Program Assessment Report (PAR)

Electrical Engineering (EE) Baccalaureate Degree

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ACADEMIC YEAR COVERED BY THIS REPORT: 2020-2021

I. PROGRAM LEARNING OUTCOMES

Student learning outcomes are adopted from the Engineering Accrediting Commission of ABET. The Learning Outcomes are revised by the Electrical Engineering (EE) program when ABET publishes updated outcomes. At the current time, the ABET outcomes are sufficient and satisfy the Department of Electrical Engineering program objectives. Faculty reviewed and voted to accept the following learning outcomes during the 2018-2019 academic year as recorded in the Department meeting minutes and are posted in the department webpages, the university catalog, and Electrical Engineering advising notes that are provided to department and university advising teams. Additionally, the learning outcomes are mapped to Program Objectives which have been reviewed and approved by the program's multiple constituents. The EE Undergraduate Studies committee plans the data collection to assess the outcomes on a yearly basis, and maintains a record of the data, and meeting minutes to record faculty analysis and decisions for improving the program. _____ Student Learning Outcomes (or, Student Outcomes) ----------
1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics 2. 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. Communicate effectively with a range of audiences 4, 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. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives 6. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions 7. Acquire and apply new knowledge as needed, using appropriate learning strategies

II. PROCEDURES USED FOR ASSESSMENT

A. Direct Assessment

As part of the 6-year ABET review process, the EE program follows a schedule to collect data and to assess each outcome. The schedule is recorded electronically and available from the EE Department's shared folder OneDrive/UGS/ABET-Interim-2020-2021/abetData_2017-2023.xlxs. The specific courses listed below constitute the set of courses for a full-major EE student. Some sections have non-EE students but only works by EE students are used in the assessment. For each learning outcome and assessment method listed by course in the table below, all works by EE students are evaluated to determine the percentage of EE students who demonstrated satisfactory performance. Key questions from exams are used for all Exam and Quiz-based assessments. Lab reports and lab performances are evaluated for lab-based learning sections. Rubrics are used to evaluate assignments in the capstone course (EE4910). The samples of student works are collected during the year of a pending ABET review which is at least every 6 years. The complete set of assessment instruments (e.g., quiz/exam problem, etc.) are listed below by the course where the data is collected. Learning outcomes are listed as (1) to (7) and specific instruments for each outcome are listed as (1-x), (2-x), etc. where x represents the assessment/instrument number. ----------
Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics EE 3210 (1-1) Prerequisite quiz circuit analysis, calculus, differential equations (1-2) Exam/quiz problem application of Laplace transforms to system with input (1-3) Exam/quiz problem application of Fourier transform to system with sinusoidal input (1-4) Exam/quiz problem application of Bode analysis to system EE 3260 (1-5) Prerequisite quiz convolution/transform via integration linear algebra (1-6) Exam/quiz problem compute moments of random variables and functions of random variables (1-7) Exam/quiz problem compute moments of random vectors and functions of random vectors (1-8) Exam/quiz problem analysis of a linear system with a wide-sense stationary input EE 3450 (1-9) Exam/quiz problem Application of vector calculus (1-10) Exam/quiz problem Apply Coulomb, Gauss, Poisson theorems to compute electric force, field, and potential in homogeneous medium and cross the interface of two different materials. (1-11) Exam/quiz problem Apply Biot-Savart and Ampere law to compute magnetic field, force and torque. (1-12) Exam/quiz problem Apply time-varying Maxwell equations to calculate electromotive force and to investigate electromagnetic wave propagation in free space and along guided transmission lines. EE 4130 (1-17) Prerequisite quiz Use of LT to find TF of circuit (1-18) Exam/quiz problem Root-locus plot and control design (1-19) Exam/quiz problem Transient response analysis and design (1-20) Exam/quiz problem Steady-state error analysis and design EE 4620 (1-21) Prerequisite quiz use of k-maps/Boolean algebra to design combinational circuit (1-22) Combinational logic (1-23) Synchronous sequential design (1-24) Asynchronous design EE4910 (1-25) Individual White Paper Identify and describe a design project to solve a realistic engineering problem 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 EE 4000 (2-1) Exam/quiz problem Design of an ideal anti-aliasing filter (2-2) Exam/quiz problem Design of an finite impulse

response filter (2-3) Exam/quiz problem Design of an infinite impulse response filter EE 3310 (2-4) Prerequisite quiz circuit analysis (2-5) Exam/quiz problem Design and analyze diode circuits such as rectifiers, clippers, etc. (2-6) Exam/quiz problem Design and perform small-signal analysis of FET amplifiers (2-7) Exam/quiz problem Design and perform small-signal analysis of BJT amplifiers EE 4130 (2-8) Prerequisite quiz Use of LT to analyze system steady state response. (2-9) Exam/quiz problem Stability analysis and design (2-10)Exam/quiz problem Motor control system design and implementation (2-11)Exam/quiz problem Modeling of electrical and mechanical systems EE4910 (2-12) Design Specification Document Specify design to meet requirements under multiple technical and non-technical constraints and incorporating design standards (2-13) PDR System overview, design functionality (2-14) PDR Risks (include safety, budget, schedule) (2-15) PDR HW design (2-16) PDR SW design (2-17) Worksheet 3.7 Global Impact of Their SD Project (2-18) Worksheet 3.7 Economic Impact of Their SD Project (2-19) Worksheet 3.7 Environmental Impact of Their SD Project (2-20) Worksheet 3.7 Societal Impact of Their SD Project (2-17) Worksheet 3.7 Public Health Impact of Their SD Project (2-18) Worksheet 3.7 Public Safety Impact of Their SD Project (2-19) Worksheet 3.7 Public Welfare Impact of Their SD Project (2-20) Worksheet 3.7 Cultural Impact of Their SD Project EE4910 – potential solutions (2-12) Quiz Design with public health considerations (2-13) Quiz Design with public safety considerations (2-14) Quiz Design with public welfare considerations (2-15) Quiz Design with global considerations (2-16) Quiz Design with cultural considerations (2-17) Quiz Design with social considerations (2-18) Quiz Design with environmental considerations (2-19) Quiz Design with economic considerations Communicate effectively with a range of audiences EE4910 (3-1) Elevator Pitch Compliance (3-2) Elevator Pitch Content (3-3) Elevator Pitch Delivery (3-4) White paper Writing Quality (3-5) White paper Writing Syle (3-6) White paper Credibility (3-7) PDR presentation Organization (3-8) PDR presentation Mechanics (3-9) PDR presentation Delivery (3-10) PDR presentation Relating to audience 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 EE4910 (4-1) Ethics quiz Identifies dilemma (4-2) Ethics quiz Considers impacted parties (4-3) Ethics quiz Analyzes alternatives and consequences (4-4) Ethics quiz Chooses an action (4-5) Ethics quiz Global (4-6) Ethics quiz Economic (4-7) Ethics quiz Environmental (4-8) Ethics quiz Societal EE 4910 – Relevant facts (4-1) Quiz Ethical and professional responsibilities with public health considerations (4-2) Quiz Ethical and professional responsibilities with public safety considerations (4-3) Quiz Ethical and professional responsibilities with public welfare considerations (4-4) Quiz Ethical and professional responsibilities with global considerations (4-5) Quiz Ethical and professional responsibilities with cultural considerations (4-6) Quiz Ethical and professional responsibilities with social considerations (4-7) Quiz Ethical and professional responsibilities with environmental considerations (4-8) Quiz Ethical and professional responsibilities with economic considerations EE 4910 – Competing interests (4-9) Quiz Ethical and professional responsibilities with public health considerations (4-10) Quiz Ethical and professional responsibilities with public safety considerations (4-11) Quiz Ethical and professional responsibilities with public welfare considerations (4-12) Quiz Ethical and professional responsibilities with global considerations (4-13) Quiz Ethical and professional

responsibilities with cultural considerations (4-14) Quiz Ethical and professional responsibilities with social considerations (4-15) Quiz Ethical and professional responsibilities with environmental considerations (4-16) Quiz Ethical and professional responsibilities with economic considerations EE 4910 – Affected parties (4-17) Quiz Ethical and professional responsibilities with public health considerations (4-18) Quiz Ethical and professional responsibilities with public safety considerations (4-19) Quiz Ethical and professional responsibilities with public welfare considerations (4-20) Quiz Ethical and professional responsibilities with global considerations (4-21) Quiz Ethical and professional responsibilities with cultural considerations (4-22) Quiz Ethical and professional responsibilities with social considerations (4-23) Quiz Ethical and professional responsibilities with environmental considerations (4-24) Quiz Ethical and professional responsibilities with economic considerations Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives EE4910 (5-1) Teamwork (Marshmallow Challenge) Prepared for Assignment (5-2) Teamwork (Marshmallow Challenge) Assisted in Planning (5-3) Teamwork (Marshmallow Challenge) Completed Assigned Task (5-4) Teamwork (Marshmallow Challenge) Listens to Feedback Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions EE 4620 (6-1) Lab 1 Design complex combinational circuits, take data, and analyze data to design a circuit that (6-2) Lab 2 Design, simulate, implement and test a complex sequential circuit to meet or exceed design (6-3) Lab 3 Design, simulate, implement and test an asynchronous circuit to meet or exceed design con- (6-4) Project Design and demonstrate a spectrum analyzer that uses an FFT. Students will design/conduct EE4910 – Design specification (6-5) Appendix A Test and Evaluation Master Plan (TEMP) (6-6) TEMP Experimental Design (6-7) TEMP Experimental Execution (6-8) TEMP Data Evaluation Acquire and apply new knowledge as needed, using appropriate learning strategies EE 4910 – White Paper References (7-1) Information gathering (7-2) Information evaluation (7-3) Information application EE 4910 – Design Specification References (7-4) Information gathering (7-5) Information evaluation (7-6) Information application EE 4910 (7-1) Number of white paper references (7-2) Technique discussion – threads (7-3) Technique discussion – replies (7-4) Technique discussion – reads (7-5) Technique discussion – total posts

B. Scoring of Student Work

The program goal is to have at least 70% of EE students score a satisfactory score (70% or better) on each assessment instrument. The results of data collection and analysis are recorded in the data collection spreadsheet and in the program's internal self-improvement report which are both located in the EE Department's shared folder. Each learning outcome is assessed as follows a. Program faculty (full-time and part-time), and teaching assisstants score the individual works (selected exam question, quiz question, lab skills demonstration, lab report, capstone course presentation, etc.). Most works are graded using an answer key developed by the faculty but some graded with a rubric such as communication-based instruments (reports and presentation), lab

skills demonstrations, and team-based exercises. b. During the evaluation term, the instructor of record submits a list of the specific, the number of students in the section, and the number of students who performed satisfactorly (typically 70% or better) on the assignment. c. The full-time Program facutly, by means of the EE Undergraduate Studies Committee collects the data and calculates the percentage of students who performed satisfactorily. d. Each year, the EE Underrgraduate Studies Committee analyzes the past-year's assessments and determines courses of action as needed. In cases where the results for a specific outcome's evaluation instrument are below the goal of 70% the committee solicites additional information such samples of the instruments (quiz/exam question, etc.).

C. Indirect Assessment

Each senior class completes an exit survey and meets with the Department Chair or the Chair's delegate to share their experiences and provide feedback on the BSEE Program. In addition, program faculty receive student feedback through the course evaluations, employer feedback from those students who complete an internship with industry, alumni, and the EE Department's External Advisory Board (EAB). Also, the Program Education Objectives which state what a BSEE graduate should be doing within a few years after graduation are evaluated with feedback from the agencies and companies who hire the WSU BSEE graduates, alumni, and the EAB.

III. ASSESSMENT RESULTS/INFORMATION:

The complete listing of the results are listed in the continuous improvement document EE-Self-Study-Continuous-Improvement-2017-2019.pdf, responsesTo19-20data.pdf, and responsesTo20-21data.pdf, which are located on the EE shared drive OneDrive/UGS/ABET-Interim-2020-2021/

During 2018-2019, EE faculty assessed Outcomes (2), (3), (4), (5), (6), and (7). Outcome (1) is scheduled for assessment in 2017-2018 and 2019-2020.
---------- Outcome (2) is assessed in 3 of the core EE courses that are in the 3rd and 4th years, and the senior design capstone course. Outcome (2) analysis The assessments were redefined beginning fall 2018 because the ABET Student Outcomes changed in the previous year. Of the 11 assessments in the core courses (numbered (2-1) to (2-11)) only (2-3) showed consistent student success for both fall and spring. Whereas of the 8 assessments in the capstone course 5 showed consistent student success for both fall and spring semesters. Of the assessments where less than 70% of students achieved the desired minimum level of performance, (2-1), (2-2), (2-4), (2-5), (2-9), (2-11), (2-18) each had one of the two semesters where student performance met the assessment goal and one semester where the performance was less than the goal. Also, (2-1),

(2-2),(2-4), (2-5), and (2-18) were only marginally low (greater than 60% but less than 70%). Four of the assessments were also unobserved during spring 2019 (2-8) to (2-11). Only (2-6), (2-7), (2-12) and (2-17) showed less than 70% of students achieved the desired goal for both semsters and occured in two specific courses. Overall, students marginally achieved outcome (2) during the 2018-2019 assessment cycle. ---------- Outcome (3) is assessed in the senior design capstone course. Outcome (3) analysis Three of the 6 assessments showed students performance strongly exceeded the 70% learning goal (3-1), (3-2), and (3-3). Each of the remaining assessments resulted in one semester where student performance exceeded the goal and one semester where it was short of the goal. (3-4) and (3-5) were substantially low during fall 2018 but were marginally above the goal for spring 2019. (3-6) exceeded the goal in fall 2018 but was marginally low in spring 2019. Overall, students achieved outcome (3) during the 2018-2019 assessment cycle. ---------- Outcome (4) is assessed in the senior design capstone course. Outcome (4) analysis Seventeen of the 24 assessments showed students performance exceeded the 70% learning goal (4-1), (4-5) to (4-9), (4-12), (4-13), (4-15) to (4-17), (4-19) to (4-24). Assessments (4-10), (4-14), and (4-18) resulted in one semester where student performance exceeded the goal and one semester where it was short of the goal. (4-10) and (4-18) were substantially low during fall 2018 but were marginally above the goal for spring 2019. (4-14) exceeded the goal in fall 2018 but was marginally low in spring 2019. Assessments (4-2), (4-3), (4-4) and (4-11) fell short of the goal during both fall and spring terms. Overall, students achieved outcome (4) during the 2018-2019 assessment cycle. ---------- Outcome (5) is assessed in the senior design capstone course. Outcome (5) analysis Each of the 4 assessments showed student performance exceeded the 70% learning goal (5-1) to (5-4) although (5-1) was unobserved during spring 2019. Overall, students achieved outcome (5) during the 2018-2019 assessment cycle. ---------- Outcome (6) is assessed in one core 4th-year EE lab course and the senior design capstone course. Outcome (6) analysis Three of the 4 lab course assessments showed student performance strongly exceeded the 70% learning goal (6-1) to (6-3) but (6-4) was marginally below the 70% threshold for both fall 2018 and spring 2019 terms. Assessment (6-5) was observed only during spring 2019 following a redesign of the the assessement in fall 2018 and showed student performance exceeded the goal. Overall, students achieved outcome (6) during the 2018-2019 assessment cycle. ---------- Outcome (7) is assessed in the senior design capstone course. Outcome (7) analysis Assessments (7-1) to (7-5) are measured by direct observation and showed student performance exceeded the goal for both fall 2018 and spring 2019 terms. Overall, students achieved outcome (7) during the 2018-2019 assessment cycle.

Overall, students in the EE program are achieving the learning objectives. The continuous improvement process has identified specific assessments and instruments that have varying results from cycle to cycle and faculty have since made changes in communicating expectations, content, delivery, and assessment instruments.

IV. ACTIONS TO IMPROVE STUDENT LEARNING

A complete discussion of actions taken by faculty is available in the continuous improvement documents EE-Self-Study-Continuous-Improvement-2017-2019.pdf, responsesTo19-20data.pdf, and responsesTo20-21data.pdf, which are located on the EE shared drive OneDrive/UGS/ABET-Interim-2020-2021/. Results are shared with EE faculty as a whole at Department meetings or by electronic communication from the Undergraduate Studies Committee. Individual faculty who direct courses such as the capstone course make regular adjustments based on the information. Some changes as shown in the self-study report include redefined assessments and instruments, changes in course content and materials, and policies. When assessment results were strong during one semester but fell short during the second semester faculty wait for the next assessment cycle to reevaluate and determine if action is warranted.

V. SUPPORTING DOCUMENTS

Additional documentation, when provided, is stored in the internal Academic Program Assessment of Student Learning SharePoint site.