ELEC 474 | M | M | | | | M | |
| Smart Grid | ELEC 475 | M | | | M | | | |
| Selected Topics in Power Electronics | ELEC 480 | M | M | M | M | | | |
| Industrial Control | ELEC 484 | M | M | | | | M | |
| Introduction to Robotics | ELEC 485 | M | | | | | | |
| RF Communication Electronics | ELEC 489 | M | M | | | | | |
| Independent Study | ELEC 495 | M | | | M | | | M |

# 3 ASSESSMENT PLAN

## 3.1 Assessment Plan for The Current Cycle

***Table 3-1 Assessment Plan for the Current Academic Cycle***

| | *A.Y 2022 /2023* | | | *A.Y 2023 /2024* | | |
|---|---|---|---|---|---|---|
| **PLO Id** | **Fall** *<Year 1>* | **Spring** *<Year 1>* | **Summer** *<Year 1>* | **Fall** *<Year 2>* | **Spring** *<Year 2>* | **Summer** *<Year 2>* |
| 1 | ELEC 311<br>ELEC 371 | ELEC 341 | | ELEC 371 | ELEC 325 | |
| 2 | ELEC 371<br>ELEC 428 | ELEC 499 | | ELEC 428 | ELEC 499 | |
| 3 | ELEC 428 | ELEC 499 | | ELEC 428 | ELEC 499 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | ELEC 498 | | | ELEC 498 | | |
| 4 | ELEC 428 | | | ELEC 428<br>ELEC 498 | ELEC 499 | |
| 5 | ELEC 428<br>ELEC 498 | ELEC 499 | | ELEC 498 | ELEC 499 | |
| 6 | ELEC 367<br>ELEC 313 | ELEC 342 | | ELEC 367 | ELEC 342 | |
| 7 | ELEC 428 | | | ELEC 428 | ELEC 499 | |

## 3.2 Detailed Assessment Plan for The Current Academic Year:

***Table 3-2 Assessment Plan for the Current Academic Year***

| PLO Id | Program Learning Outcome Statement | PI / Rubric dimension | PI / Rubric dimension Statement | Assessment Activity* | Context for Assessment** |
|---|---|---|---|---|---|
| (1) | An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. | PI(1) 1 | Identify and formulate a complex engineering problem. | • Embedded Assessment | ELEC 311 (FL22)<br>ELEC 371 (FL22)<br>ELEC 341 (SP23) |
| | | PI(1) 2 | Solve a complex engineering problem by applying principles of engineering. | | |
| | | PI(1) 3 | Solve a complex engineering problem by applying principles of science. | | |
| | | PI(1) 4 | Solve a complex engineering problem by applying principles of 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. | PI(2) 1 | Identify and formulate technical specifications of the electrical engineering system to meet the design goals under specific constraints and standards. | • Embedded Assessment | ELEC 371 (FL22)<br>ELEC 428 (FL22)<br>ELEC 499 (SP23) |
| | | PI(2) 2 | Evaluate the design concepts and select the one that best matches the design constraints considering public health,<br>safety, and welfare, as well as global, cultural, social, environmental, and economic factors. | | |
| (3) | An ability to communicate effectively with a range of audiences | PI(3) 1 | Communicate effectively in writing. | • Embedded Assessment | ELEC 428 (FL22)<br>ELEC 498 (FL22)<br>ELEC 499 (SP23) |
| | | PI(3) 2 | Demonstrate effective oral communication 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. | PI(4) 1 | Recognize ethical and professional responsibilities in engineering situations. | • Embedded Assessment | ELEC 428 (FL22) |
| | | PI(4) 2 | Make informed judgments that 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. | PI(5) 1 | Provide collective leadership to successfully complete the tasks | • Embedded Assessment | ELEC 428 (FL22)<br>ELEC 498 (FL22)<br>ELEC 499 (SP23) |
| | | PI(5) 2 | Contribute effectively and positively within the team whose members<br>together create a collaborative and inclusive environment. | | |
| | | PI(5) 3 | Establish goals, plan and accomplish tasks, and contribute to meeting objectives. | | |
| (6) | An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions | PI(6) 1 | Develop an experiment to reach an engineering conclusion. | • Embedded Assessment | ELEC 313 (FL22)<br>ELEC 367 (FL22)<br>ELEC 342 (SP23) |
| | | PI(6) 2 | Conduct an engineering experiment. | | |
| | | PI(6) 3 | Analyze and interpret experimental data to draw conclusions. | | |
| (7) | An ability to acquire and apply new knowledge as needed, using appropriate learning strategies. | PI(7) 1 | Demonstrate an ability to acquire new knowledge (e.g. entrepreneurship, sustainability)<br>using appropriate learning strategies (e.g. seminars, various online and library resources). | • Embedded Assessment | ELEC 428 (FL22) |
| | | PI(7) 2 | Demonstrate the application of acquired knowledge | | |

**Assessment activity is an activity such as an embedded assignment, field observation, or standard exam to be used in assessing the PLO/OE*

[**]*Context for assessment is the course or other setting in which assessment data is to be collected*.

***Table 3-3 Achievement Targets***

| PLO | Achievement Target |
|---|---|
| **SO(1)** | Overall at least 80% of students achieve a score of 3 or more on a 4-level scale rubric for the Program level Student Learning Outcome, and at least 80% of students achieve a score of 3 or more in each of the Outcome Elements (Performance Indicators) associated with the SLO. |
| PI(1)1 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(1)2 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(1)3 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(1)4 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| **SO(2)** | Overall at least 80% of students achieve a score of 3 or more on a 4-level scale rubric for the Program level Student Learning Outcome, and at least 80% of students achieve a score of 3 or more in each of the Outcome Elements (Performance Indicators) associated with the SLO. |
| PI(2)1 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(2)2 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| **SO(3)** | Overall at least 80% of students achieve a score of 3 or more on a 4-level scale rubric for the Program level Student Learning Outcome, and at least 80% of students achieve a score of 3 or more in each of the Outcome Elements (Performance Indicators) associated with the SLO. |
| PI(3)1 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(3)2 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| **SO(4)** | Overall at least 80% of students achieve a score of 3 or more on a 4-level scale rubric for the Program level Student Learning Outcome, and at least 80% of students achieve a score of 3 or more in each of the Outcome Elements (Performance Indicators) associated with the SLO. |
| PI(4)1 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(4)2 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| **SO(5)** | Overall at least 80% of students achieve a score of 3 or more on a 4-level scale rubric for the Program level Student Learning Outcome, and at least 80% of students achieve a score of 3 or more in each of the Outcome Elements (Performance Indicators) associated with the SLO. |
| PI(5)1 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(5)2 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(5)3 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| **SO(6)** | Overall at least 80% of students achieve a score of 3 or more on a 4-level scale rubric for the Program level Student Learning Outcome, and at least 80% of students achieve a score of 3 or more in each of the Outcome Elements (Performance Indicators) associated with the SLO. |
| PI(6)1 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(6)2 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(6)3 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| **SO(7)** | Overall at least 80% of students achieve a score of 3 or more on a 4-level scale rubric for the Program level Student Learning Outcome, and at least 80% of students achieve a score of 3 or more in each of the Outcome Elements (Performance Indicators) associated with the SLO. |
| PI(7)1 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |
| PI(7)2 | at least 80 % of students achieve a score of 3 or more on a 4-level scale rubric |

# 4 ASSESSMENT IMPLEMENTATION DETAILS:

***Table 4-1 Assessment activities implementation details***

| PLO Id | Program Learning Outcome Statement | PI / Rubric dimension | Outcome Element Statement (Performance Indicator), if any | Context for Assessment | No. of assessed students | Reference to Assessment Tool | Reference to Rubric |
|---|---|---|---|---|---|---|---|
| (1) | An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. | PI(1) 1 | Identify and formulate a complex engineering problem. | ELEC 311 (FL22)<br>ELEC 371 (FL22)<br>ELEC 341 (SP23) | ELEC 311: 53<br>ELEC 371: 58<br>ELEC 341: 54 | OAS/EASE package* | OAS/EASE package |
| | | PI(1) 2 | Solve a complex engineering problem by applying principles of engineering. | | | | |
| | | PI(1) 3 | Solve a complex engineering problem by applying principles of science. | | | | |
| | | PI(1) 4 | Solve a complex engineering problem by applying principles of 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. | PI(2) 1 | Identify and formulate technical specifications of the electrical engineering system to meet the design goals under specific constraints and standards. | ELEC 371 (FL22)<br>ELEC 428 (FL22)<br>ELEC 499 (SP23) | ELEC 371: 62<br>ELEC 428: 57<br>ELEC 499: 53 | OAS/EASE package | OAS/EASE package |
| | | PI(2) 2 | Evaluate the design concepts and select the one that best matches the design constraints considering public health,<br>safety, and welfare, as well as global, cultural, social, environmental, and economic factors. | | | | |
| (3) | An ability to communicate effectively with a range of audiences | PI(3) 1 | Communicate effectively in writing. | ELEC 428 (FL22)<br>ELEC 498 (FL22)<br>ELEC 499 (SP23) | ELEC 428: 57<br>ELEC 498: 53<br>ELEC 499: 53 | OAS/EASE package | OAS/EASE package |
| | | PI(3) 2 | Demonstrate effective oral communication 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. | PI(4) 1 | Recognize ethical and professional responsibilities in engineering situations. | ELEC 428 (FL22) | ELEC 428: 57 | OAS/EASE package | OAS/EASE package |
| | | PI(4) 2 | Make informed judgments that 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. | PI(5) 1 | Provide collective leadership to successfully complete the tasks | ELEC 428 (FL22)<br>ELEC 498 (FL22)<br>ELEC 499 (SP23) | ELEC 428: 57<br>ELEC 498: 53<br>ELEC 499: 53 | OAS/EASE package* | OAS/EASE package |
| | | PI(5) 2 | Contribute effectively and positively within the team whose members together create a collaborative and inclusive environment. | | | | |
| | | PI(5) 3 | Establish goals, plan and accomplish tasks, and contribute to meeting objectives. | | | | |
| (6) | An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions | PI(6) 1 | Develop an experiment to reach an engineering conclusion. | ELEC 313 (FL22)<br>ELEC 367 (FL22)<br>ELEC 342 (SP23) | ELEC 313: 72<br>ELEC 367: 63<br>ELEC 342: 52 | OAS/EASE package | OAS/EASE package |
| | | PI(6) 2 | Conduct an engineering experiment. | | | | |
| | | PI(6) 3 | Analyze and interpret experimental data to draw conclusions. | | | | |
| (7) | An ability to acquire and apply new knowledge as | PI(7) 1 | Demonstrate an ability to acquire new knowledge (e.g. entrepreneurship, sustainability) | ELEC 428 (FL22) | ELEC 428: 57 | OAS/EASE package | OAS/EASE package |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | needed, using appropriate learning strategies. | | using appropriate learning strategies (e.g. seminars, various online and library resources). | | | | |
| | | PI(7) 2 | Demonstrate the application of acquired knowledge | | | | |

# 5 ASSESSMENT RESULTS & FINDINGS

## 5.1 Results and findings for the current academic year

***Table 5-1 Summary of Assessment Results collected during the current academic year***

| PLO / OE ID | LO statement | Number of Students scoring 1 | Number of Students scoring 2 | Number of Students scoring 3 | Number of Students scoring 4 | Total No. assessed Students | Student Average* | Percentage students scored 1+ | Percentage students scored 3 or more++ | Defined Target |
|---|---|---|---|---|---|---|---|---|---|---|
| SO (1) | An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. | 9 | 23 | 85 | 48 | 165 | 3 | 5.5 | 80.6 | 80 |
| **PI (1) 1** | Identify and formulate a complex engineering problem. | 32 | 38 | 58 | 37 | 165 | 2.6 | 19.4 | 57.6 | 80 |
| | ELEC 311 Electromagnetics | 12 | 20 | 3 | 18 | 53 | 2.5 | 22.6 | 39.6 | 80 |
| | ELEC 371 Sensors and Instrumentation | 5 | 8 | 39 | 6 | 58 | 2.8 | 8.6 | 77.6 | 80 |
| | ELEC 341 Communications Engineering | 15 | 10 | 16 | 13 | 54 | 2.5 | 27.8 | 53.7 | 80 |
| **PI (1) 2** | Solve a complex engineering problem by applying principles of engineering. | 14 | 22 | 44 | 85 | 165 | 3.2 | 8.5 | 78.2 | 80 |
| | ELEC 311 Electromagnetics | 8 | 4 | 4 | 37 | 53 | 3.3 | 15.1 | 77.4 | 80 |
| | ELEC 371 Sensors and Instrumentation | 6 | 15 | 28 | 9 | 58 | 2.7 | 10.3 | 63.8 | 80 |
| | ELEC 341 Communications Engineering | 0 | 3 | 12 | 39 | 54 | 3.7 | 0 | 94.4 | 80 |
| **PI (1) 3** | Solve a complex engineering problem by applying principles of science. | 23 | 22 | 50 | 70 | 165 | 3 | 13.9 | 72.7 | 80 |
| | ELEC 311 Electromagnetics | 7 | 3 | 4 | 39 | 53 | 3.4 | 13.2 | 81.1 | 80 |
| | ELEC 371 Sensors and Instrumentation | 9 | 15 | 26 | 8 | 58 | 2.6 | 15.5 | 58.6 | 80 |
| | ELEC 341 Communications Engineering | 7 | 4 | 20 | 23 | 54 | 3.1 | 13 | 79.6 | 80 |
| **PI (1) 4** | Solve a complex engineering problem by applying principles of mathematics. | 30 | 32 | 38 | 65 | 165 | 2.8 | 18.2 | 62.4 | 80 |
| | ELEC 311 Electromagnetics | 8 | 12 | 2 | 31 | 53 | 3.1 | 15.1 | 62.3 | 80 |
| | ELEC 371 Sensors and Instrumentation | 12 | 8 | 19 | 19 | 58 | 2.8 | 20.7 | 65.5 | 80 |
| | ELEC 341 Communications Engineering | 10 | 12 | 17 | 15 | 54 | 2.7 | 18.5 | 59.3 | 80 |
| **SO (2)** | An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, | 0 | 16 | 62 | 94 | 172 | 3.5 | 0 | 90.7 | 80 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | safety, and welfare, as well as global, cultural, social, environmental, and economic factors. | | | | | | | | | |
| **PI (2) 1** | Identify and formulate technical specifications of the electrical engineering system to meet the design goals under specific constraints and standards. | 1 | 24 | 72 | 75 | 172 | 3.3 | 0.6 | 85.5 | 80 |
| | ELEC 371 Sensors and Instrumentation | 0 | 4 | 25 | 33 | 62 | 3.5 | 0 | 93.5 | 80 |
| | ELEC 428 Electrical Engineering Design | 1 | 18 | 20 | 18 | 57 | 3 | 1.8 | 66.7 | 80 |
| | ELEC 499 Senior Design Project II | 0 | 2 | 27 | 24 | 53 | 3.4 | 0 | 96.2 | 80 |
| **PI (2) 2** | Evaluate the design concepts and select the one that best matches the design constraints considering public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. | 3 | 19 | 72 | 78 | 172 | 3.3 | 1.7 | 87.2 | 80 |
| | ELEC 371 Sensors and Instrumentation | 0 | 2 | 22 | 38 | 62 | 3.6 | 0 | 96.8 | 80 |
| | ELEC 428 Electrical Engineering Design | 3 | 13 | 25 | 16 | 57 | 2.9 | 5.3 | 71.9 | 80 |
| | ELEC 499 Senior Design Project II | 0 | 4 | 25 | 24 | 53 | 3.4 | 0 | 92.5 | 80 |
| **SO (3)** | An ability to communicate effectively with a range of audiences | 0 | 8 | 76 | 79 | 163 | 3.4 | 0 | 95.1 | 80 |
| **PI (3) 1** | Communicate effectively in writing. | 7 | 14 | 81 | 61 | 163 | 3.2 | 4.3 | 87.1 | 80 |
| | ELEC 428 Electrical Engineering Design | 7 | 11 | 18 | 21 | 57 | 2.9 | 12.3 | 68.4 | 80 |
| | ELEC 498 Senior Design Project I | 0 | 1 | 37 | 15 | 53 | 3.3 | 0 | 98.1 | 80 |
| | ELEC 499 Senior Design Project II | 0 | 2 | 26 | 25 | 53 | 3.4 | 0 | 96.2 | 80 |
| **PI (3) 2** | Demonstrate effective oral communication with a range of audiences. | 0 | 6 | 83 | 74 | 163 | 3.4 | 0 | 96.3 | 80 |
| | ELEC 428 Electrical Engineering Design | 0 | 4 | 27 | 26 | 57 | 3.4 | 0 | 93 | 80 |
| | ELEC 498 Senior Design Project I | 0 | 2 | 29 | 22 | 53 | 3.4 | 0 | 96.2 | 80 |
| | ELEC 499 Senior Design Project II | 0 | 0 | 27 | 26 | 53 | 3.5 | 0 | 100 | 80 |
| **SO (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 | 0 | 2 | 12 | 43 | 57 | 3.7 | 0 | 96.5 | 80 |
| **PI (4) 1** | Recognize ethical and professional responsibilities in engineering situations. | 1 | 2 | 10 | 44 | 57 | 3.7 | 1.8 | 94.7 | 80 |
| | ELEC 428 Electrical Engineering Design | 1 | 2 | 10 | 44 | 57 | 3.7 | 1.8 | 94.7 | 80 |
| **PI (4) 2** | Make informed judgments that consider the impact of engineering | 0 | 5 | 14 | 38 | 57 | 3.6 | 0 | 91.2 | 80 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | solutions in global, economic, environmental, and societal contexts. | | | | | | | | | |
| | ELEC 428 Electrical Engineering Design | 0 | 5 | 14 | 38 | 57 | 3.6 | 0 | 91.2 | 80 |
| **SO (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 | 0 | 6 | 77 | 80 | 163 | 3.5 | 0 | 96.3 | 80 |
| **PI (5) 1** | Provide collective leadership to successfully complete the tasks | 6 | 18 | 69 | 70 | 163 | 3.2 | 3.7 | 85.3 | 80 |
| | ELEC 428 Electrical Engineering Design | 6 | 8 | 14 | 29 | 57 | 3.2 | 10.5 | 75.4 | 80 |
| | ELEC 498 Senior Design Project I | 0 | 4 | 31 | 18 | 53 | 3.3 | 0 | 92.5 | 80 |
| | ELEC 499 Senior Design Project II | 0 | 6 | 24 | 23 | 53 | 3.3 | 0 | 88.7 | 80 |
| **PI (5) 2** | Contribute effectively and positively within the team whose members together create a collaborative and inclusive environment. | 0 | 4 | 41 | 118 | 163 | 3.7 | 0 | 97.5 | 80 |
| | ELEC 428 Electrical Engineering Design | 0 | 0 | 4 | 53 | 57 | 3.9 | 0 | 100 | 80 |
| | ELEC 498 Senior Design Project I | 0 | 1 | 24 | 28 | 53 | 3.5 | 0 | 98.1 | 80 |
| | ELEC 499 Senior Design Project II | 0 | 3 | 13 | 37 | 53 | 3.6 | 0 | 94.3 | 80 |
| **PI (5) 3** | Establish goals, plan and accomplish tasks, and contribute to meeting objectives. | 0 | 16 | 66 | 81 | 163 | 3.4 | 0 | 90.2 | 80 |
| | ELEC 428 Electrical Engineering Design | 0 | 1 | 10 | 46 | 57 | 3.8 | 0 | 98.2 | 80 |
| | ELEC 498 Senior Design Project I | 0 | 9 | 33 | 11 | 53 | 3 | 0 | 83 | 80 |
| | ELEC 499 Senior Design Project II | 0 | 6 | 23 | 24 | 53 | 3.3 | 0 | 88.7 | 80 |
| **SO (6)** | An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions | 4 | 43 | 92 | 48 | 187 | 3 | 2.1 | 74.9 | 80 |
| **PI (6) 1** | Develop an experiment to reach an engineering conclusion | 15 | 27 | 65 | 80 | 187 | 3.1 | 8 | 77.5 | 80 |
| | ELEC 313 Electric Machines Lab | 1 | 8 | 30 | 33 | 72 | 3.3 | 1.4 | 87.5 | 80 |
| | ELEC 367 Embedded Systems Lab | 11 | 12 | 23 | 17 | 63 | 2.7 | 17.5 | 63.5 | 80 |
| | ELEC 342 Communications Engineering Lab | 3 | 7 | 12 | 30 | 52 | 3.3 | 5.8 | 80.8 | 80 |
| **PI (6) 2** | Conduct an engineering experiment | 5 | 35 | 41 | 106 | 187 | 3.3 | 2.7 | 78.6 | 80 |
| | ELEC 313 Electric Machines Lab | 0 | 2 | 15 | 55 | 72 | 3.7 | 0 | 97.2 | 80 |
| | ELEC 367 Embedded Systems Lab | 1 | 14 | 7 | 41 | 63 | 3.4 | 1.6 | 76.2 | 80 |
| | ELEC 342 Communications Engineering Lab | 4 | 19 | 19 | 10 | 52 | 2.7 | 7.7 | 55.8 | 80 |
| **PI (6) 3** | Analyze and interpret experimental data to draw conclusions | 42 | 55 | 44 | 46 | 187 | 2.5 | 22.5 | 48.1 | 80 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ELEC 313 Electric Machines Lab | 16 | 18 | 22 | 16 | 72 | 2.5 | 22.2 | 52.8 | 80 |
| | ELEC 367 Embedded Systems Lab | 20 | 9 | 13 | 21 | 63 | 2.6 | 31.7 | 54 | 80 |
| | ELEC 342 Communications Engineering Lab | 6 | 28 | 9 | 9 | 52 | 2.4 | 11.5 | 34.6 | 80 |
| **SO (7)** | An ability to acquire and apply new knowledge as needed, using appropriate learning strategies | 0 | 2 | 11 | 44 | 57 | 3.7 | 0 | 96.5 | 80 |
| **PI (7) 1** | Demonstrate an ability to acquire new knowledge (e.g. entrepreneurship, sustainability) using appropriate learning strategies (e.g. seminars, various online and library resources). | 0 | 9 | 26 | 22 | 57 | 3.2 | 0 | 84.2 | 80 |
| | ELEC 428 Electrical Engineering Design | 0 | 9 | 26 | 22 | 57 | 3.2 | 0 | 84.2 | 80 |
| **PI (7) 2** | Demonstrate the application of acquired knowledge | 0 | 2 | 8 | 47 | 57 | 3.8 | 0 | 96.5 | 80 |
| | ELEC 428 Electrical Engineering Design | 0 | 2 | 8 | 47 | 57 | 3.8 | 0 | 96.5 | 80 |

** Data from all sections of the course should be aggregated (added up) and recorded in this row*
*** Student average = [ (nbScore1 * 1) + (nbScore2 * 2) + (nbScore3 * 3) + (nbScore4 * 4)] / (Tot Nb. Students)*
*+ Percentage students with score 1 = (nbScore1 / Tot Nb. Students)*
*++ Percentage students with score 3 or more = (nbScore3 + nbScore4) / (Tot Nb. Students)*

## 5.2 Cumulative Results and findings

***Table 5-2 Summary of Assessment Results collected through the cycle***

| PLO / OE ID | Number of Students scoring 1 | Number of Students scoring 2 | Number of Students scoring 3 | Number of Students scoring 4 | Total No. assessed Students | Student Average* * | Percentage students scored 1+ | Percentage students scored 3 or more++ | Defined Target |
|---|---|---|---|---|---|---|---|---|---|
| SO (1) | 9 | 23 | 85 | 48 | 165 | 3 | 5.5 | 80.6 | 80 |
| **PI (1) 1** | 32 | 38 | 58 | 37 | 165 | 2.6 | 19.4 | 57.6 | 80 |
| **PI (1) 2** | 14 | 22 | 44 | 85 | 165 | 3.2 | 8.5 | 78.2 | 80 |
| **PI (1) 3** | 23 | 22 | 50 | 70 | 165 | 3 | 13.9 | 72.7 | 80 |
| **PI (1) 4** | 30 | 32 | 38 | 65 | 165 | 2.8 | 18.2 | 62.4 | 80 |
| **SO (2)** | 0 | 16 | 62 | 94 | 172 | 3.5 | 0 | 90.7 | 80 |
| **PI (2) 1** | 1 | 24 | 72 | 75 | 172 | 3.3 | 0.6 | 85.5 | 80 |
| **PI (2) 2** | 3 | 19 | 72 | 78 | 172 | 3.3 | 1.7 | 87.2 | 80 |
| **SO (3)** | 0 | 8 | 76 | 79 | 163 | 3.4 | 0 | 95.1 | 80 |
| **PI (3) 1** | 7 | 14 | 81 | 61 | 163 | 3.2 | 4.3 | 87.1 | 80 |
| **PI (3) 2** | 0 | 6 | 83 | 74 | 163 | 3.4 | 0 | 96.3 | 80 |
| **SO (4)** | 0 | 2 | 12 | 43 | 57 | 3.7 | 0 | 96.5 | 80 |
| **PI (4) 1** | 1 | 2 | 10 | 44 | 57 | 3.7 | 1.8 | 94.7 | 80 |
| **PI (4) 2** | 0 | 5 | 14 | 38 | 57 | 3.6 | 0 | 91.2 | 80 |
| **SO (5)** | 0 | 6 | 77 | 80 | 163 | 3.5 | 0 | 96.3 | 80 |
| **PI (5) 1** | 6 | 18 | 69 | 70 | 163 | 3.2 | 3.7 | 85.3 | 80 |
| **PI (5) 2** | 0 | 4 | 41 | 118 | 163 | 3.7 | 0 | 97.5 | 80 |
| **PI (5) 3** | 0 | 16 | 66 | 81 | 163 | 3.4 | 0 | 90.2 | 80 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SO (6)** | 4 | 43 | 92 | 48 | 187 | 3 | 2.1 | 74.9 | 80 |
| **PI (6) 1** | 15 | 27 | 65 | 80 | 187 | 3.1 | 8 | 77.5 | 80 |
| **PI (6) 2** | 5 | 35 | 41 | 106 | 187 | 3.3 | 2.7 | 78.6 | 80 |
| **PI (6) 3** | 42 | 55 | 44 | 46 | 187 | 2.5 | 22.5 | 48.1 | 80 |
| **SO (7)** | 0 | 2 | 11 | 44 | 57 | 3.7 | 0 | 96.5 | 80 |
| **PI (7) 1** | 0 | 9 | 26 | 22 | 57 | 3.2 | 0 | 84.2 | 80 |
| **PI (7) 2** | 0 | 2 | 8 | 47 | 57 | 3.8 | 0 | 96.5 | 80 |

# 6 ANALYSIS OF ASSESSMENT RESULTS

## 6.1 Activity level analysis for the actual academic year

**SO(1): "An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics."**

**Results:** A summary of the assessment results of the PIs is presented in Table 6-1.

**Table 6-1 Summary of the assessment results of SO(1)'s PIs for Cycle VIII.**

| Performance indicator | Course | Semester | Number of assessed students | % scoring 3 or 4 for the activity | Average % scoring 3 or 4 for PI | Average % scoring 3 or 4 for SO (1) |
|---|---|---|---|---|---|---|
| **PI(1)1: Identify and formulate a complex engineering problem.** | ELEC 311 Electromagnetics | Fall 2022 | 53 | 39.6 | 57.6 | 80.6 |
| | ELEC 371 Sensors and Instrumentation | Fall 2022 | 58 | 77.6 | | |
| | ELEC 341 Communication Engineering | Spring 2023 | 54 | 53.7 | | |
| **PI(1)2: Solve a complex engineering problem by applying principles of engineering.** | ELEC 311 Electromagnetics | Fall 2022 | 53 | 77.4 | 78.2 | |
| | ELEC 371 Sensors and Instrumentation | Fall 2022 | 58 | 63.8 | | |
| | ELEC 341 Communication Engineering | Spring 2023 | 54 | 94.4 | | |
| **PI(1)3: Solve a complex engineering problem by applying principles of science.** | ELEC 311 Electromagnetics | Fall 2022 | 53 | 81.1 | 72.7 | |
| | ELEC 371 Sensors and Instrumentation | Fall 2022 | 58 | 58.6 | | |
| | ELEC 341 Communication Engineering | Spring 2023 | 54 | 79.6 | | |
| **PI(1)4: Solve a complex engineering problem by applying principles of mathematics.** | ELEC 311 Electromagnetics | Fall 2022 | 53 | 62.3 | 62.4 | |
| | ELEC 371 Sensors and Instrumentation | Fall 2022 | 58 | 65.5 | | |
| | ELEC 341 Communication Engineering | Spring 2023 | 54 | 59.3 | | |

**Assessment Context/Tool:**

In ELEC 311, the assessment is conducted individually in a dedicated quiz as provided in Appendix A. PI(1)1 is evaluated in problems 1 and 2 of the quiz where the student needs to explain why the thin conductor would generate voltage, what is needed for the voltage value to be measured and what are the design requirements and constraints in order to identify and formulate a complex engineering problem. PI(1)2 is evaluated in problem 3a where in order to obtain the magnetic flux, the student needs to apply principles of engineering to solve this complex engineering problem. PI(1)3 is evaluated in problem 3b where in order to obtain the induced voltage, the student needs to apply principles of science to solve this complex engineering problem. PI(1)4 is evaluated in problem 3c where in order to obtain the current in the resistor, the student needs to apply principles of math to solve this complex engineering problem.

In ELEC 371, the assessment is individually conducted in a dedicated problem of the final exam as provided in Appendix A where all the PI(1)s are assessed through different parts of the exam problem.

In ELEC 341 (Spring 2023), the assessment was done based on students' performances in answering some questions from Quiz, part 1 and midterm exam problem number 1-3 as explained hereafter: P1(1)1 is from average marks of Quiz, part 1. P1(1)2 - P1(1)4 are from Midterm Exam, Questions 1-3. Assessment is based on question grades and comments. Rubric is roughly that from 0 to 20% of the question grade is 1, 20% to 40% is 2, 40% to 70% is 3 and 70% or above is 4.

**Assessment Sample:** All students register for the above courses are assessed and included in the assessment result. Hence, no sampling is conducted.

**SO(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."**

**Results:** A summary of the assessment results of the PIs is presented in Table 6-2.

**Table 6-2 Summary of the assessment results of SO(2)'s PIs in Cycle VIII.**

| Performance indicator | Course | Semester | Number of assessed students | % scoring 3 or 4 for the activity | Average % scoring 3 or 4 for PI | Average % scoring 3 or 4 for SO (2) |
|---|---|---|---|---|---|---|
| **PI(2)1: Identify technical specifications of the electrical engineering system to meet the design goals under specific constraints and standards.** | ELEC 371 Sensors and Instrumentation | Fall 2022 | 62 | 93.5 | 85.5 | 90.7 |
| | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 66.7 | | |
| | ELEC 499 Senior Design Project II | Spring 2023 | 53 | 96.2 | | |
| **PI(2)2: Evaluate the design concepts and select the one that best matches the design constraints considering public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.** | ELEC 371 Sensors and Instrumentation | Fall 2022 | 62 | 96.8 | 87.2 | |
| | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 71.9 | | |
| | ELEC 499 Senior Design Project II | Spring 2023 | 53 | 92.5 | | |

**Assessment Context/Tool:**

In ELEC 371, the assessment is individually conducted in a term project where a group consisting of 5 members designed an ECG amplifier with the given system specifications, standards, and constraints. Each module is randomly assigned to a group member who is responsible to design, simulate, implement and test the module separately. All modules must be integrated, tested, and function as a complete working prototype. Finally, each member of the group must prepare and submit an individual report. The details of the term project are provided in Appendix A. In ELEC 371, PI(2)1 was assessed in the term project report by evaluating how students identify and formulate the objectives in Chapter 1 of the report using applicable standards under specific constraints. Part of the evaluation includes students' ability to identify applicable standards and constraints in Chapter 3. PI(2)2 was assessed on how students develop the selection matrix by exploring alternative solutions and their evaluation following the constraints and standards in order to justify the selected design implementation in Chapter 3. The evaluation on how students validate the selected design implementation in Chapter 5 was also included in this assessment.

In ELEC 428, the assessment is conducted through a project where a group consisting of 2-4 members designed an IoT system with the following subsystems: 1) Sensors & actuators, 2) IoT controller, 3) Cloud connection, and) Mobile Application. The students are working in teams, but each student is responsible for one subsystem design and an individual report is submitted by each student in the team for assessment. The details of the project, deliverables, and the conducted assessment are provided in Appendix A. In ELEC 499, the assessment is done by the supervisor as well as two examiners.

**Assessment Sample:** All students register for the above courses are assessed and included in the assessment result. Hence, no sampling is conducted.

**SO(3): "An ability to communicate effectively with a range of audiences."**

**Results:** A summary of the assessment results of the PIs is presented in Table 6-3.

**Table 6-3 Summary of the assessment results of SO(3)'s PIs in Cycle VIII.**

| Performance indicator | Course | Semester | Number of assessed students | % scoring 3 or 4 for the activity | Average % scoring 3 or 4 for PI | Average % scoring 3 or 4 for SO (3) |
|---|---|---|---|---|---|---|
| **PI(3)1: Communicate effectively in writing.** | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 68.4 | 87.1 | 95.1 |
| | ELEC 498 Senior Design Project I | Fall 2022 | 53 | 98.1 | | |
| | ELEC 499 Senior Design Project II | Spring 2023 | 53 | 96.2 | | |
| **PI(3)2: Demonstrate effective oral communication with a range of audiences.** | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 93 | 96.3 | |
| | ELEC 498 Senior Design Project I | Fall 2022 | 53 | 96.2 | | |
| | ELEC 499 Senior Design Project II | Spring 2023 | 53 | 100 | | |

**Assessment Context/Tool:**

In ELEC 498 and ELEC 499, PI(3)1 is assessed for each student individually based on the progress reports and final report. The students provided a writing contribution table in each report and this table is used by the supervisor for individual assessment. PI(3)2 is assessed for each student individually based on the final presentation, other presentations were done for the supervisor during the semester and the weekly meeting discussions.

In ELEC 428, PI(3)1 and PI(3)2 are assessed based on the individual project report and presentation for each student. Further details on ELEC 428 project are provided in Appendix A.

**Assessment Sample:** All students register for the above courses are assessed and included in the assessment result. Hence, no sampling is conducted.

**SO(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."**

**Results:** A summary of the assessment results of the PIs is presented in Table 6-5.

***Table 6-4 Summary of the assessment results of SO(4)'s PIs in Cycle VIII.***

| Performance indicator | Course | Semester | Number of assessed students | % scoring 3 or 4 for the activity | Average % scoring 3 or 4 for PI | Average % scoring 3 or 4 for SO(4) |
|---|---|---|---|---|---|---|
| **PI(4)1: Recognize ethical and professional responsibilities in engineering situations.** | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 94.7 | 94.7 | 96.5 |
| **PI(4)2: Make informed judgments that consider the impact of engineering solutions in global, economic, environmental, and societal contexts.** | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 91.2 | 91.2 | |

**Assessment Context/Tool:**

In ELEC 428, the assessment is conducted through a quiz (see Appendix A) as well as an individual project report submitted by each student.

**Assessment Sample:** All students register for the above courses are assessed and included in the assessment result. Hence, no sampling is conducted.

**SO(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."**

**Results:** A summary of the assessment results of the PIs is presented in Table 6-6.

**Table 6-5 Summary of the assessment results of SO(5)'s PIs in Cycle VIII.**

| Performance indicator | Course | Semester | Number of assessed students | % scoring 3 or 4 for the activity | Average % scoring 3 or 4 for PI | Average % scoring 3 or 4 for SO(5) |
|---|---|---|---|---|---|---|
| **PI(5)1: Provide collective leadership to successfully complete the tasks** | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 75.4 | 85.3 | 96.3 |
| | ELEC 498 Senior Design Project I | Fall 2022 | 53 | 92.5 | | |
| | ELEC 499 Senior Design Project II | Spring 2023 | 53 | 88.7 | | |
| **PI(5)2: Contribute effectively and positively within the team whose members together create a collaborative and inclusive environment.** | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 100 | 97.5 | |
| | ELEC 498 Senior Design Project I | Fall 2022 | 53 | 98.1 | | |
| | ELEC 499 Senior Design Project II | Spring 2023 | 53 | 94.3 | | |
| **PI(5)3: Establish goals, plan and accomplish tasks, and contribute to meeting objectives.** | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 98.2 | 90.2 | |
| | ELEC 498 Senior Design Project I | Fall 2022 | 53 | 83 | | |
| | ELEC 499 Senior Design Project II | Spring 2023 | 53 | 88.7 | | |

**Assessment Context/Tool:**

In ELEC 498 and ELEC 499, the assessment is done individually based on the supervisor's interaction with students in the weekly meetings as well as the project logbook.

In ELEC 428, the assessment is conducted based on the lab activities of each student and a dedicated form is used by the Lab Instructors to assess each student individually based on observations, and questions and answers. The assessment form is provided in Appendix A.

**Assessment Sample:** All students register for the above courses are assessed and included in the assessment result. Hence, no sampling is conducted.

**<u>SO(6): "An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions."</u>**

**Results:** A summary of the assessment results of the PIs is presented in Table 6-7

**Table 6-6 Summary of the assessment results of SO(6)'s PIs in Cycle VIII.**

| Performance indicator | Course | Semester | Number of assessed students | % scoring 3 or 4 for the activity | Average % scoring 3 or 4 for PI | Average % scoring 3 or 4 for SO(6) |
|---|---|---|---|---|---|---|
| | ELEC 313 Electric Machines Lab | Fall 2022 | 72 | 87.5 | 77.5 | 74.9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **PI(6)1: Develop an experiment to reach an engineering conclusion** | ELEC 367 Embedded Systems Lab | Fall 2022 | 63 | 63.5 | | |
| | ELEC 342 Communications Engineering Lab | Spring 2023 | 52 | 80.8 | | |
| **PI(6)2: Conduct an engineering experiment** | ELEC 313 Electric Machines Lab | Fall 2022 | 72 | 97.2 | 78.6 | |
| | ELEC 367 Embedded Systems Lab | Fall 2022 | 63 | 76.2 | | |
| | ELEC 342 Communications Engineering Lab | Spring 2023 | 52 | 55.8 | | |
| **PI(6)3: Analyze and interpret experimental data to draw conclusions** | ELEC 313 Electric Machines Lab | Fall 2022 | 72 | 52.8 | 48.1 | |
| | ELEC 367 Embedded Systems Lab | Fall 2022 | 63 | 54 | | |
| | ELEC 342 Communications Engineering Lab | Spring 2023 | 52 | 34.6 | | |

**Assessment Context/Tool:**

In ELEC 313, the assessment is individually conducted in a lab exam. Three different exams are devised for different offered lab sessions in Fall 2022 and details of the exams are provided in Appendix A.

In ELEC 367, the assessment is individually conducted in a lab exam. Four different exams are devised for different offered lab sessions in Fall 2022 and details of the exams are provided in Appendix A.

In ELEC 342, the assessment is individually conducted in a lab exam and details of the exam is provided in Appendix A.

**Assessment Sample:** All students register for the above courses are assessed and included in the assessment result. Hence, no sampling is conducted.

**SO(7): "An ability to acquire and apply new knowledge as needed, using appropriate learning strategies."**

**Results:** A summary of the assessment results of the PIs is presented in Table 6-8.

**Table 6-7 Summary of the assessment results of SO(7)'s PIs in Cycle VIII.**

| Performance indicator | Course | Semester | Number of assessed students | % scoring 3 or 4 for the activity | Average % scoring 3 or 4 for PI | Average % scoring 3 or 4 for SO(7) |
|---|---|---|---|---|---|---|
| **PI(7)1: Demonstrate an ability to acquire new knowledge (e.g. entrepreneurship, sustainability) using appropriate learning** | ELEC 428 Electrical Engineering Design | Fall 2022 | 57 | 84.2 | 84.2 | 96.5 |

| | | | |
|---|---|---|---|
| **strategies (e.g. seminars, various online and library resources).** | | | |
| **PI(7)2: Demonstrate the application of acquired knowledge** | ELEC 428 Electrical Engineering Design Fall 2022 57 96.5 | 96.5 | |

**Assessment Context/Tool:**

In ELEC 428, the assessment is individually conducted based on the individual project report for each student as well as quizzes after several seminars throughout the course.

**Assessment Sample:** All students register for the above courses are assessed and included in the assessment result. Hence, no sampling is conducted.

## 6.2 Program level analysis based on cumulative results

The results of the assessment of SO(1) indicate that 80.6% of the assessed students have achieved 3 or 4 and this meets the target of 80%. In comparison with the previous cycle (Cycle VII) where 64% of the assessed student achieved 3 or 4, there exists an increase in achieving SO(1). However, the achievement percentage for PI(1)1 (57.6%) and PI(1)4 (62.4%) are far below the target of 80%.

The results of the assessment of SO(2) indicate that 90.7% of the assessed students have achieved 3 or 4 and this meets the target of 80%. In comparison with the previous cycle (Cycle VII) where 82.5% of the assessed student achieved 3 or 4, there exists an increase in achieving SO(2). Moreover, the achievement percentage for both PIs of SO are also above the target of 80%.

The results of the assessment of SO(3) indicate that 95.1% of the assessed students have achieved 3 or 4 and this meets the target of 80%. In comparison with the previous cycle (Cycle VII) where 79.7% of the assessed student achieved 3 or 4, there exists an increase in achieving SO(3). Moreover, the achievement percentage for both PIs of SO are also above the target of 80%.

The results of the assessment of SO(4) indicate that 96.5% of the assessed students have achieved 3 or 4 and this meets the target of 80%. In comparison with the previous cycle (Cycle VII) where 80.5% of the assessed student achieved 3 or 4, there exists an increase in achieving SO(4). Moreover, the achievement percentage for both PIs of SO are also above the target of 80%.

The results of the assessment of SO(5) indicate that 96.3% of the assessed students have achieved 3 or 4 and this meets the target of 80%. In comparison with the previous cycle (Cycle VII) where 87.4% of the assessed student achieved 3 or 4, there exists an increase in achieving SO(5). Moreover, the achievement percentage for both PIs of SO are also above the target of 80%.

The results of the assessment of SO(6) indicate that 74.9% of the assessed students have achieved 3 or 4 and this does not meet the target of 80%. In comparison with the previous cycle (Cycle VII) where 89.3% of the assessed student achieved 3 or 4, there exists a decrease in achieving SO(6). Moreover, the achievement percentage for PI(6)3 (48.1%) is far below the target of 80%.

The results of the assessment of SO(7) indicate that 96.5% of the assessed students have achieved 3 or 4 and this meets the target of 80%. In comparison with the previous cycle (Cycle VII) where 93.6% of the assessed student achieved 3 or 4, there exists a slight increase in achieving SO(7). Moreover, the achievement percentage for both PIs of SO are also above the target of 80%.

# 7 FUTURE IMPROVEMENT PLANS (*Actions*)

Based on the above PLO assessment results, Table 7-1 shows the improvement actions planned for the AY 2023-2024 to improve SO(1) and SO(6) along with associated PIs.

***Table 7-1 Adopted Future Improvement Actions Details***

| Improvement Action Statement/Description | Action Type* (Curriculum, Staff, Process, …) | Associated PLO / OE (if any) | Action / Step** | Planned Date | Person Responsible | Resources | | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Financial | Others | |
| Embed dedicated tutorial session to the applicable courses in the program especially in ELEC311 and ELEC341 for introducing and developing students' skills in formulating and solving complex engineering problems. This may be added as one credit unit as faculty load to TAs assisting ELEC341 and ELEC311 as extra tutorials (+1). | *Course delivery* | SO(1) | Embed dedicated tutorial session to the applicable courses in the program especially in ELEC311 and ELEC341 for introducing and developing students' skills in formulating and solving complex engineering problems. This may be added as one credit unit as faculty load to TAs assisting ELEC341 and ELEC311 as extra tutorials (+1). | Spring 2024/ Fall 2024 | Course instructors | | | |
| More credit will be allocated in the lab activities and reports related to SO(6) by emphasizing this section in a lab report. | *Assessment Tool* | SO(6) | More credit will be allocated in the lab activities and reports related to SO(6) by emphasizing this section in a lab report. | Fall 2023/Spring 2024 | Course instructors | | | |
| Improvement actions on lab activities will be applied as early as | *Assessment Rubric* | SO(6) | Improvement actions on lab activities will be applied as early as | Fall 2023 | Course instructors | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| in D level courses. ELEC201 Lab activities can be modified as part of the improvement action as an initiative. | | | in D level courses. ELEC201 Lab activities can be modified as part of the improvement action as an initiative. | | | | | |
| Lab report template will be designed with the same structure of the performance indicators to specifically target PI(6)3 so that students can practice this in each lab report in line with the assessment of this SO. | *Course delivery* | SO(6) | Lab report template will be designed with the same structure of the performance indicators to specifically target PI(6)3 so that students can practice this in each lab report in line with the assessment of this SO. | Fall 2023/Spring 2024 | Course instructors | | | |

* *Action Type: Review course or curriculum, Course delivery, Rubrics, Assessment tools, PLO statements, Assessment process or plan, New software, Equipment or facility, Professional development, Staff*

** *Many actions/ steps may be required for any specific improvement action, each step should be recorded in a separate row*

# 8 CONCLUSION

In conclusion, all the Student Outcomes (SOs) were assessed in the academic year 2022/2023 and assessment result of Cycle VIII is presented in the report. The improvement actions are summarized in Table 7.1 for Cycle VIII and will be implemented in AY 2023/2024.

***Thank You***

# Part 2

## 9 Status of Improvement Actions Adopted During Last Academic Year

***Table 9-1 Implementation Status of Improvement Actions Recorded in Most Recently Submitted Annual Assessment Report***

| # | Improvement Action Statement | Associated PLO* / OE** | Rationale for the Action (link to Assessment) | Step / Task*** | Date of Implementation | | Used Resources | | Current Status & Notes | Reference to Evidence** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Planned | Actual | Financial | Others | | |
| 1 | Embed learning activities in most of the core courses in the program for introducing and developing students' skills in solving complex engineering problems. | SO(1) | Improving students' skills in solving complex engineering problems. | Embed learning activities in most of the core courses in the program for introducing and developing students' skills in solving complex engineering problems. | Fall 2022/Spring 2023 | Fall 2023/Spring 2024 | | | The main focus of this year was to conduct individual assessment of SO(1) to better assess this SO and then embed the tailored learning activities for this. | Refer to SO(1) assessment result for the individual assessment conducted in three different courses this academic year. |
| 2 | Assessment at the Mastery level will be planned through course projects/Homework assignments and ELEC 499. | SO(1) | | Assessment at the Mastery level will be planned through course projects/Homework assignments and ELEC 499. | Fall 2022/Spring 2023 | Fall 2022/Spring 2023 | | | SO(1) is assessed in three courses individually and hence group projects will not be used any more for assessing SO(1) | Refer to SO(1) assessment result for the individual assessment conducted in three different courses this academic year. |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Modifying PI(2)1 | SO(2) | PI(2)1 was missing the design formulation aspect | Modifying PI(2)1 | Fall 2022 | Fall 2022 | | | PI(2)1 is modified. | Refer to Appendix B for the new rubric |
| 4 | Assess SO(2) in ELEC 499 to see improvement result of ELEC 428 with emphasis on all the factors mentioned in the SO description | SO(2) | | Assess SO(2) in ELEC 499 to see improvement result of ELEC 428 with emphasis on all the factors mentioned in the SO description | Spring 2023 | Spring 2023 | | | SO(2) is individually assessed in ELEC 499. | Refer to SO(2) assessment result |
| 5 | Assess SO(2) only in ELEC 428 and ELEC 499. | SO(2) | | Assess SO(2) only in ELEC 428 and ELEC 499. | Fall 2022/Spring 2023 | Fall 2022/Spring 2023 | | | It was decided to also assess SO(2) in ELEC371 to have three different courses for individually assessing this SO. This was decided in accordance to the comment received from ABET evaluator to diversify assessment context. | Refer to SO(2) assessment result |
| 6 | Revise the Mastery Level Mapping for all SOs | All SOs | | Revise the Mastery Level Mapping for all SOs | Fall 2022 | Fall 2023 | | | Due to the ABET visit and the corresponding focus on the department, this is delay to the next academic year. | |
| 7 | Coordinate with the English Department regarding effectiveness of ENGL | SO(3) | | Coordinate with the English Department regarding effectiveness of ENGL | Fall 2022 | Fall 2023 | | | Due to the ABET visit and the | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 202/203 to improve the students' communication skills. | | | 202/203 to improve the students' communication skills. | | | | | corresponding focus on the department, this is delay to the next academic year. | |
| 8 | Analyze the students' transcript to identify the semesters that the students take ENGL 202/203 | SO(3) | | Analyze the students' transcript to identify the semesters that the students take ENGL 202/203 | | | | | Due to the ABET visit and the corresponding focus on the department, this is delay to the next academic year. | |
| 9 | Put more weight on students' communication skills in ELEC 428, ELEC 498, ELEC 499 grading scheme | SO(3) | | Put more weight on students' communication skills in ELEC 428, ELEC 498, ELEC 499 grading scheme | Fall 2022/Spring 2023 | Fall 2022/Spring 2023 | | | More emphasis is considered for the individual assessment of SO(3). | Refer to SO(3) assessment result |
| 10 | Keep Ethical questions to the Exit exam | SO(4) | | Keep Ethical questions to the Exit exam | Spring 2023 | Spring 2023 | | | Ethical questions are kept in the exit exam and will be analyzed. | |
| 11 | Keep ELEC 428 to emphasize ethical issues through seminars and assessment. | SO(4) | | Keep ELEC 428 to emphasize ethical issues through seminars and assessment. | Fall 2022 | | | | A seminar on ethical issue was arranged in ELEC 428 and the assessment in conducted individually through a quiz. | Refer to SO(4) assessment result |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 12 | Modify the PIs of SO(5) | SO(5) | | Modify the PIs of SO(5) | Fall 2022 | Fall 2022 | | | PIs of SO(5) are modified and the corresponding assessment rubrics are developed | Refer to Appendix B. |
| 13 | Prepare a clear structure/template/guideline for SDP Logbook and Progress Reports/Presentations to cover the new PIs | SO(5) | | Prepare a clear structure/template/guideline for SDP Logbook and Progress Reports/Presentations to cover the new PIs | Fall 2022/Spring 2023 | Fall 2022/Spring 2023 | | | The SDP template is updated to mainly show the individual contribution of each student for the relevant SOs. More modification is planned to be implemented in Fall 2023 | |
| 14 | Introduce Project Management/Leadership in GENG 107 | SO(5) | | Introduce Project Management/Leadership in GENG 107 | Fall 2022 | Fall 2023 | | | This will be discussed in College Curriculum committee. | |

** PLO: Program Level Student Learning Outcome; ** OE: Outcome Element; ***Step/Task: Many Steps /Tasks may be defined for the same improvement action*

## 9.1 Status of Improvement Actions Adopted in Earlier Academic Years

***Table 9-2 Implementation Status of Improvement Actions Adopted and Recorded in Earlier Annual Assessment Reports***

| Report Date | # | Improvement Action Statement | Associated PLO* / OE** | Rationale for the Action (link to Assessment) | Step / Task *** | Date of Implementation | | Used Resources | | Current Status & Notes | Reference to Evidence** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Planned | Actual | Financial | Others | | |
| | 1 | | | | | | | | | | |
| | 2 | | | | | | | | | | |
| | 3 | | | | | | | | | | |
| | 4 | | | | | | | | | | |

** PLO: Program Level Student Learning Outcome; ** OE: Outcome Element; ***Step/Task: Many Steps /Tasks may be defined for the same improvement action*

## *9.2* Other Improvement Actions implemented by the program during Current AY

***Table 9-3 Implementation Status of Other Improvement Actions Not Recorded in Annual Assessment Reports***

| # | Improvement Action Statement | Associated PLO* / OE** | Rationale for the Action (link to Assessment) | Step / Task *** | Date of Implementation | | Used Resources | | Current Status & Notes | Reference to Evidence** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Planned | Actual | Financial | Others | | |
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |

** PLO: Program Level Student Learning Outcome; ** OE: Outcome Element; ***Step/Task: Many Steps /Tasks may be defined for the same improvement action*

# Appendix A: Samples of Assessment Tools

## Assessment Tool for SO (1) in ELEC311 Quiz (Fall2022)

Q1: An inductor is formed by winding *N=10* turns of a thin conducting wire into a circular loop of radius *a=2cm.* The inductor loop is in the *x-y* plane with its center at the origin, and connected to a resistor *R=1000*Ω, as shown in the figure below. In the presence of a magnetic field **B** = (**z**6+**x**14) sin *wt,* where *w* is the angular frequency=1000rad/s. You need to follow the following steps (identify, formulate, and solve):

1) Identify the problem: explain why the thin conductor would generate voltage? What is needed for the voltage value to be measured?

2) Formulate the problem:
   a. Requirement and constraints in order for the voltage to be obtained even in the presence of the magnetic field.

3) Solve the problem and obtain
   a. the magnetic flux
   b. $V_{emf}$
   c. Current *I*

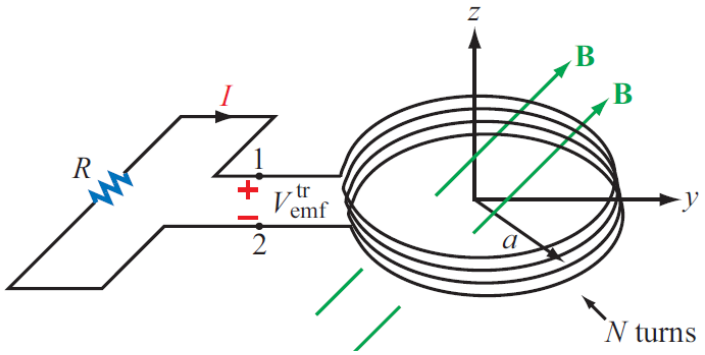



**Figure 6-3:** Circular loop wit
magnetic field is $\mathbf{B} = B_0(\hat{\mathbf{y}}2 +$

# Assessment Tool for SO (1) in ELEC371 Final Exam (Fall2022)

Problem: Explain the importance of oscillators and how active filters can be used to design an oscillator. Design an oscillator that provides 3.183 kHz sinusoidal oscillation at room temperature using active-tuned filter based on Antoniou's simulated inductor. Draw the circuit's schematic. Assuming Op-amp output voltage rating is $V_{omax}$=± 12V, specify the minimum Op-amp slew rate (SR) required in this application. Discuss briefly how temperature would affect the oscillation frequency.

Students need to follow the following steps (identify, formulate, and solve):

1) Identify the problem: explain why oscillators are important (in what applications)? What advantages Antoniou's simulated inductor-based oscillators have over other filters using real inductors?

2) Formulate the problem by:
    a. Defining technical requirements and constraints (e.g. what filter, what inductor, filter center frequency).
    b. Describing any tradeoffs or limitations between these requirements and constraints (e.g., limitation of the generated frequency and Op-amp slew rate).

3) Solve the problem:
    a. Using the Fourier series, explain how active tuned filter can be used to design an oscillator.
    b. Find the minimum Op-amp slew rate required ($SR \geq w \times V_{omax}$).
    c. Derive the expression of the transfer function and frequency of oscillation. Use engineering principles like Barkhausen criteria, approximated equations (transfer functions), and assumption like operation at room temperature.
    d. Use your science (e.g., variation of resistances with temperature) and Math (oscillator transfer function equation) knowledge to discuss how temperature affects the oscillation frequency (increase or decrease with temperature?). Hint: Electronic elements and devices are temperature-sensitive (e.g., refer to diode's Shockley equation and MOSFET and BJT equations).

## Assessment Tool for SO (1) in ELEC341 Quiz and Mid-term (Spring2023)

Quiz: An engineer is asked to design a source encoder that induces least cost when source samples are transmitted through a wireless operator. The source has 3 possible samples, and the engineer obtained the samples probabilities as follow:
Samples = {a1, a2, a3}
Probabilities = {0.1, 0.2, 0.7}

1) Identify the problem: explain what is needed to make the source encoder induce the least cost. Is there a constraint on the best encoder that can be obtained?
2) Obtain the best source code.
3) Obtain the code rate R.
4) Obtain the code efficiency.

Show the steps in your calculations.

Midterm exam-based assessment tool is attached here

# Assessment Tool for SO (2) in ELEC371 Term Project (Fall2022)

**Title:** Electrocardiogram (ECG) amplifier.

**Project description:**

A group consisting of 5 members will design an ECG amplifier following the prescribed block diagram as shown in figure1 with the given system specifications, standards, and constraints. Each module will be randomly assigned to a group member who will be responsible to design, simulate, implement and test the module separately. All modules must be integrated, tested, and function as a complete working prototype.

**Technical constraints:**

- Frequency range: 0.05 Hz to 100 Hz.
- ECG Amplitude range: 0.5 mV - 1 mV.
- Line frequency: 50 Hz.
- Loading effect considerations on each assigned module.
- Standard values of components must be use.

**Public health constraints:**

- ECG signals must be acquired for an accurate diagnosis of the patient. Failure to do so might result in wrong diagnosis and hence wrong treatment.

**Safety and welfare constraints:**

- Safety acquisition of signals from a human subject.
- Isolation of human subject from high voltage or current.
- Safety precautions during implementation and testing.

**Global constraint:**

- Not applicable.

**Cultural constraint:**

- Not applicable.

**Social constraint:**

- Not applicable.

**Environmental constraint:**

- Not applicable.

**Economic factors and risk constraints:**

- Budget for each block.
    - Instrumentation amplifier section of the circuit must not exceed 30 USD.
    - Isolation amplifier section must not exceed 10 USD.
    - High pass filter section must not exceed 10 USD.
    - Low pass filter section must not exceed 10 USD.
    - Notch filter section must not exceed 10 USD.
    - The total price must not exceed 50 USD.
- Op-amps, instrumentation amplifier and isolation amplifier are not available locally, hence, purchasing the components from an international vendor many incur risk in terms of shipping and delay.

**Standards:** IEEE P11073-10406/D10:Health Informatics--Device Specialization--Basic Electrocardiograph (ECG) (1- to 3-lead ECG)

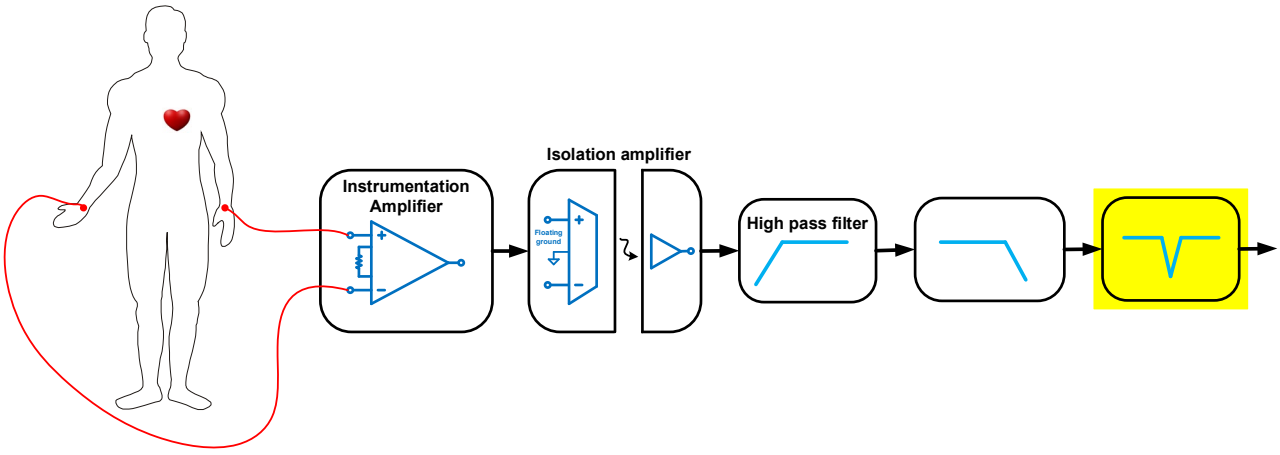



Figure1. ECG (**e**lectro-**c**ardio**g**ram) block diagram.

**Deliverables:**

1. To design, simulate, implement and test the assign module.
2. To integrate all modules and function as a complete working prototype.
3. All members of the group must prepare and submit individual reports in the link provided in the Blackboard following the report structure below.

**Title Page Main Title (Assigned module)**

**Abstract.** *(Common)*

**Table of Contents.** *(Individual)*

**List of Figures and Tables.** *(Individual)*

**Chapter 1.** Introduction. *(Be brief but concise, maximum of half-page per section)*

1.1. Background *(Common)*
1.2. Problem Statement. *(Common)*
1.3. Objectives. *(Common + Individual)*

**Chapter 2.** Related Literature. *(1 page maximum)* *(Common)*

**Chapter 3.** Design Concepts. *(2 pages maximum)*

- Standards and Constraints. *(Common)*
- Selection matrix based on constraints, standards, and risk. *(Individual)*
- Derivations of design equations *(Individual)*

**Chapter 4.** Individual Design, Simulation and Implementation. *(2 pages maximum)* *(Individual)*

**Chapter 5.** Overall System Simulation and Validation (Meeting the constraints and standards).

*(2 pages maximum)* *(Common)*

**Chapter 6.** Discussion of Results. *(1 page maximum)* *(Common + Individual)*

**Chapter 7.** Conclusions and Recommendations. *(1 page maximum)* *(Common + Individual)*

**Chapter 8.** References. *(Common + Individual)*

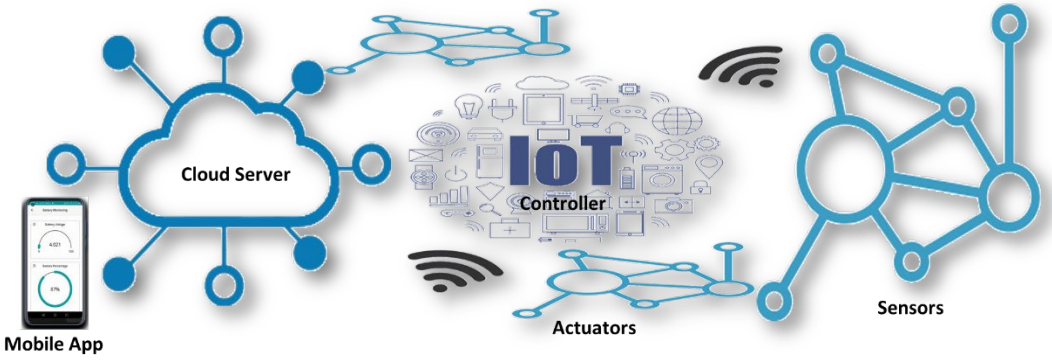
**Chapter 9.** Appendix. *(Common + Individual)*

## Assessment Tool for SO(2), SO(3), and SO(7) in ELEC 428 (Fall 2022)

# INDIVIDUAL STUDENT OUTCOME ASSESSMENT PROCEDURES

The students are grouped in teams of 2-4 students and assigned different group projects. All projects include the following subsystems:

1. Sensors & actuators
2. IoT controller
3. Cloud connection
4. Mobile Application




The students are working in teams, but each student is responsible for one subsystem design. For instance, one student designs a sensor, another one designs the IoT controller and actuator, and another one designs the mobile application.

The whole system shall have general design constraints and standards and each subsystem has specific design constraints and standards.

The deliverables are the following:

1. Progress Report (Individual)
2. Final Report (Individual)
3. PowerPoint Presentation (Individual + Team)
4. Poster (Individual + Team)
5. Prototype (Individual + Team)
6. Logbook (Individual + Team)

Lab sessions of 3 hours each are allocated weekly for the students to execute their projects following the standard design process that they have studied in the lectures. They are monitored in the lab by the Teaching Assistants and the Instructor.

Students are also attending lectures and seminars that are intended to guide the students toward enhancing their skills in achieving very good design projects. Seminars are also intended to expose the students to contemporary issues and provide them with some career guidance since most of these seminars are presented by experts from industry and government institutions.

Different assessment tools (direct and indirect) are deployed for the individual assessment of the students' outcomes (SOs) and grading the individual students performance.

This document compiles these assessment tools and explains how they are deployed.

**Assessment Forms**

# ELEC 428: Electrical Engineering Design

## 🗎 LAB ACTIVITIES ASSESSMENT FORM 🗎

The purpose of this form is to assess teamwork[1] in the class during the project lab sessions. This form is used by the Lab Instructors to assess each student individually based on student works and questions and answers.

**ELEC428 Lxx** **Group#:** **Assessment Date:**

Names of group members including your own:

Student 1 _____

Student 2 _____

Student 3 _____

Student 4 _____

Assess and score each performance/skill listed in the table below for all group members.

**PI(5)1** – Provide collective leadership to successfully complete the tasks

| Performance Indicator Element | Scores* | | | |
|---|---|---|---|---|
| | **Student 1** | **Student 2** | **Student 3** | **Student 4** |
| Delegate tasks to insure they are completed | | | | |
| Run meetings that accomplish tasks | | | | |
| Enhance the confidence and enthusiasm of team members through recognition | | | | |

* 1: Rarely; 2: Sometimes; 3: Mostly; 4: Always

**PI(5)2** – Contribute effectively and positively within the team whose members together create a collaborative and inclusive environment

| Performance Indicator Element | Scores* | | | |
|---|---|---|---|---|
| | **Student 1** | **Student 2** | **Student 3** | **Student 4** |
| Participate in team activities | | | | |
| Have a positive attitude towards collaboration | | | | |

[1] SO(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.

| | | | | |
|---|---|---|---|---|
| Handle inter-personal conflict | | | | |
| Willingly accept suggestions from others in the team | | | | |

* 1: Rarely; 2: Sometimes; 3: Mostly; 4: Always

**PI(5)3** – Establish goals, plan and accomplish tasks, and contribute to meeting objectives.

| **Performance Indicator Elements** | **Scores*** | | | |
|---|---|---|---|---|
| | **Student 1** | **Student 2** | **Student 3** | **Student 4** |
| Establish goals | | | | |
| Plan and accomplish tasks | | | | |
| Contribute to meeting objectives | | | | |

* 1: Rarely; 2: Sometimes; 3: Mostly; 4: Always

Please add your comments and/or recommendations (if any) below:

# ELEC 428: Electrical Engineering Design

## 🗎 Leadership Skills Assessment Form 🗎

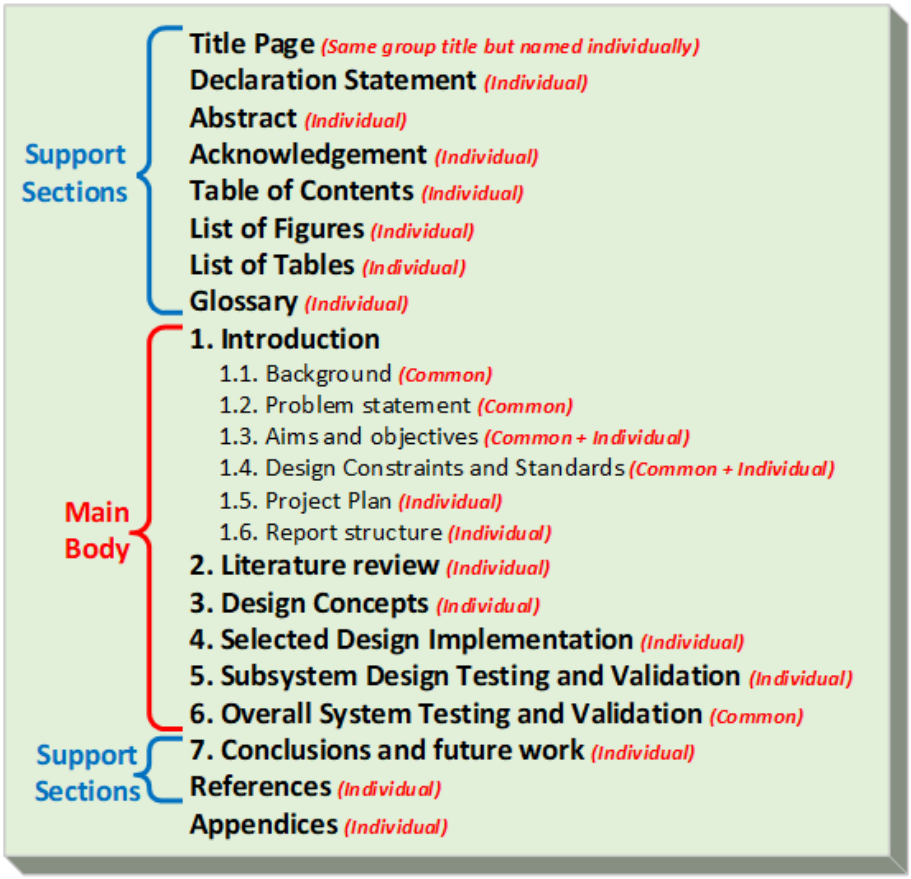
**Group Number: _____**
**Inclusive dates: _____**
**Week number: _____**

**Group leader: Name and QU ID**
**Group members: Name and QU ID**

*Present a summary of tasks and activities for the previous week(s) during which you acted as a group leader.*
*The summary should include the following but not limited to:*

1. *Summary of the tasks assigned to each individual member.*
2. *Status of achievement compared to the initial plan (Gantt chart).*
3. *Issues encountered, possible solutions and future work.*

# INDIVIDUAL FINAL REPORT STRUCTURE




All assessments of SOs are conducted based on the individually written parts only.

# Assessment Tool for SO(4) in ELEC 428 (Fall 2022)

Quiz #3 used in ELEC 428 to assess SO(4).

| | | | |
|---|---|---|---|
| **Course Code** | : ELEC428 (L01) | **Instructor** | : Prof. Adel Gastli |
| **Course Title** | : Electrical Engineering Design | **Date** | : Tue. 01-11-2022 |
| **Semester** | : Fall 2022 | **Time** | : 25 min |

**Student name:** **Student ID No.:** **Total Mark**

**Class Project Title:** / **100**

## Problem

This quiz is intended to assess your 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 context. The engineering situation that is considered here is directly related to your class design project. You are asked to reflect on why the design solution that you selected is ethically correct and a good thing by answering the following questions:

**a)** How your proposed design solution could be used for human well-being in general? (PI(4)-2) **[15 Marks]**

**b)** How can your solution impact society? (PI(4)-2) **[15 Marks]**

**c)** How can your solution impact the environment? (PI(4)-2) **[15 Marks]**

**d)** How can your solution impact economic development? (PI(4)-2) **[15 Marks]**

**e)** Your IoT design solution includes data collection on a cloud server and considering that you have mentioned to your clients that the data is private and kept confidential and will not be accessed by anyone else without their authorization and consent. However, another company approaches you and offers you a large amount of money to give them access to your client's data. Their intention is to conduct a statistical study that will help the country solve certain issues. Will you provide them with that access? Explain how and why and refer to the appropriate NSPE Code of ethics (Summarized Version is attached). (PI(4)-1) **[40 Marks]**

# Assessment Tool for SO(6) in ELEC313 Lab Exam (Fall2022)

**Exam 1:** Design/develop an experiment to observe the response of a DC shunt motor in terms of speed, torque and current.

**Exam 2:** Design/develop an experiment to determine observe the response of a three phase induction motor with increasing load in terms of speed, efficiency, power factor and current.

(a) Write the name of the test(s). **PI(6)1**
(b) Draw the practical schematic diagram(s) for the test(s). (Show all measuring devices in appropriate places as you will connect in practical, don't draw devices not connected practically) **PI(6)1**
(c) List **ALL** the equipment and measuring instruments to be used for the test(s) **PI(6)1**
(d) Write the systematic procedure for the test(s) **PI(6)1**
(e) Implement the test, Connect the circuit using proper wire colorings **PI(6)2**
(**don't** energize the circuit) show to the instructor [6 marks]
(f) Measure required data (Draw necessary tabular columns) **PI(6)2**
(g) Calculate the required parameters.( add results to the table) show sample calculations **PI(6)3**
(h) Draw graph **PI(6)3**
(i) Analyze and interpret experimental data to determine the parameters **PI(6)3**
(j) Write advantages and disadvantages of dc motors.

**Exam 3:** For the given three-phase squirrel cage induction motor connected in Y configuration, obtain the complete equivalent circuit by conducting suitable tests.

a) Write the name of the tests. **(PI(6)-1)**
b) Draw the **practical** schematic diagrams for the tests. (Show all measuring devices in appropriate places) **(PI(6)-1)**
c) List **ALL** the equipment and measuring instruments to be used for the tests. **(PI(6)-1)**
d) Write the step-by-step procedure for the tests. **(PI(6)-1)**
e) Implement the test **(PI(6)-2)**

| **Tasks** | **Max. Marks** | **Marks obtained** |
|---|---|---|
| Wiring of the circuit | 10 | |
| Connections of measuring devices and proper settings | 5 | |
| Implementation of safety measures | 5 | |
| Conducting the test | 10 | |

f) Measure required data (Draw necessary tabular columns) **(PI(6)-2)**
g) Calculate the required parameters. **(PI(6)-3)**
h) Draw the equivalent circuit as obtained from the test. (Show the values on the circuit) **(PI(6)-3)**
i) Identify the limitations of the equivalent circuit and suggest ways to improve it.
9.1 Explain what made the equivalent circuit parameters determination approximate.
9.2 Explain how the rotor equivalent resistance can be made more accurate.

j) Mention three speed control methods for the squirrel cage induction motor.
k) Draw the **Current VS Output Power**, **pf VS Output Power** of a Three Phase Induction Motor in one graph.
l) For the DC Motor speed control, do you prefer the flux control method or the armature control method, and why

**Exam 4:** For the given three-phase transformer connected in Y configuration, obtain the complete equivalent circuit referred to **LV side** by conducting suitable tests.

a) Write the name of the tests. **(PI(6)-1)**
b) Draw the **practical** schematic diagrams for the tests. (Show all measuring devices in appropriate places) **(PI(6)-1)**
c) List **ALL** the equipment and measuring instruments to be used for the tests. **(PI(6)-1)**
d) Write the step-by-step procedure for the tests. **(PI(6)-1)**
e) Implement the test **(PI(6)-2)**

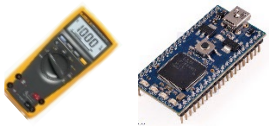
| **Tasks** | **Max. Marks** | **Marks obtained** |
|---|---|---|
| Wiring of the circuit | 10 | |
| Connections of measuring devices and proper settings | 5 | |
| Implementation of safety measures | 5 | |
| Conducting the test | 10 | |

f) Measure required data (Draw necessary tabular columns) **(PI(6)-2)**
g) Calculate the required parameters. **(PI(6)-3)**
h) Draw the equivalent circuit referred to **LV side** as obtained from the test. (Show the values on the circuit) **(PI(6)-3)**
i) Write any three assumptions/approximations used in equivalent circuit parameters determination **(3 marks)**
j) If you want to get the exact equivalent circuit of the three phase transformer, what will you do.
k) Briefly explain three speed control methods for the dc motor.
l) Draw the **Speed** VS **Output Power**, **PF** VS **Output Power** of a Three Phase Induction Motor in one graph.
m) Briefly discuss 3 applications of dc machine as generator.

# Assessment Tool for SO(6) in ELEC367 Lab Exam (Fall2022)

## Exam 1

## Subject: Design a Voltage Level Detector



### Task # 1 (15 minutes/20 Marks)

### PI(6)1: Develop an experiment to reach an engineering conclusion.

Using the Mbed LPC1768 microcontroller, develop a voltage level detector (VLD) that measures the voltage at node "VA" of the electrical circuit illustrated in figure 1. The designed control block along with its code should disconnect the load from the power source "$V_s$" when the measured voltage "VA" exceeds 3.0 V.

The control block will conisist of one relay (***WH-482***), one green LED that indicates the normal condition of the circuit (VA less than 3.0V), and one red LED that shows the abnormal condition of the circuit (VA more than or equal 3.0V).

Note: Draw your developed control block circuit using the provided separate answer sheet, then return it to the examiner before proceeding on to the next questions. You will be given the appropriate complete circuit by the examiner, which will be used in the experiment.

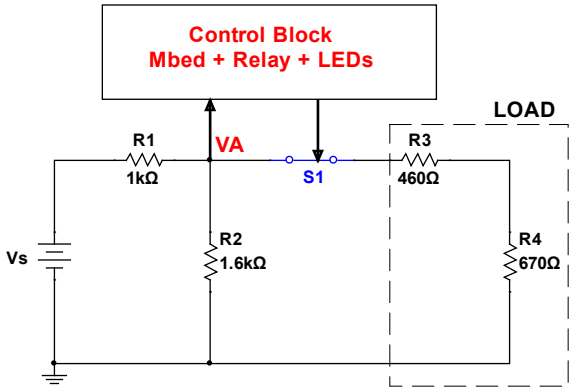



Figure 1: Monitored and Controlled Electric Circuit

### Task # 2 (25 minutes/30 Marks)

### PI(6)2 – Conduct an engineering experiment.

Implement on the breadboard the developed embedded circuit with its control block before moving on to the following tasks.

### Task # 3 (30 minutes/40 Marks)

### PI(6)3 – Analyze & interpret experimental data to draw conclusions.

For each of the following tasks, complete table 1 (Calculations and Experimental Results).

- By hand calculation, find the following parameters when the voltage source is equal to 4Vdc then 8Vdc:
  1. Current passing through the resistors $R_1$ and $R_2$.
  2. Voltage at node **VA** and across the resistors $R_1$ and $R_2$.

Calculations: (15 Marks)

### Compiler – Code (20 Marks)

- Open the Mbed compiler and write the ***code*** that performs the following steps:
  1. The first lines of the code as well as the Teraterm window must contain the following:

```
// ELEC367 Embedded Systems Final Exam Fall 2022
// [Type your Full name], [Type your Qatar University ID]
// Subject: Voltage Level Detector
```

  2. Measure and display on the Teraterm the voltage at node **VA, $V_{R1}$, $V_{R2}$, $I_{R1}$,** and **$I_{R2}$**.
  3. Display on the Teraterm window an Error Message if the voltage **VA** exceeds **3.0V**.

Note: Copy and paste the written code (adjust the lines after pasting the code) along with the screenshot of the Teraterm window showing the results into the MS Word document provided by the link in Blackboard.

**Table 1**

| | Calculations | | | | | Measurements (Teraterm) | | | | | $\%\ Difference = \frac{\lvert Cal. - Meas. \rvert}{\frac{1}{2}(Cal. + Meas.)} \times 100$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vs [V]** | **$I_{R1}$ [mA]** | **$I_{R2}$ [mA]** | **$V_{R1}$ [V]** | **$V_{R2}$ [V]** | **$V_A$ [V]** | **$I_{R1}$ [mA]** | **$I_{R2}$ [mA]** | **$V_{R1}$ [V]** | **$V_{R2}$ [V]** | **$V_A$ [V]** | |
| **4.0** | | | | | | | | | | | |
| **8.0** | | | | | | | | | | | |

Discussion (5 Marks)

Interpret and discuss your table 1 results.

### Task # 4 (5 minutes/10 Marks)

### Identify the limitations of the design and suggest improvements.

Give a brief description of some restrictions and limits of the proposed embedded system and offer some suggestions for effective ways to solve them.

# Exam 2

## Subject: Design an Overvoltage Circuit Breaker


### Task # 1. (15 minutes/20 Marks)

**PI(6)1: Develop an experiment to reach an engineering conclusion.**

Using the Mbed LPC1768 microcontroller, develop an overvoltage circuit breaker that measures the voltage between nodes A and B across Rx which represents a sensitive load as illustrated through the electrical circuit of figure 1. The designed control block along with its code should disconnect the source Vs when the measured voltage "$V_{AB}$" exceeds 500 mV.

The control block will conisist of one relay (***VT2608***), one green LED that indicates the normal condition of the circuit ($V_{AB}$ less than 500 mV), and one red LED that shows the abnormal condition of the circuit ($V_{AB}$ is more than 500 mV).

Note: Draw your developed control block circuit using the provided separate answer sheet, then return it to the examiner before proceeding on to the next questions. You will be given the appropriate complete circuit by the examiner, which will be used in the experiment.

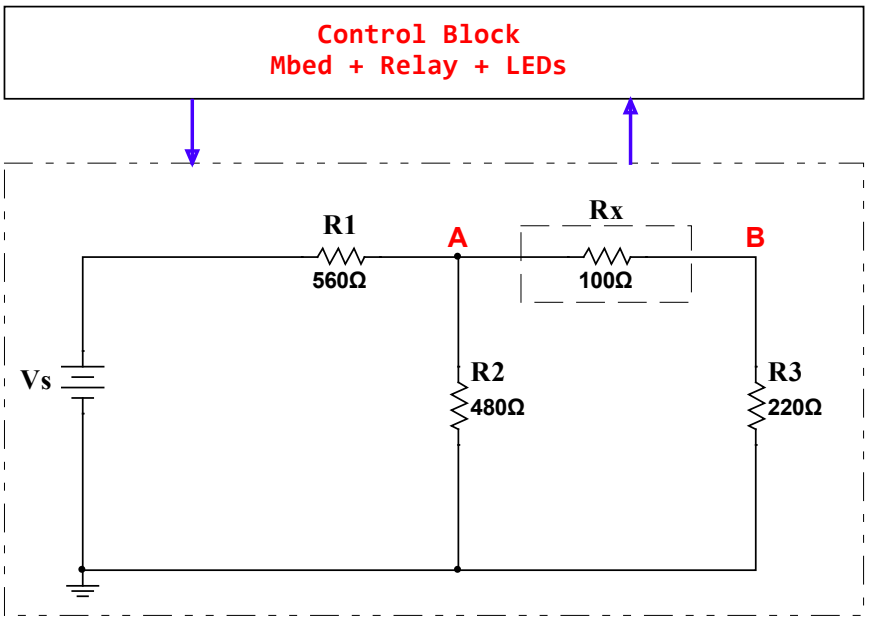



Figure 1: Monitored and Controlled Electric Circuit

### Task # 2 ..... (25 minutes/30 Marks)

**PI(6)2 – Conduct an engineering experiment.**

Implement on the breadboard the developed embedded circuit with its control block before moving on to the following tasks.

## Task # 3. (30 minutes/40 Marks)

### PI(6)3 – Analyze & interpret experimental data to draw conclusions.

For each of the following tasks, complete table 1 (Calculations and Experimental Results).

- By hand calculation, find the following parameters when the voltage source is equal to 5Vdc then 10Vdc:
  3. Current passing through the resistor $R_x$.
  4. Voltage across the resistor $R_x$.

Calculations: (15 Marks)

(Show the calculations' steps here)

### Compiler – Code (20 Marks)

- Open the Mbed compiler and write the ***code*** that performs the following steps:
  4. The first lines of the code as well as the Teraterm window must contain the following:

```
// ELEC367 Embedded Systems Final Exam Fall 2022
// [Type your Full name], [Type your Qatar University ID]
// Subject: Differential Voltmeter
```

  5. Measure and display on the Teraterm the voltage $V_{Rx}$, and the current $I_{Rx}$.
  6. Display on the Teraterm window an Error Message if the voltage $V_{Rx}$ exceeds **500 mV**.

Note: Copy and paste the written code (adjust the lines after pasting the code) along with the screenshot of the Teraterm window showing the results into the MS Word document provided by the link in Blackboard.

**Table 1**

| Vs [V] | Calculations | | Measurements (Teraterm) | | $\%\ Difference = \frac{\lvert Cal. - Meas. \rvert}{\frac{1}{2}(Cal. + Meas.)} \times 100$ | |
|---|---|---|---|---|---|---|
| | $V_{Rx}$ [V] | $I_{Rx}$ [mA] | $V_{Rx}$ [V] | $I_{Rx}$ [mA] | $V_{Rx}$ [V] | $I_{Rx}$ [mA] |
| **5.0** | | | | | | |
| **10.0** | | | | | | |

Discussion (5 Marks)

Interpret and discuss your table 1 results.

## Task # 4 (5 minutes/10 Marks)

### Identify the limitations of the design and suggest improvements.

Give a brief description of some restrictions and limits of the proposed embedded system and offer some suggestions for effective ways to solve them.

# Assessment Tool for SO(6) in ELEC342 Lab Exam (Spring 2023)

**PI (6) 1: Develop an experiment to reach an engineering conclusion**

**Objective:**

Conduct an experiment with EMONA TIMS to verify and analyze the importance of Phase Correction of the carrier in the receiver side for QAM technique. Provide details as requested in Part A that will help in the experiment.

*Note: Make sure you show the block diagram and the module details as asked in **Part A** to the Instructor, before proceeding further.*

**Part A: 30 Marks**

1. Draw a neat block diagram of QAM Modulator-Demodulator, Specify clearly the following signal points on the block diagram:

a. Messages: m1 & m2, which will be recorded signals

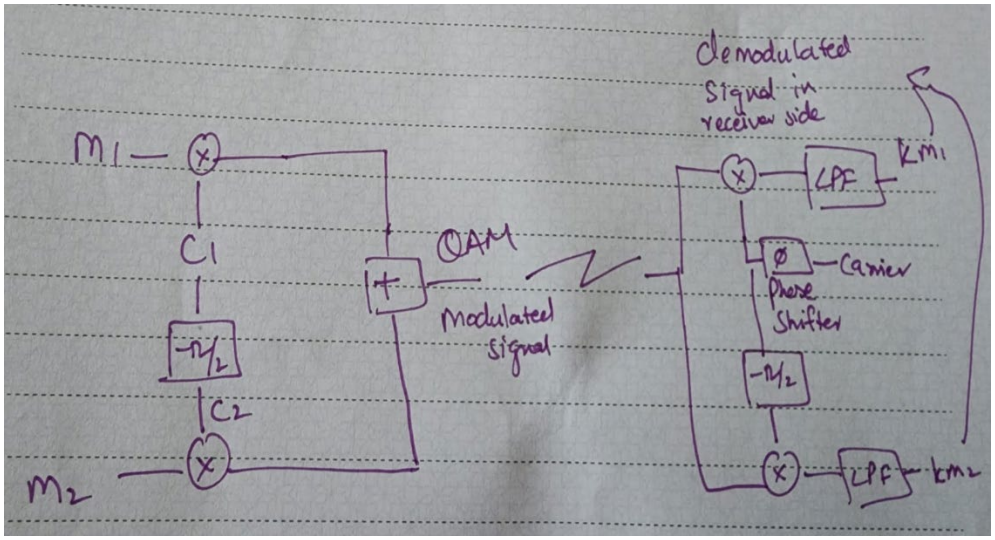
b. Carrier: c1= sin $(2 * pi * f_c * t)$ & c2= cos $(2 * pi * f_c * t)$. $f_c = 100\ kHz$

c. modulated signal

d. demodulated signals (m1 and m2) in the receiver side

State clearly the Modules needed to implement it on EMONA TIMS

**Solution:**




Modules Needed:

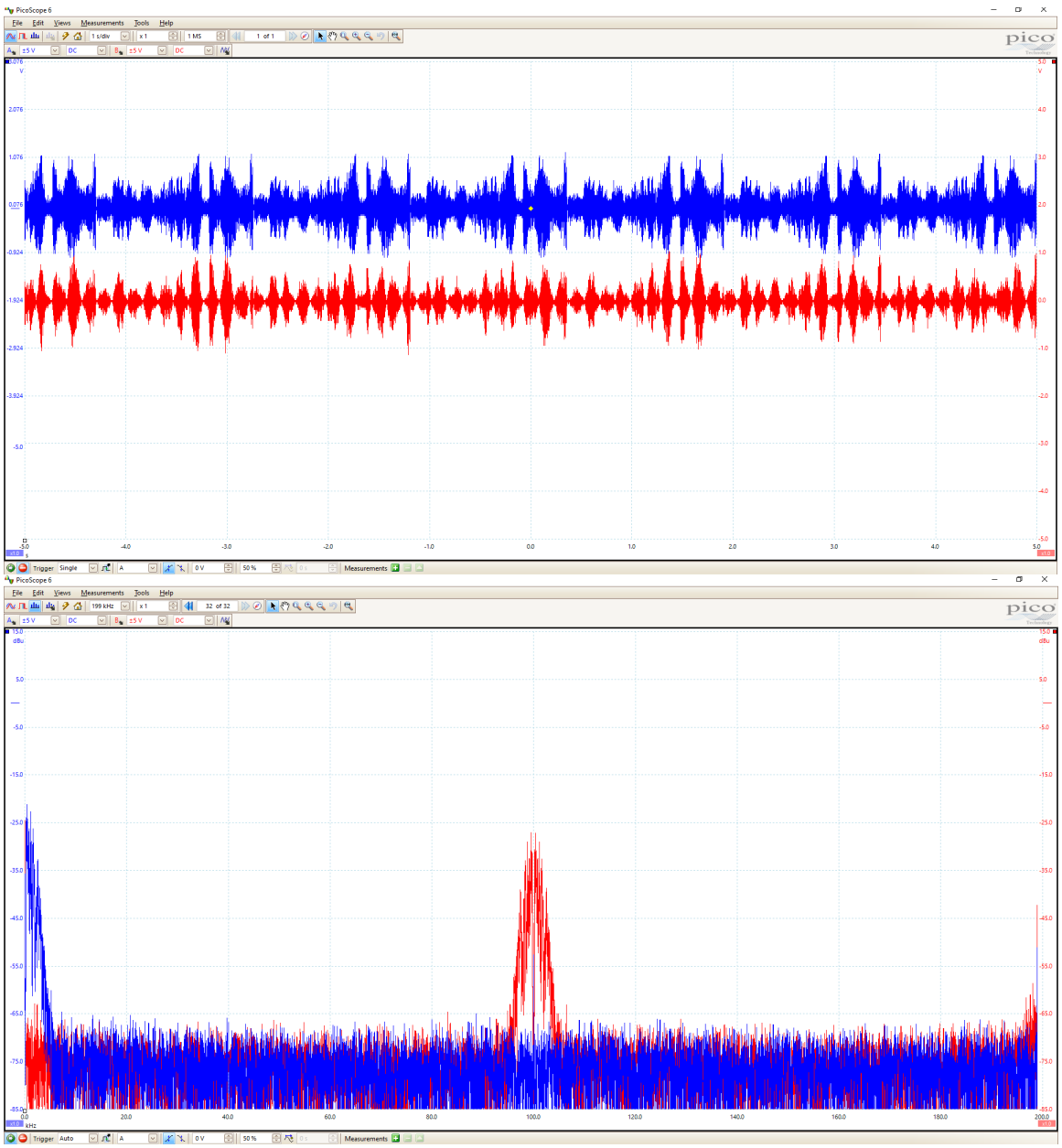
1. 1 Speech Module for the Messages m1 and m2
2. 1 Quadrature Amplitude Module
3. 2 Multipliers
4. 2 LPF
5. 1 Phase Shifter

**PI (6) 2: Conduct an engineering experiment.**

## Part B: 20 Marks

*2.* Using the Emona TIMS modules, build the circuit of the QAM Modulator. Apply a recorded message saying the *"**Message 1 by Name of the student**"* as input m1 and *"**Message 2 by Name of the student**"* as m2. Use two channels and provide two screenshots displaying the below:
a. The message m1 and modulated signal in Time domain
b. The message m1and modulated signal in Frequency domain

## Solution:

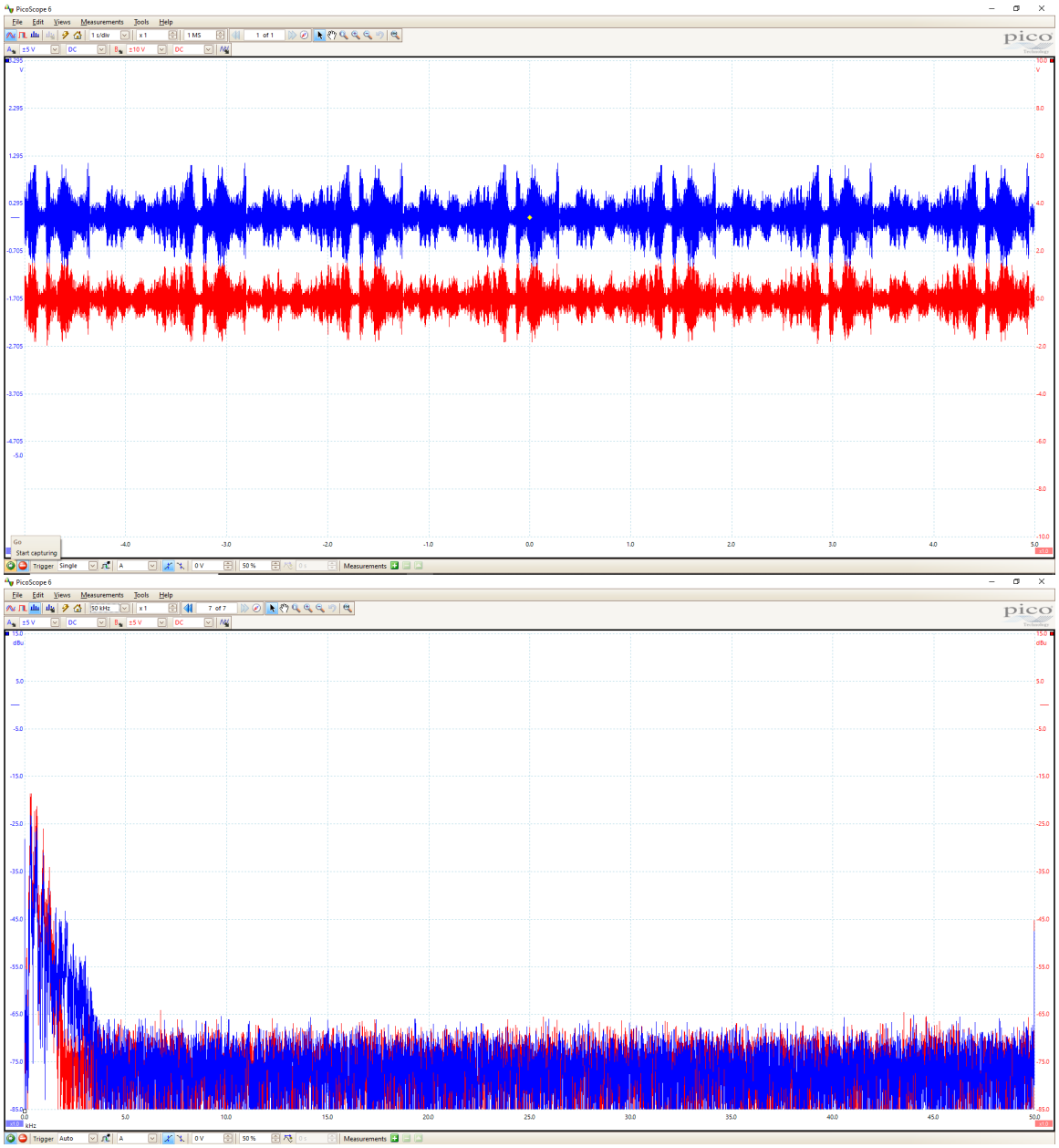


## Part C: 20 Marks

Next, build the circuit of the QAM, De-modulator and retrieve back the message send. Use two channels and provide two screenshots displaying the below:

c. The message m1 and de-modulated signal m1 in Time domain
d. The message m1 and de-modulated signal m1 in Frequency domain
*Note: Please let the instructor listen to the demodulated signal m1*

**Solution:**



**PI (6)3: Analyze & interpret experimental data to draw conclusions.**

**Part D: 30 Marks**

1) Write a discussion on the experiment performed, Analyzing and discussing the results *(Use the results in Part B and C and the Block diagram in Part A in your discussion, you can also state how you expected the frequency domain spectrum to look for a QAM modulating signal and the Demodulation steps help in the recovery of messages)*
2) State the major aspect you should consider when demodulating in QAM, please prove it if needed. Ambiguous answers won't get credits.

Hint: $cosAcosB = \frac{1}{2}(\cos(A+B) + \cos(A-B))$

**Solution:**

1. QAM has enabled us to transmit two messages using the same bandwidth. The two messages need to be modulated on carriers that are orthogonal to each other so that they do not interfere. Thus, we had m1 modulated with carrier (c1) $\sin(2 * pi * f_c * t)$ and m2 modulated with phase shifted carrier (c2)$\cos(2 * pi * f_c * t)$. Similar to AM demodulation we had to multiply with the same carrier and pass it through a LPF to remove the high frequency components and retrieve the transmitted signal. As in can be seen in Part C, we have received the transmitted signal.
2. As it can be seen in part A, we have a phase shifter in the receiver side to correct the phase shift between the carriers of the transmitter and receiver. We can also verify it mathematically, Let us assume the carrier in the demodulator has a phase shift $\phi$ compared to the carrier in the transmitter.

   Then the received message can be represented as :

$$
\begin{aligned}
&QAM * \sin(2 * pi * f_c * t + \phi) \\
&= (m_1 * \sin(2 * pi * f_c * t) + m_2 * \cos(2 * pi * f_c * t)) * \sin(2 * \mathrm{pi} * \mathrm{f_c} * t + \phi) \\
&= m_1 * \sin(2 * pi * f_c * t) * \sin(2 * pi * f_c * t + \phi) + m_2 * \cos(2 * pi * f_c * t) \\
&\qquad * \sin(2 * pi * f_c * t + \phi) \\
&= \frac{1}{2} m_1 * (\cos(-\phi) - \cos(2 * \mathrm{pi} * 2\mathrm{f_c} * t + \phi)) + \frac{1}{2} m2 \\
&\qquad * (\sin(2 * pi * 2f_c * t + \phi) - \sin(-\phi)) \\
&\qquad = \frac{1}{2} m_1 \cos(\phi) - \frac{1}{2} m_2 \sin(\phi) + HFC \\
&\qquad after\ LPF, we\ have \frac{1}{2} m_1 \cos(\phi) - \frac{1}{2}\ m_2 \sin(\phi)
\end{aligned}
$$

   In order to retrieve m1 correctly we need to have $\phi = 0$

# Appendix B: Samples of Assessment Rubrics

## Student Outcome (1)

**SO(1):** *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics*

| Performance Indicator | Poor 1 | Below Expectations 2 | Meets Expectations 3 | Excellent 4 |
|---|---|---|---|---|
| **PI(1)1** – Identify and formulate a complex engineering problem. | Not able to identify and formulate a complex engineering problem. | A complex engineering problem is poorly identified and its formulation is incomplete, vague or cannot be solved. | A complex engineering problem is well identified and formulated but with missing assumptions or constraints. | A complex engineering problem is clearly identified and formulated with appropriate constraints and assumptions. |
| **PI(1)2** – Solve a complex engineering problem by applying principles of engineering. | Not able to solve a complex engineering problem or the solution shows insufficient knowledge of engineering principles. | Able to apply some engineering principles in solving a complex engineering problem but the solution is incomplete or has major mistakes. | Able to correctly apply some engineering principles in solving a complex engineering problem and the solution is reasonably accurate. | Able to correctly apply all the appropriate engineering principles in solving a complex engineering problem and the solution is properly explained and validated. |
| **PI(1)3** – Solve a complex engineering problem by applying principles of science. | Not able to solve a complex engineering problem or the solution shows insufficient knowledge of science. | Able to apply some science principles in solving a complex engineering problem but the solution is incomplete or has major mistakes | Able to correctly apply some science principles in solving a complex engineering problem and the solution is reasonably accurate. | Able to correctly apply all the appropriate science principles to solve a complex engineering problem and the solution is properly explained and validated |
| **PI(1)4** – Solve a complex engineering problem by applying principles of mathematics. | Not able to solve a complex engineering problem or the solution shows insufficient knowledge of mathematics. | Able to apply some principles of mathematics in solving a complex engineering problem but the solution is incomplete or has major mistakes | Able to correctly apply some principles of mathematics in solving a complex engineering problem and the solution is reasonably accurate. | Able to apply all the appropriate principles of mathematics in solving a complex engineering problem and the solution is properly explained and validated. |
| | | | | |

## Student Outcome (2)

**SO(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.*

| Performance Indicator | Poor 1 | Below Expectations 2 | Meets Expectations 3 | Excellent 4 |
|---|---|---|---|---|
| **PI(2)1** – Identify and formulate technical specifications of the electrical engineering system to meet the design goals under specific constraints and standards. | Identifies and formulates few technical specifications of the electrical engineering system without meeting the design goals under specific constraints and standards. | Identifies and formulates some of the technical specifications of the electrical engineering system to meet the design goals under specific constraints and standards. | Comprehensively identifies and formulates most of the technical specifications of the electrical engineering system to meet the design goals under specific constraints and standards. | Comprehensively and extensively identifies and formulates the technical specifications of the electrical engineering system to meet the design goals under specific constraints and standards. |
| **PI(2)2** – Evaluate the design concepts and select the one that best matches the design constraints considering public health,<br>safety, and welfare, as well as global, cultural, social,<br>environmental, and economic factors. | Evaluates the design concepts poorly via modeling, simulation, prototyping and selects a one that does not match the design constraints. | Evaluates the design concepts fairly via modeling, simulation, prototyping and selects one that matches part of the design constraints. | Evaluates the design concepts via modeling, simulation, prototyping and selects the one of those that highly matches the design constraints. | Evaluates the design concepts clearly, deeply, and soundly via modeling, simulation, prototyping and proficiently selects the one that best matches the design constraints. |
| | | | | |

## Student Outcome (3)

**SO(3):** *An ability to communicate effectively with a range of audiences*

| Performance Indicator | Poor 1 | Below Expectations 2 | Meets Expectations 3 | Excellent 4 |
|---|---|---|---|---|
| **PI(3)1** – Communicate effectively in writing. | Does not follow the provided organization and structuring.<br><br>Does not convey the content in a technical and organized manner.<br><br>Has many grammatical and typographical errors. | Follows partially the provided organization and structuring.<br><br>Convey partially the content in a technical and organized manner.<br><br>Has some grammatical and/or typographical errors. | Follows mostly the provided organization and structuring.<br><br>Convey mostly the content in a technical and organized manner.<br><br>Has few grammatical or typographical errors. | Follows always the provided organization and structuring.<br><br>Convey always the content in a technical and organized manner.<br><br>Has very few grammatical and typographical errors. |
| **PI(3)2** – Demonstrate effective oral communication with a range of audiences. | Speaker is rarely able to communicate the content using proper vocabulary and complete sentences to the given range of audiences. | Speaker is sometime able to communicate the content using proper vocabulary and complete sentences to the given range of audiences. | Speaker is mostly able to communicate the content using proper vocabulary and complete sentences to the given range of audiences. | Speaker is always able to communicate the content using proper vocabulary and complete sentences to the given range of audiences. |
| | | | | |

## Student Outcome (4)

**SO(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*

| Performance Indicator | Poor 1 | Below Expectations 2 | Meets Expectations 3 | Excellent 4 |
|---|---|---|---|---|
| **PI(4)1** – Recognize ethical and professional responsibilities in engineering situations. | Does not show awareness for the need to incorporate ethical and professional understanding in the given engineering situation. | Shows awareness for the need to incorporate code of ethics and professional responsibilities in the given engineering situation but does not provide related details. | Shows a good awareness for the need to incorporate relevant code of ethics, and professional responsibilities in the given engineering situation and provides most of the related details. | Shows a strong understanding of relevant code of ethics and professional responsibilities in an engineering situation and provides related details matching the given engineering situation. |
| **PI(4)2** – Make informed judgments that consider the impact of engineering solutions in global, economic, environmental, and societal contexts. | Unable to identify or to discuss the impact of engineering solutions in global, economic, environmental, and societal contexts. | Able to identify and gives a limited explanation of the impact of engineering solutions with respect to one of the global, economic, environmental, and societal contexts. | Able to identify and give an adequate explanation of the impact of engineering solutions with respect to up to three of the global, economic, environmental, and societal contexts. | Able to identify and give a comprehensive explanation of the impact of engineering solutions with respect to global, economic, environmental, and societal contexts. |
| | | | | |

## Student Outcome (5)

**SO(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.*

| Performance Indicator | Poor 1 | Below Expectations 2 | Meets Expectations 3 | Excellent 4 |
|---|---|---|---|---|
| **PI(5)1 –** Provide collective leadership to successfully complete the tasks | Rarely provide leadership and initiatives within the team | Sometime provide leadership and initiatives within the team | Mostly provide leadership and initiatives within the team | Always provide leadership and initiatives within the team |
| **PI(5)2 –** Contribute effectively and positively within the team whose members together create a collaborative and inclusive environment. | Rarely contribute effectively and positively within the team in collaborative and inclusive manner. | Sometimes contribute effectively and positively within the team in collaborative and inclusive manner. | Mostly contribute effectively and positively within the team in collaborative and inclusive manner. | Always contribute effectively and positively within the team in collaborative and inclusive manner. |
| **PI(5)3 –** Establish goals, plan and accomplish tasks, and contribute to meeting objectives. | Rarely establish goals, plan and accomplish tasks, and contribute to meeting objectives | Sometimes establish goals, plan and accomplish tasks, and contribute to meeting objectives. | Mostly establish goals, plan and accomplish tasks, and contribute to meeting objectives. | Always establish goals, plan and accomplish tasks, and contribute to meeting objectives. |
| | | | | |

## Student Outcome (6)

**SO(6):** *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions*

| Performance Indicator | Poor 1 | Below Expectations 2 | Meets Expectations 3 | Excellent 4 |
|---|---|---|---|---|
| **PI(6)1** – Develop an experiment to reach an engineering conclusion. | Most of the elements of experiment design are not developed (steps, equipment, procedure, etc.), which affects significantly reaching an engineering conclusion. | Insufficient elements of experiment design are developed (steps, equipment, procedure, etc.). | Most of the elements of experiment design are developed (steps, equipment, procedure, etc.). | All elements of experiment design are proficiently developed (steps, equipment, procedure, etc.). |
| **PI(6)2** – Conduct an engineering experiment. | Most of the experiment steps were not conducted successfully and safely. | Some of the experiment steps were conducted successfully and safely. | Most of experiment steps were conducted successfully and safely. | All experiment steps were conducted successfully and safely. |
| **PI(6)3** – Analyze and interpret experimental data to draw conclusions. | Incorrectly analyzes and interprets experimental data that lead to drawing incorrect or insufficient conclusions. | Insufficiently analyzes and interprets experimental data that lead to drawing insufficient conclusions. | Adequately analyzes and interprets experimental data that lead to drawing proper conclusions. | Thoroughly and insightfully analyzes and interprets experimental data that lead to drawing insightful conclusions. |
| | | | | |

## Student Outcome (7)

**SO(7):** *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.*

| Performance Indicator | Poor 1 | Below Expectations 2 | Meets Expectations 3 | Excellent 4 |
|---|---|---|---|---|
| **PI(7)1 -** Demonstrate an ability to acquire new knowledge (e.g. entrepreneurship, sustainability) using appropriate learning strategies (e.g. seminars, various online and library resources). | Not able to acquire new knowledge using appropriate learning strategies. | Able to acquire new knowledge using appropriate learning strategies, but unable to synthesize the acquired information. | Able to acquire new knowledge using appropriate learning strategies, and to synthesize the acquired information to some extent. | Able to acquire new knowledge using appropriate learning strategies and synthesize the acquired information. |
| **PI(7)2** – Demonstrate the application of acquired knowledge | Not able to apply acquired knowledge | Demonstrates little ability to apply acquired knowledge | Demonstrates adequate ability to apply acquired knowledge | Fully able to apply acquired knowledge |
| | | | | |