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Strategies for Continuous Improvement in ETAC of ABET Programs: A Novel Approach

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Abstract:

This paper explicates the unique strategies utilized in the implementation of the continuous improvement (CI) process in the department of Engineering Technology (ET) programs at Austin Peay State University (APSU). Three ET programs – Bachelor of Science (BS) in Electrical ET, Mechanical ET and Manufacturing ET – are accredited by the Engineering Technology Accreditation Commission (ETAC) of ABET by involving the constituents (students, faculty, alumni, and Industrial Advisory Board or, IAB) that are integral to the CI process. ETAC of ABET's Criterion 4 CI [11] states, "The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the program's continuous improvement actions". To accomplish the CI requirements, the department followed four strategies that encapsulate the faculty efforts toward CI.

The four strategies were: (1) Department faculty, led by the main author of this paper, developed a 3-year schedule of assessment and evaluation, two Student Outcomes (SO) each year in a rotating cycle. (2) Documented evidence of implemented action items (2019-22) demonstrating that the results of student outcome assessment and evaluation are systematically utilized as input for the program's continuous improvement actions (involving the constituents). (3) As part of the CI process, during spring and fall 2022, department faculty led by the main author, performed a periodic review and revision of the course description, pre-requisite, and degree requirements of all the course offerings in the three BS in ET/ABET Programs. (4) Documented evidence of implemented action items demonstrating that feedback from the regional industry / IAB was systematically utilized as input for the program's continuous improvement actions.

The full paper is aimed at elucidating all the four strategies (1- 4) deployed in the efficacious implementation and attainment of ABET Criterion 4 CI in the three BS ET programs – Electrical ET, Mechanical ET and Manufacturing ET, a description of assessment methods used for the CI process, statement of results and conclusion. Strategy 1 is ongoing and strategies 2, 3, and 4 are complete.

Introduction:

Higher education institutions strive to acquire and maintain the accreditation status to offer quality education and employment opportunities to students. In addition, they help to build confidence among their constituents in the value of the programs offered. Accrediting bodies highlight the need for program assessment, evaluation, and continuous improvement as a measure of quality assurance to help maintain the rigor and relevance of the program to the professions it serves [1], [2]. Accreditation [3] status encourages confidence among students that the educational experience offered by an institution meets international standards, affords access to federal grants and scholarships, and augments the employment opportunities. According to [4], high standard teaching process involves updated technological tools which demands the educational institutions to provide well-equipped infrastructure. Some state-funded public institutions offering degrees in multiple disciplines are required to maintain a certification or accreditation at the program level [4]. To comply with the accreditation agency requirements, it is important to design, deliver and assess the academic programs that also incorporates a continuous improvement process.

The Department of ET in APSU offers ETAC of ABET accredited degree programs at the four-year bachelor's degree level. For people interested in gaining practical skills, this degree can be an ideal fit. With its focus on applications, it fits the person who has been in the workplace and now needs a degree for advancement as well as others wanting a hands-on approach to engineering and technology [5]. The ET program prepares students for technical careers in multiple concentrations (electrical, mechanical, manufacturing, and mechatronics) in a wide range of applications and provides leadership in developing solutions to industrial problems [6], [7], [8]. The primary method of instruction for courses in the various concentrations in the ET programs is based on the traditional structure of lectures and hands-on laboratory sessions. Most of the program courses are taught in person during the days, in the evenings on the main campus, or in the evenings at the Fort Campbell Center. A number of studies [8], [9], [10] reported that at least a direct assessment tool is needed to ensure developmental and learning benefits of the students in ET demonstrating the workplace competencies. In line with the assessment objective, the University's administration and faculty practice various assessment tools to ensure that the constituents they serve are meeting their personal and professional goals upon graduation.

Assessment [11] is the systematic collection and analysis of data to advance student learning. Program assessment [12] focuses on assessing student learning and experience to ascertain whether students have acquired the skills, knowledge, and competencies related to their program of study. The ET department faculty use a combination of direct and indirect methods for assessment and evaluation of the SOs. The results and findings of these evaluations are systematically utilized as input for the program's CI actions[1], [13]. Direct methods require students to exhibit their knowledge and skills as they respond to the instrument itself. Objective tests, projects, laboratory work, presentations, and classroom assignments all meet this criterion [14]. Indirect methods such as surveys and interviews require students to reflect on their learning rather than to display it [12]. An assessment and evaluation process will be effective only if the results are systematically utilized as input for the program's CI actions [15].

Program assessment is all about the program's continuous improvement. The ETAC of ABET's Criterion 4 CI states [11],

(I) The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the program's continuous improvement actions.

(II) Other available information may also be used to assist in the CI of the program.

This paper will refer to the above as ABET C4 CI (I) and ABET C4 CI (II) respectively. The ET department faculty have been working on the assessment and evaluation of SOs for the three ETAC of ABET BS ET programs – Electrical ET, Mechanical ET, and Manufacturing ET for the past several years. This paper includes the sample forms for the direct and indirect methods of assessment and evaluation along with the results, findings and reflection / faculty discussion leading to implementation of action items for the BS Electrical ET program only.

The four strategies listed in the abstract submission are discussed in the following order in the paper. Strategies 1, 2 focus on the CI efforts because of assessment, evaluation, and results from SO for the BS Electrical ET program. This is referred to as ABET C4 CI (I). Strategies 3, 4 pertains to ABET C4 CI (II) – "Other available information may also be used to assist in the CI of the program."

Strategy 1: Department faculty, led by the main author of the paper, developed a 3-year schedule of assessment and evaluation, two SOs each year in a rotating cycle. Faculty discussed and developed forms to document direct measures (through specific PIs) and indirect measures (student and faculty survey forms). The faculty had weekly meetings, year-round, to discuss progress made and to address any concerns or challenges. In fall and spring of each year, during the "ABET Faculty Retreat Meeting" faculty methodically discussed the results and findings of the assessed and evaluated data for follow up on recommendations and action items. As part of the CI process, all SO's have been scheduled to be systematically assessed and evaluated, with documented reflection and CI action items for implementation during the 3-years (2021-24). In a six-year period between ABET site visits, the plan is to have two iterations of the CI process to be completed. Appendix (A-F) includes sample data for the assessment, evaluation, and CI efforts for the BS Electrical ET program.

Strategy 2: Documented evidence of implemented action items (I a, I b) demonstrating that the results of student outcome assessment and evaluation are systematically utilized as input for the program's CI actions. This includes the assessment, evaluation, and CI efforts of the program for the period, fall 2019 to summer 2022. The four constituents – faculty, students, IAB and alumni were involved in the CI process.

Strategy 3: As part of the CI process, in spring and fall 2022, department faculty led by the main author, performed a periodic review and revision of the course description, pre-requisite of all the course offerings and the degree requirements in the three BS ET / ABET programs. The paperwork was processed and approved in Curriculog (University's curriculum process) for implementation effective fall 2023. The course / degree requirements review process resulted in the BS in Manufacturing ET and BS in Mechanical ET programs to move ENGT 4150, Programmable Logic Controllers from an elective course to a required course effective fall 2022. In addition, BS in Mechanical ET program has been revised to include ENGT 4210, Industrial Automation Systems as a Concentration Elective Course. A description of documented evidence of implemented action items (II a, II b) is included.

Strategy 4: A description of documented evidence of implemented action items demonstrating that feedback from the regional industry / IAB was systematically utilized as input for the programs' CI actions is included in the paper.

ABET C4 CI (I) – **Strategy 1:**

(I) During fall 2021 and spring 2022, program faculty had "Weekly Working Group Meetings" to discuss ABET Criterion 4 CI and to ensure that all SOs are systematically assessed and evaluated that includes reflection and CI action items for implementation for the BS in Electrical ET program. The team of faculty led by the department chair worked on developing an assessment cycle that allows for systematic distribution of workload based on the teaching schedule of all full-time and part-time faculty teaching the courses. Faculty agreed to assess and evaluate two SOs each academic year (AY) in a rotating cycle as below:

- BS in Electrical Engineering Technology (EET) – two SO's (SO 2, 3) in AY 2021-22; two SO's (SO 5, 6) in AY 2022-23; two SO's (SO 1, 4) in AY 2023-24.

The BS EET program has six SOs – SO 1, 2, 3, and 4 are linked to ETAC ABET general criteria and SO 5, 6 are related to program criteria. As part of the CI process, all SO's are scheduled to be systematically assessed and evaluated, with documented reflection and CI action items for implementation during the 3-years (2021-24). The three-year schedule of SOs (SO 1 – 6) and the courses are included in **Appendix A,** titled "Assessment, Evaluation and CI" for BS in EET. In a six-year period between ABET site visits, the plan is to have two iterations of the CI process completed.

Faculty Discussion: The department had "Faculty Retreat Meeting" during fall (August) and spring (January) of each year. Concentration faculty made a presentation to all department faculty on the major results and action items leading to further discussion on assessment and evaluation. In the Fall Retreat, faculty discuss the results and action items of the assessed and evaluated data collected for SOs scheduled during spring and summer terms, for follow up on recommendations and action items, as applicable. In the Spring Retreat, the discussion will focus on the assessment and evaluation efforts for the SOs scheduled in the fall term courses.

IAB Discussion: IAB members are involved in the ET department ABET accreditation efforts as one of the constituents and the IAB meetings are scheduled in fall and spring of each year. The objective of IAB is to (a) evaluate industry skill requirements, provide recommendations for curriculum improvements and revisions, and assemble representative cross-section of the regional industries. (b) provide continuous input as required by ETAC of ABET, this will include systematic documented review of program educational objectives (PEO), curriculum, and CI processes to ensure they remain consistent with the institutional mission and the needs of the program's constituents.

Assessment, Evaluation, and CI action / recommendation for implementation:

Although PI and rubrics help with the direct assessment of outcomes, questionnaires / surveys are indirect assessment methods that are often viewed as a secondary approach. Evidence that supports achievement of knowledge and learning imparted by the instruction can be collected by employing multiple assessment methods. A comprehensive assessment program may incorporate both direct and indirect assessment methods involving the key constituents.

Faculty discussed and developed forms to document direct measures (through specific PIs) and indirect measures (student and faculty Survey forms). They are:

- Student Learning Self-Evaluation Survey – **Appendix B**
- Faculty Evaluation of Student Learning / Performance by Student Outcome - **Appendix C**
- Assessment and Evaluation of specific PIs for SOs scheduled in AY 2021-22, AY 2022-23, and AY 2023-24. See **Appendix D** for Sample PI Form.

The department faculty created the faculty and student survey forms that map specific PI to the SOs, which supports attaining course goals and aligning the coursework to ABET SO mapped to it. In addition to feedback from students and faculty (two key constituents), input from alumni and the IAB partners are also solicited as applicable. The faculty assessment team has much more to learn to establish a cohesive plan aligned with the ABET accreditation process. Therefore, department faculty will be participating in the Annual ABET Symposium and other conferences (organized by ABET) to stay current, refine ideas and approach and get feedback as the department embarks upon the journey of reaccreditation of the BS ET program every 6-years.

Assessment and Evaluation leading to CI – Summary Report:

Assessment Summary reports do not necessarily have to be several pages of material and graphs to be effective. We can choose to prepare a report that briefly outlines the assessment program results, faculty reflection, and recommended action items for implementation. By highlighting the focal points and significant results, we can convey in a very concise manner what we were trying to accomplish, what we did and did not accomplish, and what changes we will implement as a result. The form in **Appendix E** is an example of a format the department uses to report CI results and action items for implementation as part of the Program Level Assessment Report.

ABET C4 CI (I) – **Strategy 2:**

(I a) Documented evidence demonstrating that the results of student outcome assessment and evaluation are systematically utilized as input for the program's CI actions – Requiring and allowing students to use TI CAS (Computer Algebra System) Calculators [16] – Implementation: In fall I 2019, assessment and evaluation were performed on SO 1, PI – Knowledge & Skills – Mathematics –Calculus – Final Exam – a set of calculus problems (ENGT 3050, Problem Solving in Engineering Tech.) and the result was a score of 63%. This did not meet the target score of 75 % (department standard).

Of greater concern are the results for calculus. Three PIs focus on the student's abilities in this area. Two, both based on derivations, gave satisfactory results. However, with a PI in an upper-level course where students were expected to solve calculus problems (ENGT 3050) they gave substandard results. Anecdotal evidence collected by the instructor indicated that students do not make much use of their calculus skills after taking the required calculus course in the first or second year. Then, despite efforts by the instructor to help them regain those skills, they seem to struggle with this topic in ENGT 3050.

The department decided to evaluate the requirements for mathematics and how students are expected to use mathematics. Some students have purchased calculators capable of performing symbolic operations (CAS calculators). The department faculty needed to consider whether it is appropriate for them to assume that students will have these tools in the workplace and, if so, if they should focus less on traditional methods and more on teaching students to use these tools. The IAB needed to be consulted to confirm that this would be satisfactory to regional employers. The plan was included in the IAB Meeting agenda for spring 2021 for discussion and to solicit input. While students should be able to apply basic rules of calculus, it may be better to focus more on other topics and allow them to use these calculators.

The timeline for the implementation of this CI action item is below:
Faculty: Initial Discussion – Faculty Meeting, April 2021 – Approved.
IAB: Presented, Discussed and Voted at IAB Meeting, April 2021
Alumni and Students: Surveyed Separately in May 2021; A majority of both students and alumni support a move to CAS calculators.

In Nov. 2021, during the ET Department Working Group Meeting, department faculty members reviewed and discussed in detail the alumni and student survey responses regarding CAS Calculators as part of the ABET C4 process for the various ABET concentrations, including BS Electrical ET. The proposed action was approved and the target for implementation confirmed effective fall, 2021 and beyond.

This is an ABET Criterion 4 CI action item that involves all four constituents (students, faculty, alumni, and IAB) and the recommended action, implementation of CAS Calculators has been completed. The ET department faculty implemented the recommendation of requiring CAS calculators by incorporating a statement in the syllabus in fall II 2021, spring, spring I & II 2022, and summer III 2022 in several of its MATH based 2000 level courses, 3000 and 4000 level courses.

(I b) Documented evidence demonstrating that the results of student outcome assessment and evaluation are systematically utilized as input for the program's CI actions – Continued implementation of Oral Presentation in ENGT 2030, AC Circuits and Applications, a course that is required for the BS in EET program:

In fall 2019, assessment and evaluation were performed in ABET SO 2 – Students have the ability to communicate information in written, oral, and graphical forms as well as use technical literature. The results and findings demonstrated that it would benefit students to have additional opportunities to develop their "Oral Communication" skills which is also an important soft skill required in the industry.

To bridge the gap in "oral communication", department faculty introduced oral class presentation as a rubric in the fall II 2020 – ENGT 2030, AC Circuits class that was taught at the Fort Campbell location. 85% of the students in the class passed the Oral presentation. Department faculty decided to continue incorporating the oral presentation rubric in ENGT 2030, a course offered in fall and spring of each year. ENGT 2030 is a required major course for the BS in EET program. Subsequently, the course was offered with the "Oral Presentation" graded rubric in summer III 2021, Fall II 2021, and Summer III 2022.

ABET C4 CI (II) – Other available information may also be used to assist in the CI of the program.

ABET C4 CI (II) – **Strategy 3:**

(II a) During spring 2022, as part of the CI process, department faculty performed a periodic review of the course description and pre-requisite requirements for all the course offerings - lower division, upper division and concentration specific for the BS in EET, BS in Mechanical ET, and BS in Manufacturing ET ABET programs. Concentration coordinators and department faculty reviewed the courses and had discussions during the ET Department Working Group Meetings (January through May 2022). In fall 2022, the paperwork was processed in Curriculog (University's Curriculum process) and was approved for successful implementation effective fall 2023.

(II b) BS ET – Manufacturing ET – Program Revision

Documented evidence demonstrating faculty feedback while identifying PIs, for the assessment and evaluation of concentration specific SO 5 and 6, being systematically utilized as input for the Manufacturing ET program's CI actions – BS in Manufacturing ET Program was revised to move ENGT 4150, Programmable Logic Controllers from an elective course to a required course effective fall 2022.

Background:

ETAC of ABET accreditation criteria for manufacturing ET calls for programs to provide a curriculum that covers critical technologies used in manufacturing. On the advice of the electrical ET faculty in the department, the currently required DC and AC circuits courses do not reach the systems level of complexity. Therefore, it was proposed to move an elective course with electrical systems content - ENGT 4150 Programmable Logic Controllers (PLC) - to the required category. This will provide the graduates from the program with more electrical content, at the systems level that is highly sought out in today's heavily automated manufacturing industry. This will also upgrade the curriculum to require a course covering PLC, which is of high interest to regional industrial employers. This requirement will better prepare students for employment and will give assurance to potential employers that students have been exposed to this material.

In January 2022, during the ET Department Working Group Meeting, department faculty proposed to move ENGT 4150, PLC from an elective course to a "required course", based on the rationale discussed above. In addition, a department faculty member researched and confirmed that most ABET accredited ET programs in the state and nationwide have PLC as a required course. The proposal was unanimously approved by the department faculty.

In April 2022 IAB Meeting, the breakout session agenda included input / discussion on the proposed change of PLC from an elective to a required course. The advisory board members were in favor of the revision.

With the proposed change, the Upper Division Course (UDC) required hours changed from 24 to 27 credits and elective credits from 9 to 6. The total UDC credits remain at 33. The curriculum paperwork was processed and approved in Curriculog (University's Curriculum process) for implementation effective fall 2022 for the main campus and Fort Campbell location.

ABET C4 CI (II) – **Strategy 4:**

(II) Documented evidence demonstrating that feedback from the regional industry was systematically utilized as input for the program's CI actions:

Department faculty received feedback during the spring 2022 IAB Meeting (April 2022) regarding Industry 4.0. The feedback / input from the breakout session was to introduce students to Industry 4.0 skill set, which is highly sought out in the regional industry. Knowledge of Industrial Automation is an important skill that is vital to today's industry. Department faculty discussed and agreed to include ENGT 4210, Control Systems that covers Industrial Automation, as an elective course for all ET concentrations (Electrical, Manufacturing, and Mechanical). In addition, faculty agreed to incorporate Industry 4.0 concepts as part of classroom discussion and include them in courses across the curriculum, wherever pertinent.

In May 2022, during the "ET Dept. Working Group Meeting", faculty discussed and approved the proposal to revise the "Course Description for ENGT 4210, Control Systems". Concentration faculty presented a proposed change to course title and description for ENGT 4210, Control Systems course, which was presented and approved by the Curriculum Committee in fall 2022 for implementation effective fall 2023. The revised course description and course title were closely aligned to incorporate industry skills and was also included in the fall 2022 IAB Meeting agenda for further input and discussion with the IAB members.

Revised Course Description:

ENGT 4210, Industrial Automated Systems -
Introduction to Industrial Control Systems, Interfacing Devices, Process Control, and Instrumentation - Proportional (P), Integral (I), Derivative (D), PI and PID controls; tuning of closed-loop systems; Industrial Detection Sensors and Interfacing; Motion Control; Includes circuit simulation using LabVIEW [17].

Pre-requisite: ENGT 2030 OR Permission of Instructor
Department faculty voted in favor of the revision to proposal regarding change of course title and description.

Present and Future Work:

As noted in the abstract, strategy 1 is ongoing. In AY 2021-22, two SOs (SO 2, 3) were assessed and evaluated in fall 2021 and spring 2022 with clear documentation of faculty discussion and reflection, and the results were utilized in decisions made on the CI actions. Appendix A includes samples of direct and indirect methods of assessment and evaluation instruments that resulted in the implementation of the recommended action items for SO3. For AY 2022-23, two SOs (SO 5, 6) are currently being assessed and evaluated from courses offered in fall 2022 and spring 2023 along with the documentation of faculty reflection and CI action items for implementation. In AY 2023-24, the remaining two SOs (SO 1, 4) have been scheduled, which will bring the 3-year assessment, evaluation and CI cycle to completion in spring 2024. The department will use those results to ensure systematic implementation of the program's CI process and improved student attainment of SO. Department faculty will continue to ensure that the constituents (students, faculty, IAB members, and alumni) are also involved in the CI process as pertinent. As specified in the abstract, in a six-year period between ABET site visits, the plan is to have two iterations of the CI process completed.

Results and Conclusion:

Although the ET department faculty have been involved in the assessment and evaluation of SOs for the ETAC of ABET programs for more than a decade, there are lessons learned that led to the unique strategies (1-4) in this paper. Strategies 1 and 2 are presented as primary, as suggested by the ABET team chair, as they are direct contributions to CI because of assessment and evaluation of the programs SO whereas strategies 3 and 4 are typically viewed as secondary.

Lessons learned that lead to Strategy 1: (A) Based on the input from the ABET review team, faculty learned that they must develop and follow regularly a clearly documented assessment and evaluation cycle which includes all SOs for each ABET program. The cycle needs to be systematic, and not periodic or random. (B) Faculty also learned that the data collected through assessment and evaluation needs to be clearly documented in the faculty and IAB meeting minutes to demonstrate that the results were systematically utilized for implementation of action items. Since fall 2019, faculty have been participating in weekly meetings, year-round, to discuss the progress made in CI and to address any concerns or challenges. In fall and spring of each year, during the “ABET Faculty Retreat Meeting” faculty systematically discussed the results and faculty reflections of the assessed and evaluated data for follow up on action items and recommendations related to CI. Based on past ABET experience, the main author concludes items A and B above as a best practice in accreditation and therefore recognizes strategy 1 as a novel approach in this paper.

Lessons learned that lead to Strategy 2: Based on the input from the ABET review team and insight from attending ABET symposiums, faculty learned that in addition to assessing and evaluating all the SOs regularly, it is imperative to ensure that there is clear documentation (through faculty meeting minutes) on how the results are used for CI actions. An Assessment and evaluation process are meaningful only if the results and findings are systematically utilized as input for the program’s CI actions. Items I a and I b have been included as part of strategy 2 in this paper.

Rationale for Strategy 3: Faculty, led by the main author of this paper, are regularly involved in efforts related to curriculum development and program improvements to stay current in the ET discipline and meet the demands of the skilled workforce needs regionally and globally. In spring and fall 2022, a review of the course descriptions, prerequisites and degree requirements involving students, faculty, and IAB lead to the revision of degree requirements to the Manufacturing ET and Mechanical ET programs. This contribution aligns to ABET C4 CI (II) - "other available information used to assist in the CI of the program".

IAB input that lead to Strategy 4: The IAB meetings are scheduled in fall and spring of each year to evaluate industry skill requirements, provide recommendations for curriculum improvements and revisions. During the spring 2022 IAB meeting, department faculty received feedback related to Industry 4.0 that resulted in the title change along with the revision of course description and change of textbook to ENGT 4210, Industrial Automated Systems. This aligns to ABET C4 CI (II) – "other available information used to assist in the CI of the program" [18].

In conclusion, strategies 1 through 4 have been successfully implemented.

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Appendix A:

Academic Year 2021-22 Schedule – Assessment, Evaluation, and CI – BS EET SO 2, 3

Schedule for:
(a) Student Learning Self-Evaluation Survey (Indirect)
(b) Faculty Assessment of Student Learning Survey (Indirect)
(c) Performance Indicators (direct) – See SOs highlighted for specific course offerings.
BS Electrical Engineering Technology (EET)
Fall II 2021 – ENGT 2240, Electronics FUND II **[SO 3 (PI-Test Equipment & MultiSIM Software)]**
Spring Semester – Jan. 2022 – "Faculty Return to work week" - Faculty meeting to discuss results and findings for follow up on recommendations to "close the loop".
Spring II 2022 – ENGT 4220, Communications Systems II [**SO 2 (PI-Graphical form)]**
Summer III 2022 – ENGT 4250, Linear Electronics & Capstone Experience **[SO 2 (PI-Written & Oral)]**
Fall 2022 - August 2022 - Faculty Retreat – Faculty will discuss the results and findings for follow up on recommendations and action as needed.

Academic Year 2022-23 Schedule – Assessment, Evaluation, and CI – BS EET SO 5, 6

Schedule for:
(a) Student Learning Self-Evaluation Survey (Indirect)
(b) Faculty Assessment of Student Learning Survey (Indirect)
(c) Performance Indicators (direct) – See SOs highlighted for specific course offerings.
Fall II 2022 – ENGT 2250, Digital Design II **[SO 5 (PI-Digital)]**
Spring Semester – Jan. 2023 – "Faculty Return to work week" - Faculty meeting to discuss results and findings for follow up on recommendations to "close the loop".
Spring I 2023 – ENGT 4150, Programmable Logic Controllers **(SO 5 PI-Control)**
Spring I 2023 – ENGT 2260, Microcontrollers **(SO 5 PI-Robotic Applications)**
Spring II 2023 – ENGT 4220, Communications Systems II **[SO 5 (PI- Math & Communication)]**

Summer III 2023 – ENGT 4250, Linear Electronics **[SO 5 (PI-Analog)]** & Capstone Experience **[SO 6 (PI-Design, Implement & Manage Project)]**
Fall 2023 - August 2023 - Faculty Retreat – Faculty will discuss the results and findings for follow up on recommendations and action as needed.

Academic Year 2023-24 Schedule – Assessment, Evaluation, and CI – BS EET SO 1, 4

Schedule for:
(a) Student Learning Self-Evaluation Survey (Indirect)
(b) Faculty Assessment of Student Learning Survey (Indirect)
(c) Performance Indicators (direct) – See SOs highlighted for specific course offerings.
Fall II 2023 – ENGT 2240, Electronics FUND II [**SO 1 (PI-Circuit Design & Engineering Problem Solving)]**
Spring Semester – Jan. 2024 – "Faculty Return to work week" - Faculty meeting to discuss results and findings for follow up on recommendations to "close the loop".
Summer III 2024 – ENGT 4250, Linear Electronics & Capstone Experience **[SO 4 (PI-Team work in design and implementation of Capstone Project)]**
Fall 2024 - August 2024 - Faculty Retreat – Faculty will discuss the results and findings for follow up on recommendations and action as needed.

Appendix B:

College of Science, Technology, Engineering and Mathematics
Engineering Technology ETAC/ABET Student Outcome Assessment and Evaluation
BS Electrical Engineering Technology

Student Learning Self-Evaluation Survey

Course Name: ENGT 2240: ELECTRONIC FUNDAMENTALS II (3)	
Term / Section / Site	
Instructor: John Doe	Term: Fall II 2021 FC

Directions: *Please evaluate your perception of your performance and abilities on each item listed using the scale below:*
4 – Excellent 3 – Good 2 – Satisfactory 1 – Unsatisfactory N/A–Not applicable

Topics are arranged by Student Outcome (SO). We are looking for your help here to see what you believe you have - or have not - gotten from the program of study for this degree program. While this is linked to the content in a specific course, this is **NOT** a course evaluation or an evaluation of the instructor. Instead, this is an evaluation of the curriculum based on student performance as a group related to specific student outcomes.
This survey will serve as an indirect, subjective measure of performance on relevant student outcomes. While separate from direct evaluation of student outcomes based on specific performance indicators, please consider the performance indicators when making your subjective judgment.
The overarching goal is to use this survey instrument as part of the assessment and evaluation process to determine the extent to which the student outcomes are being attained.
Some questions here may not be applicable in your opinion. In those cases, list that as NA (non-applicable).

SO	**Course Objective**	**Student Evaluation**				
		4	**3**	**2**	**1**	**NA**
3	***Students have the ability to perform experiments, analyze and interpret results using test equipment and productivity software***					
	(a) Student ability to work in teams on lab experiment to test the circuit, measure output using physical test equipment (Multimeter, Function Generator and Oscilloscope) and interpret results.					
	(b) Student ability to work in teams on lab experiment to test the circuit, measure output using industry-based simulation software – MultiSIM and interpret results.					

Directions: *Please evaluate the Student Outcome (SO) a, b, c …, use the scale below:*
4 – Excellent 3 – Good 2 – Satisfactory 1 – Unsatisfactory N/A–Not applicable

Appendix C:

College of Science, Technology, Engineering and Mathematics
Engineering Technology ETAC/ABET Student Outcome Assessment and Evaluation
BS Electrical Engineering Technology

Faculty Evaluation of Student Learning Survey

Course Name: ENGT 2240: ELECTRONIC FUNDAMENTALS II (3)	
Term / Section / Site	
Instructor: John Doe	Term: Fall II 2021 FC

Directions: *Please evaluate your perception of your performance and abilities on each item listed using the scale below:*
4 – Excellent 3 – Good 2 – Satisfactory 1 – Unsatisfactory N/A–Not applicable

Topics are arranged by Student Outcome (SO). We are looking for what you believe the students have - or have not - gotten from the program of study for this degree program. While this is linked to the content in a specific course, this is **NOT** a course evaluation or an evaluation of the instructor. Instead, this is an evaluation of the curriculum based on student performance as a group related to specific student outcomes.

This survey will serve as an indirect, subjective measure of performance on relevant student outcomes. While separate from direct evaluation of student outcomes based on specific performance indicators, please consider the performance indicators when making your subjective judgment.

The overarching goal is to use this survey instrument as part of the assessment and evaluation process to determine the extent to which the student outcomes are being attained.

Some questions here may not be applicable in your opinion. In those cases, list that as NA (non-applicable).

SO	**Course Objective**	**Student Evaluation**				
		4	**3**	**2**	**1**	**NA**
3	***Students have the ability to perform experiments, analyze and interpret results using test equipment and productivity software***					
	(a) Student ability to work in teams on lab experiment to test the circuit, measure output using physical test equipment (Multimeter, Function Generator and Oscilloscope) and interpret results.					
	(b) Student ability to work in teams on lab experiment to test the circuit, measure output using industry-based simulation software – MultiSIM and interpret results.					

Directions: *Please evaluate the Student Outcome (SO) a, b, c …, use the scale below:*
4 – Excellent 3 – Good 2 – Satisfactory 1 – Unsatisfactory N/A–Not applicable

Appendix D:

Performance Indicator (PI) Form

Student Outcome:
SO 3: Students have the ability to perform experiments, analyze and interpret results using test equipment and productivity software.

Specific Performance Indicator (PI): **Student ability to work in teams on a lab experiment to test the circuit, measure output using physical test equipment (Multimeter, Function Generator and Oscilloscope) and interpret results.**

Degree Program (AAS or BS): **BS Engineering Technology**

Concentration Being Assessed & Evaluated: **Electrical**

Course: **ENGT 2240 Electronics FUND II**

Site(s): **Fort Campbell; Class offered in person**

Term(s): **Fall II, 2021**

Instructor: **John Doe**

Evidence Collected: **Student scores on Lab 5: The Schmitt Trigger.**

Problem Statement:

Note: A small portion of the lab is presented below.

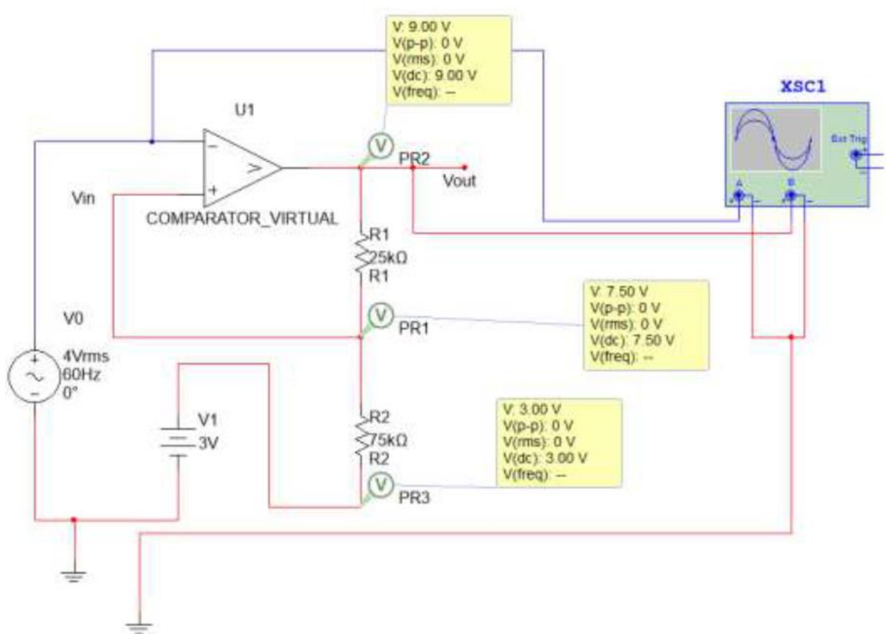

Figure 3(a)

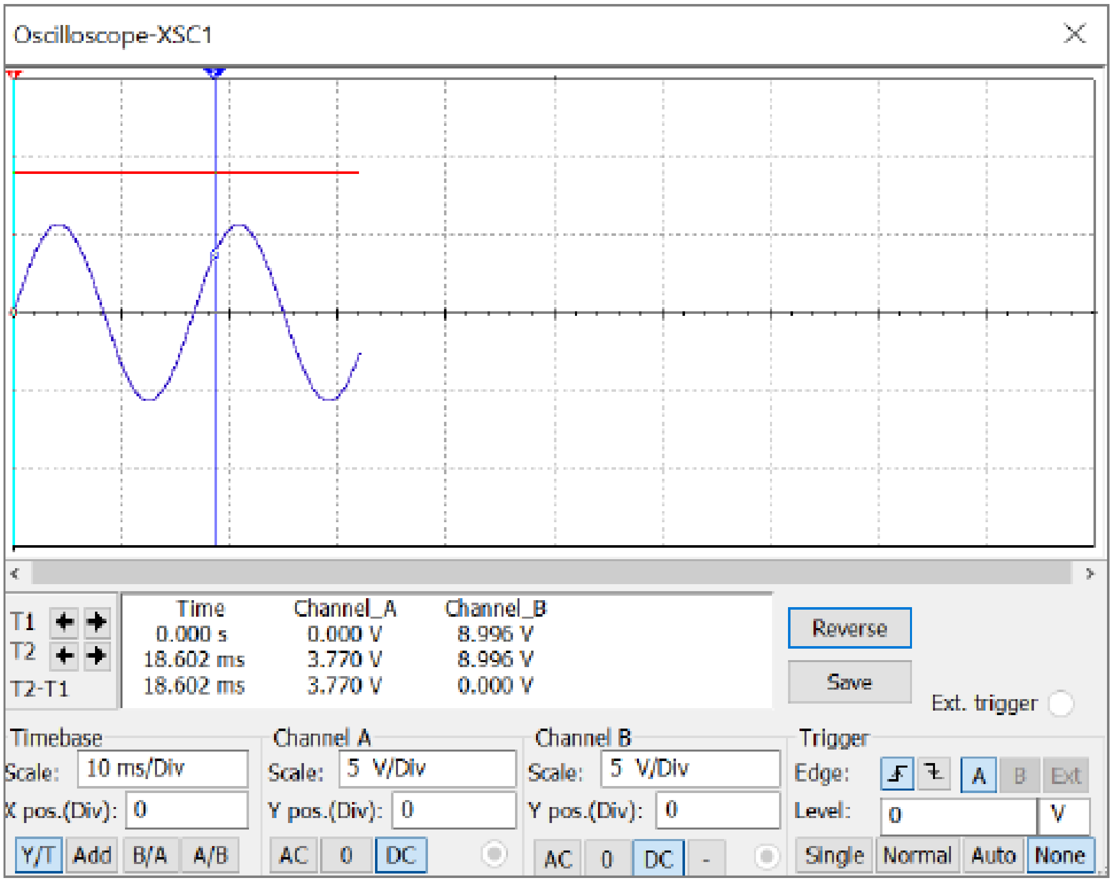

Figure 3(b)

Q4. The DC power supply to the op-amp is ±9V. From the figures above (Figure 3(a) and 3(b)), it is obvious that the Schmitt trigger is not functioning. How you can solve this problem? State and explain all possible ways.

Q5. Say you have fixed the above issue and the. What change you expect if you ground the negative power supply. Explain with the graph how the upper and lower trigger point will be effected by such change.

Q6. Repeat the functional circuit in Q5 with increasing the positive power supply to +18V and keep the negative grounded. Explain with the graph how the upper and lower trigger point is changed.

Q7. Summarize the important differences between a comparator and a Schmitt Trigger.

Description of Work Being Assessed and Evaluated:

Students analyze the input-output relationship of the Schmitt trigger by comparing the measured and calculated voltages, investigate the hysteresis behavior of Schmitt trigger by sketching the output in response to the different periodic waveforms. Students build a Schmitt trigger circuit by using the operational amplifier (Op-Amp), use a function generator to generate low frequency periodic input signals, and use oscilloscope to investigate the output characteristics of the Schmitt trigger. Verify the noise immunity of the circuit by changing different parameters such as biasing voltages or the triggering voltages from the closed loop feedback network.

Results:

	Total Number of Students	Students Scoring 75% or Above on This Activity		Meets Benchmark?
Electrical Engineering Concentration	**6**	**6**	**100%**	**YES**

	Student	**Score (Max=100%)**
BS in Electrical Engineering Technology Concentration	**S1**	**80%**
	S2	**100%**
	S3	**100%**
	S4	**80%**
	S5	**80%**
	S6	**100%**

Notes:

The department benchmark is that, at a minimum, 75% of students in the concentration should score 75% or better on the assessed activity.

Correction action is required for scores below the benchmark level. Even if action is not required, consideration is to be given to ways to improve the performance of students falling below this benchmark.

Discussion of Results / Faculty Reflection:

Direct measurement was acquired from 6 student results which manifests that more than 75% students has achieved the benchmark level. In this direct measure of PI1, the students scored between 80% and 100% in PI1. Eventually, this score is well above the set standard benchmark of 75%. After having input from students at the beginning of the semester, it was expected that majority of the students had enough proficiency in running MultiSIM to simulate basic but simple electronic circuits. However, it would be better to extend the discussion on circuit simulation with one or two extra examples. In this evaluation 75% or more of the total students did well in determining the Schmitt trigger characteristics and finding the solution of this particular problem.

Actions for Improvement:

A portion of the problem will be added to ask students to simulate the given circuit in the problem using MultiSim and use the result to verify their solution. This will cause them to do brainstorming on how to trade off among various characteristics of a given circuit and help them sharpening their conceptual background. To improve this performance indicator, initiatives will be taken in future so that they will be tested on simulating a simple electronic circuit (e.g. a half wave rectifier) before advancing to the more complex labs. *Two measurable actions will be taken to familiarize the students with Multisim software and gauge students' level of understanding.*

(a) At the beginning of the course they will be given in-class guided assignment to implement a circuit using Multisim.

(b) After completion of this task, they will be assigned to build another circuit and simulate it to obtain desired results which will be graded.

In addition, before starting each lab, a detailed but recurring discussion will be made to address the common mistakes and errors related to the circuit design and simulation.

Appendix E:

CI Summary of assessment and evaluation that includes implementation of action items from AY 2021-22 - SO 3 - BS EET

Assessment and Evaluation:

Based on the 3-year schedule of SOs for the BS Electrical Engineering Technology, SO3 assessment and evaluation was performed in Fall II 2021 (ENGT 2240). The results and findings are presented below.

Student Outcomes or, SOs with Performance Indicators, or PIs of interests are highlighted for the specific course offerings.

SO3 (ABET): ***Students have the ability to perform experiments, analyze and interpret results using test equipment and productivity software.***

Discussion on Assessment and Evaluation data collected: BS EET)

Academic Year	Course	SO, and PI
2021-22	**ENGT 2240, Electronics FUND II**	**[SO 3 (PI-Test Equipment & MultiSIM Software)]**

Summary of Direct Measures based on the selected Performance Indicators

Notes: **The department benchmark is that, at a minimum, 75% of students in the concentration should score 75% or better on the assessed activity.**

Performance Indicator (PI)
1. Student ability to work in teams on a lab experiment to test the circuit, measure output using physical test equipment (Multimeter, Function Generator and Oscilloscope) and interpret results.
2. Student ability to work in teams on a lab experiment to test the circuit, measure output using industry-based simulation software – MultiSIM and interpret results.

Results:

	PI	Total Number of Students	Students Scoring 75% or Above on This Activity		Meets Benchmark?
Electrical Concentration	**1**	**6**	**6**	**100%**	**YES**
	2	**6**	**5**	**83%**	**YES**

Summary of results and faculty reflection / CI action:

Direct measurement was acquired from 6 student results which manifests that more than 75% students has achieved the benchmark level. In the direct measure of PI2, only one student scored just 40% while rest of the students scored between 80% and 100% in both PI1 and PI2. Eventually, both scores are well above the set standard benchmark of 75%. After having input from students at the beginning of the semester, it was expected that majority of the students had enough proficiency in running MultiSIM to simulate basic but simple electronic circuits. However, it would be better to extend the discussion on circuit simulation with one or two extra examples.

In order to continually improve performance and to systematically use the results of the assessed and evaluated data, the action items for implementation are below:

To improve this indicator, initiatives will be taken in future so that they will be tested on simulating a simple electronic circuit (e.g. a half wave rectifier) before advancing to the more complex labs. *Two measurable actions will be taken to familiarize the students with Multisim software and gauge students' level of understanding.*

(a) At the beginning of the course they will be given in-class guided assignment to implement a circuit using Multisim.

(b) After completion of this task, they will be assigned to build another circuit and simulate it to obtain desired results which will be graded.

In addition, before starting each lab, a detailed but recurring discussion will be made to address the common mistakes and errors related to the circuit design and simulation.

Reassessment and Re-evaluation:

SO3 reassessment and re-evaluation was performed in the Fall II 2022 offering of ENGT 2240. The results and findings are summarized below.

Reassessment of the performance indicators included both the implementation of the highlighted action items (a and b) above and measurement of the effectiveness of the improved performance.

Assessment Item: Homework and Simulation of Problem.

The assessment item addresses both action plans: a) following the given instructions, students implement a circuit using Multisim, and b) build and simulate another example circuit to ensure specific outputs.

At the beginning of the course students were demonstrated how to use MultiSim to design and evaluate circuit performance. Students were asked to change appropriate circuit elements to adjust a specific parameter (such as changing the feedback resistor to obtain a specific gain of an operational amplifier). This will help them learning to design the electric circuit in compliance with the desired outcome.

Students were required to calculate the output of an operational amplifier which included a reactive element (such as a capacitor) to obtain the characteristics of an integrator. They sketched the output and simulated to verify their findings. This will give them the opportunity to observe how a mathematical concept can be transformed into a visible tool which can be used to solve a specific problem, in this case integrating a function.

Results: This course was taken by 13 students. 6 out of 13 students were from BS in EET.

	PI	Total Number of Students	Students Scoring 75% or Above on This Activity		Meets Benchmark?
Electrical Concentration	**1**	**6**	**6**	**100%**	**YES**
	2	**6**	**6**	**100%**	**YES**

Notes: **The department benchmark is that, at a minimum, 75% of students in the concentration should score 75% or better on the assessed activity.**

	Student	**Sum of PI1 and PI2 Score (Max=100%)**
BS in Electrical Engineering Technology (EET) Concentration	1	78%
	2	78%
	3	100%
	4	89%
	5	95%
	6	98%

Summary: All of the students have achieved the 75% benchmark or more.

So, in the next offering of the course, students will be challenged to verify some of the homework solutions with Multisim results. This will empower them to gain deeper knowledge on how to implement a complex circuit and simulate it to obtain desired result. In fact, a set of problems will be selected to solve using mathematical tools and theoretical concepts. The findings will be supplemented by designing the relevant circuit in Multisim software and comparing the findings with the associated outcome from the Multisim simulation. Such steps will allow the students to test their skill to identify the circuit characteristics and troubleshoot, if there are any discrepancies in both results.

Appendix F:

PROGRAM LEVEL ASSESSMENT REPORT – one report / SO for all SOs (1-6) – BS EET

1. Intended Student Outcome: (number #) – SO 3
Description of the Outcome: **SO3 (ABET):** ***Students have the ability to perform experiments, analyze and interpret results using test equipment and productivity software.***
2. Means of Assessment for Intended Outcome (number #): ***PI 1, PI 2 relates to SO #3***
Means of assessment and criteria for success:
ENGT 2240, Electronics Fundamentals II. The evaluator will be specifically looking for overall experimental process, analysis, and interpretations of the results. Fall II 2021, 2022
PI 1: Student ability to work in teams on a lab experiment to test the circuit, measure output using physical test equipment (Multimeter, Function Generator and Oscilloscope) and interpret results. PI 2: Same as PI 1 but use MultiSIM software.
2 students scored 78%; the others scored 89, 95, 98, 100 %
- Score of 85 % and above exceeds the standard
- Score below 75 % does not meet the standard
The department benchmark is that, at a minimum, 75% of students in the concentration should score 75% or better on the assessed activity.
3. Description of the student population to be sampled:
All students in the concentration specific course (s) in the ABET program will be required to participate. The sample for this class is 6. The sample size is normally less than 24.
4. Summary of results and findings for this assessment: *Reassessment in Fall II 2022* *Direct measurement was acquired from 6 student results which manifests that more than 75% of students have achieved the benchmark level. In the direct measure of PI 2, only one student scored just 40% while the rest of the students scored between 80% and 100% in both PI1 and PI2. Eventually, both scores are well above the standard benchmark set of 75%. After having input from students at the beginning of the semester, it was expected that the majority of the students had enough proficiency in running MultiSIM to simulate basic but simple electronic circuits. However, it would be better to extend the discussion on circuit simulation with one or two additional problems.*
5. Action to be taken in addressing these assessment findings: *Department benchmark was met both in Fall II 2021 and when reassessed in Fall II 2022.* *In the next offering of the course, students will be challenged to verify some of the homework solutions with Multisim results. This will empower them to gain deeper knowledge on how to implement a complex circuit and simulate it to obtain desired result. In fact, a set of problems will be selected to solve using mathematical tools and theoretical concepts. The findings will be supplemented by designing the relevant circuit in Multisim software and comparing the findings with the associated outcome from the Multisim simulation. Such steps will allow the students to test their skill to identify the circuit characteristics and troubleshoot, if there are any discrepancies in both results.*