# School of Electrical and Computer Engineering

BS Degree in Electrical Engineering and BS Degree in Computer Engineering

***Assessment Report Form 2015-2016***

**Date of Report: 7/27/2016**

**Name of Person Submitting Report: Jeffrey L. Young, Professor and Head, School of Electrical and Computer Engineering**

## A. Program Information:

**Assessment Coordinator's Name: Keith A. Teague, Professor**

**Assessment Coordinator's Email Address: keith.teague@okstate.edu**

**Number of students enrolled in the program 2015-2016: 450**

**Number of students graduated in 2015-2016: Fall 2015: 4 CpE, 18 EE; Spring 2016: 11 CpE; 25 EE**

## B. Program Mission Statement

**In the box below, provide the mission statement for the program.**

*The mission statement, educational objectives, and goals for program should guide the assessment process. The mission statement should align with department, college, and institutional mission statements.*

The mission School of Electrical and Computer Engineering is to provide a high-quality, comprehensive electrical and computer engineering education for both undergraduate and graduate degree seeking students. The primary forms of educational delivery are classroom instruction, laboratory experiences utilizing both hardware and software technologies, and research experiences. To this end, the School offers a Bachelor of Science Degree in Electrical Engineering (BSEE), a Bachelor of Science Degree in Computer Engineering (BSCpE), Masters of Science in Electrical Engineering (MSEE), and a Doctorate in Electrical Engineering (PhDEE).

The School is chartered to perform both basic and applied research in the broad areas of electrical and computer engineering. The School acquires external support to establish research enterprises for student-centric discovery that culminates in the publication of findings in international, peer-reviewed journals and conference proceedings of the highest reputation.

Ancillary to the teaching and research mission of the School, the faculty of the School engage in extramural activities of service, extension, and outreach by serving the School, College, or University on internal committees, organizing conferences, developing short courses, reviewing papers, participating on professional committees, and the like.

## C. University Assessment Funds

**Were university assessment funds used by the department/program for assessment activities?** ☐Yes ☒No

*If university assessment funds were used by the department or program, describe how university assessment funds were used and the contribution the funds had on the assessment process. Funding requests for the next academic year have a separate process and should not be included here.*

## D. Student Learning Outcomes

On the pages that follow, list the Student Learning Outcomes associated with the program identified in this assessment form.

The Electrical Engineering (EE) and Computer Engineering (CpE) BS Degree Programs both have **Program Educational Objectives** (an overall description of the goals of the program for its graduates several years following graduation) and **Student Outcomes** (an expectation of achievement for all students by graduation). Student Outcomes are assessed, evaluated, and acted upon in a process of Continuous Improvement as prescribed under accreditation requirements specified by ABET, Inc., and are the focus of this assessment report. Because EE and CpE programs have identical Objectives and Outcomes, separate assessment processes and data collection are not conducted. The joint process and data are presented in the subsequent paragraphs and sections.

The **Program Educational Objectives** are stated as follows.

The School of Electrical and Computer Engineering at Oklahoma State University strives to produce outstanding graduates in Electrical Engineering and Computer Engineering who are successful in their careers. Specifically,

- Our Graduates will be widely employed across the range of subdisciplines within electrical engineering and computer engineering, and will be highly sought after by industry, academia, non-profit, and governmental organizations.
- Our Graduates will compete in a technologically changing world, collaborate in a diverse workforce, and communicate effectively their knowledge and ideas to colleagues, employers, customers, and stakeholders.
- Our Graduates will be recognized leaders**,** team players, problem solvers, innovators, and entrepreneurs in their profession.
- Our Graduates will identify and contribute to solving grand-challenge problems that improve the lives of people in Oklahoma, the United States, and around the world, serving their communities and their profession to produce a lasting, significant, and positive impact.
- Our Graduates will abide by the highest ethical standards of professional practice.
- Our Graduates will continue to develop professionally throughout their lives by being adaptive learners with a never ending desire to assimilate new knowledge and embrace new technologies.
- Our Graduates will have the knowledge to earn professional registration or certification in their field or earn an advanced post-graduate or professional degree should they choose.
- **Our Graduates will make a positive difference in the world.**

The aforementioned Objectives were vetted with the students of the School and with the ECE Industrial Advisory Board. They were approved by the ECE faculty in November, 2015.

The **Student Outcomes** are:

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

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

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

(d) an ability to function on multidisciplinary teams

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

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

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

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

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

The (a) through (k) designation is a standard ABET practice that we follow for consistency.

The following sections describe (i) the Student Outcomes and their relationship to the overall program and (ii) the process of Assessment and Continuous Improvement that are essential parts of our undergraduate programs in Electrical Engineering and Computer Engineering.

For clarity and simplicity, the information that follows is presented in the format requested by ABET such that this report can be tracked one-for-one with the OSU ECE ABET Self-Study Report, June 2015, and in subsequent accreditation cycles. Most of the material that follows is copied directly from the most recent (2015) Self-Study with updates reflecting new assessment data, evaluation, and actions. **Criterion 3** refers to Student Outcomes and the relationship of the outcomes to the program and its objectives. **Criterion 4** refers to the Continuous Improvement process which includes the program assessment plan, assessment and evaluation of attainment of student outcomes, and actions taken as a result of assessment.

# CRITERION 3. STUDENT OUTCOMES

## *A. Student Outcomes*

In support of achieving the Program Educational Objectives, the School has established Student Learning Outcomes that are regularly assessed and expected of all students upon completion of their chosen program in Electrical Engineering or Computer Engineering.

These student outcomes include:

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

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

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

(d) an ability to function on multidisciplinary teams

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

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

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

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

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

Information related to program accreditation, including Program Educational Objectives and Student Learning Outcomes, can be found on the School's web site at http://ece.okstate.edu/content/abet-accreditation.

## *B. Relationship of Student Outcomes to Program Educational Objectives*

The program educational objectives are closely related to and supported by the student outcomes as shown in the Table 3.1 below. An "x" is inserted only where there is strong correspondence between an objective and an outcome, although the support is not strictly limited to only these.

Table 3.1. Relationship between Objectives and Outcomes

| **Outcome**<br><br>**Objective** | a | b | c | d | e | f | g | h | i | j | k |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Be sought after and widely employed across a range of sub-disciplines in electrical engineering and/or computer engineering | x | x | x | | x | | | | | | x |
| Be able to compete, collaborate, and communicate in a diverse world | | | | | | | x | | | x | |
| Be leaders, team players, problem solvers, innovators, and entrepreneurs | | | | x | | | | x | | | |
| Identify and contribute to solving important problems that improve our lives | | | | x | | | | x | | | |
| Follow ethical standards of professional practice | | | | | | x | | | | | |
| Continue to develop professionally throughout their careers by begin adaptive learners and embracing new technologies | | | | | | | | | x | | |
| Have the knowledge to earn professional registration or | | | | | | | | | x | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| certification in their field or earn an advanced degree | | | | | | | | | | | |

Each major course in the curriculum supports one or more student outcomes. Table 3.3 below illustrates the student learning outcomes that are supported by each ECEN prefix course in the curriculum. An "x" is inserted for each course where an outcome is addressed with relative strength as shown in Table 3.2 ("2" or "3" on the scale). This correspondence is further defined and applied in Criterion 4.

Table 3.2 Definitions for Strength of Outcome

**3** – The outcome is a significant part of the course, is covered over multiple lectures, and addressed with some depth. There is at least one collected and graded assignment demonstrating the outcome, or the outcome is demonstrated as part of a project or an exam question. This outcome is an objective of the class.

**2 –** The outcome is covered in more than once lecture or it is revisited during the semester. The outcome may be demonstrated on an assignment or exam, but it is not a focus of the class. Coverage is less than "3" but still meaningful.

**1** – The outcome is addressed briefly in class. Demonstration of the outcome is limited or missing. Coverage is limited.

"**blank**" – The outcome is not addressed in class or is addressed only very casually.

Table 3.3. Mapping of Outcomes to Major Courses

| Course | Outcome | a | b | c | d | e | f | g | h | i | j | k |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ECEN 2011 | Methods | x | x | x | | | | | | | | x |
| ECEN 3113 | Energy Environment and Economics | x | | x | x | x | x | | x | x | x | |
| ECEN 3233 | Digital Logic Design | x | x | x | x | x | x | x | | | | x |
| ECEN 3314 | Electronic Devices | x | x | x | | x | | x | | x | | x |
| ECEN 3513 | Signal Analysis | x | x | | | x | | | | | | x |
| ECEN 3613 | Electromagnetic Fields | x | x | | x | x | | x | | | | x |
| ECEN 3623 | Math Found of EM and Photonics | x | x | | | x | | x | | | | x |
| ECEN 3714 | Network Analysis | x | x | x | | x | | x | | | | x |
| ECEN 3723 | Systems I | x | | x | | x | | | | | | x |
| ECEN 3913 | Solid State Devices | x | | x | | x | | | x | x | x | x |
| ECEN 4013 | Design of Engineering Systems | x | x | x | x | x | x | x | | | | x |
| ECEN 4024 | Capstone Design | x | x | x | x | x | x | x | x | | | x |
| ECEN 4133 | Power Electronics | x | | x | x | x | | | | x | x | x |
| ECEN 4153 | Power System Analysis and Design | x | | | | x | | | | x | | x |
| ECEN 4213 | Embedded Computer Systems | x | x | x | x | x | | x | | | | x |
| ECEN 4233 | High Speed Computer Arithmetic | x | x | x | x | x | x | x | x | x | | x |
| ECEN 4243 | Computer Architecture | x | x | x | x | x | | x | | | | x |
| ECEN 4303 | Digital Electronic Circuit Design | x | x | x | x | x | | x | | | | x |
| ECEN 4413 | Automatic Control Systems | x | x | x | | x | | | | | | x |
| ECEN 4503 | Random Signals and Noise | x | x | | | x | | | | | | x |
| ECEN 4523 | Communication Theory | x | x | x | | x | | x | x | x | | x |
| ECEN 4533 | Data Communication | x | x | x | | x | | | | | x | x |
| ECEN 4613 | Microwave Engineering | x | x | x | x | x | | x | | | | x |
| ECEN 4743 | Biomedical Modeling and Systems | x | x | x | | x | | | | | x | x |
| ECEN 4763 | Introduction to Digital Signal Processing | x | x | x | | x | | | | | | x |
| ECEN 4773 | Real Time Signal Processing | x | x | x | | x | | x | | x | | x |
| ECEN 4823 | Design of Optical Systems | x | x | x | x | x | | | x | x | x | x |
| ENSC 2613 | Introduction to Electrical Science | x | x | | | x | | | | | | x |
| ENSC 3213 | Computer Based Systems | x | x | x | x | x | | x | | | | x |

Only selected courses from Table 3.3 above, which are required of all students in the corresponding degree program, are part of the assessment process for accreditation in order to ensure that all students are represented in the data. However, other courses may be assessed on an as-needed basis for the purpose of program improvement when student outcome concerns arise. Assessment for attainment of student outcomes is performed using both direct and indirect methods, with the former preferred when reasonable to do so. The assessment process and the methodology are discussed in the next section, Criterion 4.

# CRITERION 4. CONTINUOUS IMPROVEMENT

## *A. Introduction*

The assessment process is designed to be more targeted by focusing on a small number of courses that are taken by all students in a particular degree program (Electrical Engineering and/or Computer Engineering), and produce much less data with less redundancy. The highest priority for assessment is given to the required senior courses (e.g., the capstone design sequence – ECEN4013 and ECEN4024) for efficiency and to address attainment of outcomes at graduation as specified in our accreditation requirements.

The process of data collection for assessment takes place at specific intervals depending upon what is being assessed. Table 4.1 in the next section summarizes the data collection process.

The process of evaluation takes place periodically by the Undergraduate Program and Assessment Committee. The Committee meets frequently during the academic year, redefining and modifying processes and examining data on a more or less continuous basis. The frequency of assessment is currently being evaluated. Beginning in 2016, a schedule was established for the committee to meet at least annually (at a time to be determined) to review assessment from the previous period, with the full cycle taking nominally two years.

## *B. Student Outcomes*

Assessment Data Collection Processes

The data collection processes used in Electrical Engineering and Computer Engineering are listed and described in the table and narrative below.

Table 4.1 below summarizes the basic assessment instruments and outcomes assessed for Electrical Engineering and Computer Engineering. Both direct and indirect methods are used. Descriptions of all the data collection methods and the desired performance levels follow in the text.

Table 4.1 Assessment Instruments, Outcomes Addressed, and Frequency

| Instrument | Description | Outcomes Assessed | Frequency |
|---|---|---|---|
| Selected Final Exam Problems (mathematics, science and engineering) | Selected final exam problems are collected in two required upper division classes (ECEN3513 and ECEN4503). | a; program criteria | Annual |
| Selected Final Exam Problems (embedded systems and software) | Selected final exam problems are collected in one senior computer engineering course (ECEN4213) | c, k | Annual |
| Senior Exit Survey | A detailed online survey is completed by all students in the final capstone design class; an informal group meeting between the ECE Head and graduating students occurs at the end of each semester. | All outcomes, esp. f, h, i, j | Semester |

| | | | |
|---|---|---|---|
| CATME Teamwork Peer Evaluation | This survey is administered online at the end of the final capstone design class to assess teaming ability and success | d | Semester |
| Ethics Evaluation | An online survey based on the IEEE Code of Ethics is administered at the end of the first capstone class, Design of Engineering Systems (ECEN4013) | f | Semester |
| Engineering Design Evaluation | Rubric based evaluation of the design, simulation, prototype process<br>1. Research and Simulation<br>2. Prototype and Demonstration | b, c, e, k | Semester |
| Capstone Project Evaluation | Rubric based evaluations address<br>1. Oral Communication<br>2. Written Communication<br>3. Design and Prototyping<br>4. Human Factors, Safety, etc. | a-e, g, k | Semester |
| OSU Alumni Survey | A telephone survey of recent graduate is administered every two years by the University asking 15 general questions and 15 discipline specific questions | d, h, i, j | Biennial |

**Selected Final Exam Problems (mathematics, science and engineering)**. Selected problems from the final exam in ECEN4503 (Random Variables) and ECEN3513 (Signal Analysis), both required of all students in both Electrical Engineering and Computer Engineering, are used to assess outcome "a" (ability to apply knowledge of mathematics, science and engineering) as well as the discipline specific outcome for Electrical Engineering and Computer Engineering of probability and statistics with applications appropriate for the discipline.

One or two mathematical problems that a typical student would be expected to be able to solve are selected by the instructor of the course and the individual scores are collected. The relative performance of each student is included in a histogram which is compared with past semesters. Data are currently collected approximately annually. This interval is being studied. Action is considered if the average score is less than 70%, if there is a significant drop in scores over two or more semesters, or if the distribution includes a larger than expected number of low scores.

**Selected Final Exam Problem (design a system, component or process; use techniques, skills, and modern engineering tools – software)**. A selected problem from the final exam in ECEN4213 (Embedded Computer Systems) required of all Computer Engineering students is used to assess the students' ability to solve a problem involving embedded systems and software.

One problem related to embedded systems and software that a typical student would be expected to be able to solve is selected by the instructor of the course and the individual scores are collected. The relative performance of each student is included in a histogram which is compared with past semesters. Data are currently collected annually.

Action is considered if the average score is less than 70%, if there is a significant drop in scores over two or more semesters, or if the distribution includes a larger than expected number of low scores.

**Senior Exit Survey**. A comprehensive and lengthy survey (more than 100 questions) is administered to each student in the final capstone design course, Capstone Design (ECEN4024), for the purpose of gathering students' self-assessment, attitudes, and opinions of a variety of issues related to their time at OSU. A majority of the respondents are in their final semester.

Included in the survey questions is a self-assessment of each student's perceived ability in, and importance of, a variety of areas including all student outcomes. A five-level Likert scale is used. Selected relevant questions are used for assessment. The responses in selected areas are compared from semester to semester to assess whether students feel their abilities are increasing or decreasing. In addition, this survey provides valuable input on curricular areas and issues in ECE and outside the School.

Our expectation is that the results of the Senior Exit Survey will be relatively consistent from semester to semester. When changes do occur, or if the results are consistently low, then additional evaluation and study may be needed.

For each question that is considered for assessment, a running average score is computed typically over four semesters. The average score and the trend are considered. If the average is consistently below 3.0, if there are abrupt changes, or if the trend becomes strongly negative then additional action is considered.

In addition to the formal Senior Exit Survey, the School Head meets informally with graduating seniors at the end of each semester. This group meeting is designed to gather additional information from the students about their experiences in the EE and CpE programs. The informal structure of this meeting allows the Head to probe areas of concern. At the end of each meeting, the Head sends the meeting minutes to the Assessment Coordinator for his/her review. Action is taken if identifiable trends are observed from semester-to-semester or if concerns align with other assessment data.

**CATME Teamwork Peer Evaluation Survey**. The CATME Peer Evaluation Survey is one of several tools developed as part of a research project called Comprehensive Assessment of Team-Member Effectiveness (http://info.catme.org/) which has seen been extensively tested. This survey is administered at the end of the semester in the final capstone course, Capstone Design (ECEN4024), for the purpose of assessing the teaming ability of students.

The nationally vetted CATME survey measures several dimensions of teamwork including contributions to team, interaction with team, keeping on track, expecting quality, and having KSAs. These individual measures are reported individually by CATME for each team member using a 1-5 Likert scale. In addition, the instrument provides evaluation of several "exceptional conditions" (over/under confident, high/low performer, conflict, manipulator, etc.) that may be useful in evaluating the students' performance.

The results of the CATME Peer Evaluation are compared from semester to semester at the conclusion of the Capstone Design class. Statistics are computed from the students' raw data. The survey results are also compared against the instructor's own professional evaluation of teaming performance to help identify possible areas of concern. A significant deviation of the CATME results over two or more semesters is cause for additional evaluation and possible action.

**Ethics Evaluation**. This short local survey asks students to make decisions on the relative importance of ethical and professional concepts from the IEEE code of Ethics (http://www.ieee.org/about/corporate/governance/p7-8.html). The survey is administered near the end of the first capstone class, Design of Engineering Systems (ECEN4013), at which time the students should have an understanding and appreciation for the importance of ethical and professional behavior as an engineer. Conclusions about a student's "understanding of professionalism and ethical responsibility," (ABET Outcome "f"), which they have learned from a variety of experiences, are drawn from the Ethics Evaluation.

Our expectation is that the average result on every question will be 4.0 or higher on a five point Likert scale. The results of the evaluation will be compared from semester to semester to identify trends that may be of concern. This evaluation was introduced in spring 2015 so there is very limited data. The departure of a faculty member in spring 2016 resulted in this evaluation not being administered in the previous academic year.

**Engineering Design Evaluation**. The first course in the capstone design sequence, Design of Engineering Systems (ECEN4013), requires students to work in teams and demonstrate design of a specified project. A rubric is applied to assess the students' ability to solve engineering problems, design, simulate and construct a system to meet particular needs, and interpret and analyze their results. The evaluation is performed by the instructor and trained teaching assistants. There are two specific activities selected for assessment.

> **Research and Verification.** Students are required to perform background research on possible approaches to solve their portion of a team-based term project using appropriate resources. They make value judgments on at least two alternative approaches and collect technical information such as data sheets, application notes, and schematics to support their decisions. Where possible, they perform simulation and verification using MultiSim and/or Altium to show that their circuit performs as it is supposed to as part of the team's overall project. The assessment consists of a rubric-based evaluation of the activity. Each student must achieve a score of at least 70% in order to proceed to the next stage of the project. For the purpose of assessment, a class average of not less than 80% is considered adequate.
>
> **Prototype and Demonstration.** Students are required to construct and demonstrate a working implementation of the circuit or block diagram they proposed and designed during the research phase of the project. The prototype demonstration should show that each of the blocks functions independently and for a given input produces the correct output. The assessment consists of a rubric based evaluation of the activity. Each student must achieve a score of at least 70% in order to proceed to the next stage of the project. For the purpose of assessment, a class average of not less than 80% is considered adequate.

**Capstone Project Evaluation**. The final course in the capstone design sequence, Capstone Design (ECEN4024), provides a challenging culminating team-based design experience. It is heavily assessed related to student outcomes as it brings together many aspects of a student's education into a single experience. This is a relatively unstructured course where the students are expected to demonstrate qualities and skills they will need as a practicing engineer. Each team works with a faculty Project Advisor for guidance.

The capstone design experience begins with a general open-ended problem statement for each team. The teams must analyze the problem to determine a path forward to produce a solution. Successful completion requires analysis of the problem and consideration of practical constraints, design, oral and written communication, prototyping and analysis, and demonstration of the result.

Rubrics are used for all evaluations, and the evaluations are conducted by the instructor of the course along with two to three faculty evaluators. Final scoring is determined by the instructor and faculty evaluators through a consensus process. The evaluations described below are conducted for all teams each semester. A class average of at least 80% is expected on each assessment.

> **Project Proposal.** After each team is formed and assigned a project for the semester, the team members analyze their problem to determine requirements and constraints, and then propose a design and process to create a solution to the problem. The team creates and presents a 20 minute presentation to the class (and instructor and faculty evaluators) on their proposed solution to the problem they have been assigned. A PowerPoint

presentation is created to support the presentation along with a Gantt chart and task breakdown. The presentation is evaluated by the instructor and several faculty evaluators. A rubric is used for the evaluation. A team member who does not achieve an individual score of at least 70% must repeat the assignment before proceeding.

**Prototype Demonstration.** Each team member designs and constructs a software and/or hardware prototype for their subsystems and demonstrates correct operation to the instructor and faculty evaluators. A rubric is used for evaluation. Failure of a prototype to function properly requires the student to repeat the demonstration the following week before continuing with the project. A team member who does not achieve an individual score of at least 70% must repeat the assignment before proceeding.

**Final Oral Presentation**. Each team creates and presents a 30 minute formal presentation on their final design and the results of their capstone project. All team members are required to participate approximately equally. The presentation is evaluated by the instructor and faculty evaluators. A rubric is used for the evaluation.

**Final Written Report**. Each team writes a formal final report and documentation on their capstone project. The reports are read by nominally three faculty members including the instructor, one faculty evaluator, and the team's faculty Project Advisor. A rubric is used for the evaluation.

**Final Project Demonstration**. During ECE Design Day (usually the Tuesday of pre-finals week each semester) all teams put their projects on public display and provide demonstrations of what they have accomplished. A poster suitable for communicating to the general public the objectives of the project is prepared and displayed along with the demonstration. The instructor and faculty evaluators view the demonstration and challenge the teams to defend the technical and practical aspects of the design, including human factors, safety, etc. A rubric is used for the evaluation.

**OSU Alumni Survey**. The University administers a telephone survey to recent alumni every other year. The target population consists of graduates from two years and six years in the past. This telephone survey contains 15 general questions asked of all students and 15 discipline specific questions provided by ECE. The information collected consists of both objective (numerical) responses and subjective long answers to open-ended questions. The answers to selected questions are used to provide assessment of several outcomes.

Outcomes and Assessment Mapped to ECEN Prefix Courses

Table 4.2 below lists required major courses that are taken by all students in Electrical Engineering and/or Computer Engineering. The table indicates the outcome mapping and the strength of coverage of each outcome in the particular required course. The strength of coverage is based on the description and notation given previously in Table 3.2.

Table 4.2 Outcomes Associated with Required ECEN Major Courses

| Course | Outcome | a | b | c | d | e | f | g | h | i | j | k |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENSC2613 | Introduction to Electrical Science | 3 | 3 | 1 | 1 | 2 | | | | | | 2 |
| ENSC3213 | Computer Based Systems | 3 | 3 | 2 | 2 | 2 | | 2 | | | 1 | 3 |
| ECEN2011 | Methods | 3 | 3 | 2 | | 1 | | 1 | 1 | | 1 | 3 |
| ECEN3233 | Digital Logic Design | 2 | 3 | 2 | 2 | 3 | 2 | 2 | | | | 3 |
| ECEN3314 | Electronic Devices | 3 | 3 | 3 | | 3 | 1 | 3 | 1 | 2 | 1 | 3 |
| ECEN3513 | Signal Analysis | 3 | 2 | 1 | | 2 | | 1 | | 1 | 1 | 2 |
| ECEN3714 | Network Analysis | 3 | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 3 |
| ECEN4013 | Design of Engineering Systems | 2 | 3 | 3 | 3 | 3 | 3 | 3 | | | | 3 |
| ECEN4024 | Capstone Design | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 3 |
| ECEN4213 | Embedded Computer Systems | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 3 |
| ECEN4243 | Computer Architecture | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | | 3 |
| ECEN4303 | Digital Electronic Circuit Design | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | | 3 |
| ECEN4503 | Random Signals and Noise | 3 | 2 | | | 2 | 1 | 1 | | | | 3 |

Table 4.3 below lists the outcome mapping for elective and other ECEN courses that are not necessarily taken by all ECE students. These courses are not part of the regular assessment for the purpose of accreditation since they are not taken by all students, but assessment may be performed as needed for program improvement. Although these courses are not taken by all students, they do provide support for the outcomes, as all students take some of these courses.

Table 4.3 Outcomes Associated with Elective and Other ECEN Courses

| Course | Outcome | a | b | c | d | e | f | g | h | i | j | k |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ECEN3113 | Energy, Environment and Economics | 2 | | 3 | 2 | 2 | 3 | 1 | 3 | 2 | 2 | 1 |
| ECEN3613 | Electromagnetic Fields | 3 | 3 | 1 | 2 | 3 | 1 | 3 | 1 | 1 | 1 | 3 |
| ECEN3723 | Systems I | 3 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 3 |
| ECEN3913 | Solid State Devices | 2 | 1 | 3 | | 2 | 1 | 1 | 2 | 2 | 2 | 2 |
| ECEN3623 | Math Found of EM and Photonics | 3 | 3 | 1 | 1 | 3 | 1 | 2 | | 1 | | 3 |
| ECEN4133 | Power Electronics | 3 | | 2 | 2 | 3 | 1 | 1 | | 2 | 3 | 2 |
| ECEN4153 | Power System Analysis and Design | 2 | | 1 | 1 | 3 | 1 | | 1 | 2 | 1 | 2 |
| ECEN4233 | High Speed Computer Arithmetic | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 3 |
| ECEN4413 | Automatic Control Systems | 3 | 2 | 3 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 3 |
| ECEN4523 | Communication Theory | 3 | 3 | 2 | 1 | 2 | 1 | 3 | 2 | 2 | 1 | 3 |
| ECEN4533 | Data Communication | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 3 |
| ECEN4613 | Microwave Engineering | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 3 |
| ECEN4743 | Biomedical Modeling and Systems | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 3 |
| ECEN4763 | Introduction to Digital Signal Processing | 3 | 2 | 2 | 1 | 2 | | 1 | | 1 | 1 | 3 |
| ECEN4773 | Real Time Signal Processing | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 3 |
| ECEN4823 | Design of Optical Systems | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 2 | 3 |

Summary and Evaluation of Assessment Data

Each assessment instrument was described in detail in the previous section and the process and outcome mapping were summarized in Table 4.1. The discussion here focuses on particular aspects of the actual administration of the instrument and the results.

**CATME Teamwork Peer Evaluation Survey – Outcome "d"**

Raw scores (contributions to team, interaction with team, keeping on track, expecting quality, and having KSAs) for each member of a team are reviewed and averaged. For assessment, the individual measures are combined into an average score for each student and the set of student scores is analyzed for several statistical measures that can be compared from semester to semester.

Table 4.4 presents the class average and the fraction of students scoring on average below 3.0 and at or above 4.0 on a five point Likert scale. Data is available for the past three semesters. The objective is to see at least 70% of the class having a score of 4.0 or above and a minimum number of students with a score less than 3.0.

The slightly lower than desired scores during spring 2015 are attributed to having two relatively weak teams (out of 7) that had some particular problems. Results from the most recent academic year are fully satisfactory.

No action is needed at this time.

Table 4.4 Results of the CATME Evaluation for the Past Three Semesters

| CATME | F13 | S14 | F14 | S15 | F15 | S16 |
|---|---|---|---|---|---|---|
| **Average** | | 4.2 | 4.3 | 4.1 | 4.3 | 4.4 |
| **Below 3.0** | | 6% | 3% | 11% | 9.1% | 4% |
| **At or Above 4.0** | | 83% | 84% | 67% | 81% | 84% |
| **Standard Dev** | | 0.7 | 0.4 | 0.6 | 0.7 | 0.6 |

**Ethics Evaluation – Outcome "f"**

For this ethics evaluation students state their degree of agreement or disagreement with ten statements covering several dimensions of the IEEE Code of Ethics. Results are reported in Table 4.5 on a five point Likert scale with 5.0 indicating strongest agreement.

An average score for all ten questions is reported, along with the results for questions relating to safety, honesty, lifelong learning, and service that have been selected to form four dimensions.

The objective is to see all raw responses in agreement or strong agreement (not reported here), and at the least an average score and individual dimension scores of not less than 4.0/5.0. As noted above, the departure of a faculty member resulted in the ethic evaluation not being administered in the current academic year. It will be administered during fall 2016.

No action is needed at this time.

Table 4.5 Results of the Ethics Evaluation (begun in spring 2015)

| Ethics Evaluation | F13 | S14 | F14 | S15 | F15 | S15 |
|---|---|---|---|---|---|---|
| Average | | | | 4.5 | | |
| Safety | | | | 4.8 | | |
| Honesty | | | | 4.4 | | |
| Lifelong Learning | | | | 4.4 | | |
| Service | | | | 4.7 | | |

**Selected Final Exam Problems – Outcome "a"**

Final exam problems in two theory courses having high mathematical content are sampled to assess the application of advanced mathematics, and principles of science and engineering.

An overall score of 70% or greater is considered adequate for outcome "a" and the Electrical Engineering and Computer Engineering program criteria for probability and statistics, and advanced mathematics.

Table 4.6a Average Percentage Score on Selected Final Exam Problems

| Final Exam Problems | S14 | F14 | S15 | F15 | S16 |
|---|---|---|---|---|---|
| ECEN4503 (2 problems) | 72.5% | | 71.6% | TBD | |
| ECEN3513 (1 problem) | (not collected) | | 66% | 67 | |
| ECEN3233 (1 problem) | | | To Be Added | | |

The scores are near the bottom of the anticipated minimum selected as the threshold (70%). As there are limited data (collection of exam problem data began in spring 2014 for ECEN4503 and spring 2015 for ECEN3513) future data will be collected and monitored.

The results will continue to be monitored, with no action at this time.

**Selected Final Exam Problem (design a system, component or process; use techniques, skills, and modern engineering tools – software) – Outcomes "c, k"**

A selected problem from the final exam in ECEN4213 (Embedded Computer Systems) required of all Computer Engineering students is used to assess the students' ability to solve a problem involving embedded systems and software. The problem requires an understanding of what is needed, a method of solution, and a software program to implement the desired solution.

Table 4.6b Average Percentage Score on Selected Final Exam Problem

| Final Exam Problems | S14 | F14 | S15 | F15 | S16 |
|---|---|---|---|---|---|
| ECEN4213 | | 82% | | TBD | |

This computer engineering specific assessment was first performed in fall 2014. The scores are well above the assumed minimum level of performance. The significance and usefulness of this assessment will be considered going forward.

No action is required.

**Engineering Design Evaluation – Outcomes "b, c, e, k"**

Table 4.7 gives the results for the two assessments being performed in Design of Engineering Systems (ECEN4013) each semester.

Table 4.7 Engineering Design Evaluation of Research and Verification and Prototype and Demonstration Activities

| Engineering Design Evaluation | S13 | F13 | S14 | F14 | S15 | F15 | S16 |
|---|---|---|---|---|---|---|---|
| Research and Verification | 84% | 90% | 93% | 85% | 86% | 91% | |
| Prototype and Demonstration | 79% | 85% | 94% | 77% | 86% | 91% | |

The objective is for the class average to be not less than 80% for both activities. The research activity tends to be somewhat easier for most students and the scores are consistently high. Prototyping is almost always more challenging since students are less familiar with this task.

Performance in the current academic year satisfies the criterion. Data are not available for the spring 2016 semester due to the departure of a faculty member.

No action is taken at this time.

**Capstone Project Evaluation – Outcomes "a-e, g, k"**

The class averages for the five specific dimensions assessed in the Capstone Design course (ECEN4024) are summarized in Table 4.8 for the past five semesters.

Table 4.8 Summary of Data for Capstone Project Evaluation for Five Activities

| Capstone Project | F13 | S14 | F14 | S15 | F15 | S16 |
|---|---|---|---|---|---|---|
| Project Proposal | | 88% | 92% | 90% | 90% | 88% |
| Prototype Demo | | 93% | 92% | 90% | 85% | 92% |
| Oral Presentation | | 90% | 89% | 78% | 92% | 95% |
| Written Report | | 85% | 91% | 80% | 91% | 95% |
| Project Demo | | 85% | 89% | 82% | 91% | 96% |

The desired performance criteria are as follows.

**Project Proposal.** A class average of at least 80% is expected (each student must receive a score of at least 70% in order to proceed).

**Prototype Demonstration**. A class average of at least 80% is expected (each student must receive a score of at least 70% in order to proceed).

**Final Oral Presentation.** A class average of at least 80% is expected.

**Final Written Report.** A class average of at least 80% is expected.

**Final Project Demonstration.** A class average of at least 80% is expected.

The results from these assessments are all acceptable and easily meet the specified criteria.

No immediate action will be taken other than to monitor performance in the coming few semesters.

**Senior Exit Survey – Outcomes "all outcomes, but particularly f, h, i, j"**

The senior exit survey provides qualitative evidence for achievement of certain outcomes, but is often redundant with more objective sources. Some selected interesting information from the most recent two senior exit surveys (current academic year) are presented below – there is much more data that is not reported here. Responses are on a five point Likert scale. The outcomes addressed by each question are listed. Where no outcome is listed the question addresses an opinion expressed by the students related to the general program or other issue of interest which may apply to another accreditation criterion.

1. **Your desire to continue your education with graduate work or other professional development**. Students report their interest in this area as a **3.3** which represents a small increase from the past several years (**2.9**) There seems to be only moderate interest in continuing their education. (lifelong learning, "i")

2. **Your understanding of engineering ethics**. **4.0**. Students indicate a relatively strong awareness of ethics and professional behavior. This represents a small increase since the previous evaluation. (ethics, "f")

3. **Importance of engaging in professional activities such as IEEE, honor societies, or community outreach projects (service)**. **3.0**. Our graduating seniors do not highly value service activities, but according to previous results from the Alumni Survey they do become more involved after graduating and beginning work. (broad education, lifelong learning, contemporary issues, "h, i, j")

4. **The importance of knowing topics in Computer Science to being an Electrical Engineer or Computer Engineer**. **4.1**. Students report that topics in computer science are very important to their career.

5. **The quality of instruction provided by faculty in Computer Science at OSU**. **2.8**. Although students express that topics in computer science are important, the perceived quality of instruction by Computer Science faculty at OSU is consistently very low. A significant number of CpE and EE students rate instruction by Computer Science faculty as "poor" or "unacceptable", lower than any other area of instructional area in the program. Actions were taken in the Computer Science Department in fall 2015 to assign better instructors to computer science courses with ECE student enrollments. These courses are being assessed to determine if improvement has occurred.

6. **The quality of instruction provided by faculty in ECE at OSU**. **3.9**. A majority of ECE students consistently rate ECE faculty members as "good" or "excellent". This result is relatively stable over a number of academic years.

7. **Your overall preparation to be an Electrical Engineer or Computer Engineer**. **4.0**. At graduation ECE students strongly believe their preparation is very good.

8. **Your overall preparation to develop professionally as an engineer**. **4.2**. Graduates are confident in their ability for future professional development. This represents a small increase from previous academic years. (lifelong learning, "i")

9. **Your overall preparation to contribute to society and your profession**. **4.2** Graduates are confident in their ability to make a difference. This represents a small increase from previous academic years. (professional and ethics, broad education, contemporary issues, "f, h, j")

The results of the Senior Exit Survey tend to be relatively stable with time, probably because the survey is administered only once to a student at the end of his/her career at OSU. As a result, the responses probably represent a smooth average measure rather than a "snapshot" at a particular point in time. For this reason we also look at trends that may be represented over time by doing a best line fit through the results of each question over approximately two years and noting the slope (not reported here). There are no areas currently where the slope is either extraordinarily positive or negative.

**Alumni Survey – Outcomes "d, h, i, j"**

The alumni survey is administered by the University every other year to recent graduates from ECE. Many of the questions are open ended. The most recent alumni survey was administered in 2014 and the results were reported last year. Another survey will be administered this year (2016) and reported in 2017.

Summary of Continuous Improvement

The section above describes the new assessment and evaluation processes that have been put in place beginning in 2013 and which are continuing to evolve. As a result data reflect at most three years of assessment. Direct methods have been used where possible, but indirect methods are used as well particularly for outcomes "h, i, and j".

Evaluation of assessment data over the period continues to suggest considerable strength meeting outcomes "a-g, i, and k". These also happen to be outcomes that can be directly measured or observed with relative ease. Outcomes "h, and j" are more difficult to assess due to the need for indirect measurement, but there is still good supporting evidence as indicated by the Senior Exit Survey and OSU Alumni Survey.

There are currently no areas of particular concern, although we will continue to monitor and adjust several assessment methods.

Assessment and Evaluation thus provide reasonable confidence that student outcomes are being met with relative strength. During the coming year additional evaluation of the processes will continue and changes may be made if deemed necessary.

## E. Summary of Assessment Results

**Describe the overall results of the program assessment and program faculty members' interpretation of the assessment results.**

*What did the assessment reveal? What do faculty interpret the results to mean? What do the results suggest about the curriculum, teaching practices, and/or student achievement of the program learning outcomes?*

Overall results suggest students in the BS Degree Programs in Electrical Engineering and Computer Engineering are meeting our expectations for Student Outcomes. The only area of concern involves a significant and strong lack of satisfaction among students in instruction provided in Computer Science courses, which are taught outside the School of Electrical and Computer Engineering. Action has been initiated to resolve this situation.

## F. Dissemination of Results

**Describe the individual(s) or committee (e.g., a curriculum committee) responsible for reviewing and interpreting assessment data.**

Assessment data for the undergraduate programs is collected, reviewed, and acted upon by the ECE Undergraduate Program and Assessment Committee, which is responsible for oversight of the BS degree programs in the School of Electrical and Computer Engineering. When action is deemed necessary, this committee generates an appropriate recommendation to the School Head who, in consultation with the faculty, is responsible for further evaluation and possible action.

**Describe the process for sharing and discussing assessment results with program faculty.**

Assessment information is shared with the faculty at least annually as part of regular faculty meetings.

## G. Program Improvements Based on Assessment

**Based on the findings of this assessment, what changes are being considered or planned for the program?**

*Describe the actions that will be taken as a result of the discussion of the assessment evidence.*

The issue of lack of student satisfaction with instruction in Computer Science courses has been raised to the Dean of the College of Engineering, Architecture and Technology (CEAT) for remediation. Actions have been initiated and assessment and evaluation will continue in order to monitor future trends.

**Based on the findings of this assessment, what (if any) changes are planned for the assessment process?**
*For example, are there additional assessment data that may need to be collected? Are changes to the program assessment plan warranted?*

The assessment process has been simplified and streamlined over the past three years. The process itself is under continuous evaluation to ensure that it provides appropriate assessment while being sustainable. Initial results with the new process are positive.

**Describe the process for implementing these changes/planned program improvements.**

College administrators in CEAT and A&S have discussed student satisfaction in Computer Science courses. New instructors for these courses have been identified. Communication between the department heads has been strengthened. Further assessment is now needed to determine if the problem has been resolved.

## H. Assessment Tools

**Please provide a copy of any assessment tools** (questionnaire, scale, interview questions, etc.) **here.**

We apply a comprehensive set of assessment instruments and rubrics in several courses. Some of these are implemented electronically and are not easily distributed in a report. All instruments can be provided upon request.