ABET
Self-Study Report

for the

Electrical and Computer Engineering program

at

Western Washington University

Bellingham, Washington

June 22, 2022

CONFIDENTIAL

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Program Self-Study Report
for
EAC of ABET
Accreditation or Reaccreditation

BACKGROUND INFORMATION

A. Contact Information

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B. Program History

The Electrical and Computer Engineering program began in fall 2014 and had its first graduates in spring 2016. The initial and most recent general review of the program was conducted during the 2016-17 academic year, with the site visit occurring in October 2016. The program evolved out of an ETAC-ABET accredited Engineering Technology program (ET). The ET version of the program was first TAC-ABET accredited in 1989 and was terminated at the end of summer 2016.

Major program changes since the last review are:

- The program changed its name from "Electrical Engineering" to "Electrical and Computer Engineering" to more accurately reflect the curriculum being offered, and all students receive an "Electrical and Computer Engineering" degree. ABET was informed of this name change in November 2019.
- The program grew significantly in size, both in terms of students and faculty. Since the last review, the program added 5 T/TT faculty (including 2 starting in fall 2022), and the number of students admitted to the program each year doubled from 24 to 48 students per year.
- The program developed and offered three new experimental elective courses in wireless networking (EECE 397A), machine learning (EECE 397B), and artificial intelligence and

reinforcement learning (EECE 397C). As part of a significant revision of our “core curriculum” structure due to be implemented starting in fall 2022, these new courses will be part of a new concentration in Machine Learning and AI that will be available to students starting in fall 2022.

- With commitments from both the state and private donors, the university is in the final stages of designing a new, $72 million state-of-the-art building, expected to be completed in 2024, which will house Electrical and Computer Engineering, Computer Science, and the Institute for Energy Studies. The new building will advance the program's commitment to student-centered learning and will provide research and development space for faculty and student projects. One of the forward-looking goals of the Electrical and Computer Engineering program is the development of a graduate program, which the new building is being designed to accommodate. Significant effort has been devoted to providing input to the design of this new facility to ensure that it will meet these goals.

C. Options

The Electrical and Computer Engineering program has two concentrations: Energy and Electronics. Both concentrations include a common electrical and computer engineering core.

Energy courses include a combination of advanced electrical and computer engineering courses and interdisciplinary courses in the sciences, economics, policy, and the environment. Topics include generation, control, and distribution of electricity, energy conversion and storage, and smart grid topics such as system analysis, protection and stability, electrical machines, power electronics, industrial process control systems, and embedded microcontrollers. Projects are normally interdisciplinary, in collaboration with faculty in the Institute for Energy Studies.

Electronics courses involve the development, design, and application of circuits, devices, and firmware for embedded systems. Content includes digital and analog electronics, embedded microcontrollers, communications, controls, and digital signal processing.

D. Program Delivery Modes

Up until winter quarter 2020, all classes and laboratories were only offered in face-to-face format on weekdays. One course, the summer offering of EECE 111, is offered remotely.
Due to the COVID-19 pandemic, the end of winter quarter 2020 and all of spring quarter 2020 were offered remotely, including laboratories, primarily asynchronously. During the 2020-21 academic year, lectures were offered remotely, primarily synchronously, but 50-60% of laboratories were offered in a face-to-face format on campus, with the remainder occurring remotely. For the 2021-22 academic year, all laboratories and all classes returned to a face-to-face format on campus, with the exception of the summer offering of EECE 111 which is the only remote course offered by the program.

E. Program Locations

The Electrical and Computer Engineering program is offered at Western Washington University’s Main Campus, located at 516 High St., Bellingham, WA. The majority of classes taught by the Engineering and Design department are conducted in the Ross Engineering Technology building. All supporting courses are also offered on the Main Campus in Bellingham.

F. Public Disclosure

Program Education Objectives (PEOs), Student Outcomes (SOs), annual student enrollment, and graduation data specific to the program are posted at: https://engineeringdesign.wwu.edu/assessment-and-accreditation.

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

There were no Deficiencies, Weaknesses, or Concerns from the most recent ABET Final Statement.

GENERAL CRITERIA

CRITERION 1. STUDENTS

A. Student Admissions

Admission to the Electrical and Computer Engineering (EECE) major is a two-phase process. After acceptance to WWU, students first declare as an EECE Pre-major when they begin courses at WWU. Pre-majors must complete the set of foundational courses in math, physics, computer programming, and engineering principles listed below in order to apply to the full major. Pre-majors who have sufficient math preparation to register for calculus in their first quarter typically complete the foundational courses in 3 quarters. Some of the foundational courses may be taken at a community college or other institutions. Information about the acceptance of transfer courses is in Section 1.C. Upper-division courses, which begin in year 2, are restricted to students who have been accepted to the full major.

Required coursework:

- EECE 108 and 109 - Intro to Electrical and Computer Engineering[1]
- EECE 111 - Circuit Analysis I
- CSCI 140 or 141 - Programming Fundamentals in C++ or Python
- MATH 124 - Calculus I
- MATH 125 - Calculus II
- MATH 204 - Linear Algebra
- PHYS 161 - Physics w/ Calculus I
- PHYS 162 - Physics w/ Calculus II

Additional coursework - not required to apply:

- PHYS 163 - Physics w/ Calculus III
- MATH 224 - Multivariable Calculus
- MATH 331 - Differential Equations
- MATH 345 - Engineering Statistics
- CHEM 161 - General Chemistry I

Grades in these courses are reviewed if completed at the time of application.

The Electrical and Computer Engineering program only accepts applications at the end of spring quarter and the beginning of fall quarter. Students accepted into the major begin taking major courses in the fall.

Admission to full major status is determined by academic performance as a pre-major as well as other factors including an application questionnaire about the applicant's experience, motivation, and goals. Admission to the major is competitive. Neither completion of the prerequisites nor

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[1] For transfer students, EECE 108 and 109 courses may be waived as a required courses for admissions, but EECE 108 must be taken during the first Winter quarter at WWU.

attainment of any specific GPA guarantees admission. Information about EECE admissions is also available on the EECE Admissions web page.

Students must obtain a C- or above in the required courses listed above, and an overall GPA of 2.0 or higher to be considered. AP scores are converted to GPA as follows: 5 = A; 4 = B; 3 = C. Decisions are based primarily on cumulative GPA in the prerequisite courses, however the questionnaire, successful completion of other required major courses, GPA in the major, and overall GPA are also considerations. The required pre-major coursework is the same for both the Energy and the Electronics Concentrations.

Applications are reviewed by all tenured and tenure-track EECE faculty members, and selections are made based on the above criteria. Students are notified of acceptance via email and are required to complete the major declaration process. Forty-eight students are typically accepted into the major each year.

B. Evaluating Student Performance

Student performance in all courses is evaluated and graded on an A through F scale or as Satisfactory/Unsatisfactory (S/U) or Pass/No Pass (P/NP). Under normal circumstances, all courses that are required for the EECE program are graded on the A through F scale, and a student must receive a grade of C- or better to receive credit for having completed that course requirement for the major. A student who earns a grade lower than C- in a course required for the major must repeat that course unless he or she is granted an exception request. The exception request process is described later in this section, after the discussion of pre-requisite enforcement. Due to the COVID-19 pandemic, from spring quarter 2020 through spring quarter 2021, students were allowed to take any course Pass/No Pass. The Pass level was set at D+ by the University. If a student elected to take a class Pass/No Pass due to the pandemic, a course successfully completed shows up as an EP (Exceptional circumstances Pass) on the student's transcript. EP grades were accepted as meeting program requirements for graduation.

Monitoring of student progress is done at all levels of a student's education but is done differently for pre-majors than it is for majors. Pre-majors' progress is monitored by the Department Program Coordinator & Pre-major Advisor. All students are contacted and encouraged to seek advising each quarter before registration but advising is not mandatory. However, if a student is struggling academically, an extra effort is made to prompt the student to seek advising. WWU has multiple advising tools, including Navigate, which provides an academic tracking tool that flags a student who is having academic problems so that the Program Coordinator is aware of them quickly and can reach out to the student, and Degree Works, which maintains a record of students' progress towards their declared majors.

Once a student has been accepted to the EECE major, academic advising is conducted by EECE faculty members. All newly accepted students are assigned a program faculty member who advises them throughout their time in the program. Students have a minimum of three required meetings with their advisors, typically held in the fall of each year. The first required meeting occurs at the time of acceptance to the major, the second required meeting occurs in the fall of the junior year, and the third required meeting is conducted two quarters before students are due to graduate, so it usually occurs during the fall quarter of students' senior year. At this latter meeting, the faculty advisors review and approve students' plans to complete program requirements and graduate. Beyond these required annual advising meetings, students are encouraged to seek advising quarterly to ensure their progress toward the degree, and many do, but since all students take classes from all program faculty members over the course of their degree, much advising is informal and takes place on an ad hoc rather than planned schedule.

The EECE program has a strong prerequisite structure. If a student does not pass a prerequisite course with a C- or better, the registration system does not allow that student to register for the next course. However, if the student is taking a pre-requisite course at the time of registration, that student is allowed to register for the next course, and then the Engineering & Design (ENGD) Department office staff must confirm that the student received an appropriate grade of C- or better in the pre-requisite class. Every quarter after grades have been submitted, the ENGD office staff runs grade reports and identifies any and all students who did not attain a grade of C- or better in a pre-requisite course. The ENGD Program Coordinator then sends notices to those students who have not met prerequisites, notifying them that they must drop the course that requires the pre-requisite that was not successfully met and seek advisement. If the student does not drop the class voluntarily the Program Coordinator contacts the faculty member teaching the course so that she or he knows to make the student drop on the first day the class meets. The only reason that a student would be allowed to stay in a class without the appropriate pre-requisites being completed with a grade of C- or better is if he or she has an exception request approved to take the courses out of order or concurrently.

Students who believe that they have a legitimate reason for being allowed to stay in a class without having passed the pre-requisite course(s) with a C- or better must file an exception request. The student must submit the request for the exception and the reason for the exception in writing using the ENGD Department exception request form, which is available on the Department's Policies, Procedures, and Student Forms web page. For a EECE student or EECE pre-major, the EECE program faculty then review the student's request and submit a recommendation for or against the exception in writing to the ENGD Curriculum Committee. The Curriculum Committee then discusses the merits and drawbacks of the student's request and makes a decision for or against the exception. The ENGD Department Chair then informs the student of the decision. Records of all exception requests are maintained in the ENGD Department office and entered into students' University records in Degree Works.

The progress of students in the major is discussed during program meetings. If a student is identified as potentially failing a course or courses, then someone, usually the student's advisor, reaches out to talk with the student about the situation and possibly develop a new plan for the student to graduate in a timely manner. If a student does fall into academic difficulties, the University has an Insufficient Progress Policy. If a student fails one or more courses, withdraws from multiple courses during the same academic term, or gets a term GPA below 2.0, that student is notified that they are in potential violation of the Insufficient Progress Policy. If a student violates the Insufficient Progress Policy again, such as by failing a course for a second time, the program faculty discuss the student's academic progress and any circumstances that may have led to the student's academic difficulties. If there is not an assignable cause, such as illness or injury, then the student is removed from the major.

C. Transfer Students and Transfer Courses

Transfer students are accepted to WWU according to WWU admission policies. If a student has been admitted to WWU and is interested in the EECE program, that student applies for the program following the procedure described above. A transfer student may only be accepted into the EECE major by successfully completing, with a grade of C- or better, the same or equivalent courses to all of the courses a native student must complete before applying to the EECE program.

The process for the validation and acceptance of credits from other institutions is handled in one of two ways. Institutions in the state of Washington have developed a thorough list of standard course transfers, including universal course numbers for certain classes, while courses that are not on that list and course transfers from out-of-state universities and community colleges are all reviewed before being accepted.

If a class at another Washington university or community college uses a common course number, then that course gets entered into the WWU system as a course that can be transferred to WWU. Transferred courses without a direct equivalent course at WWU are listed on a student's transfer report as a 1TT or 2TT equivalent, meaning that the course is at the 100 or 200 level (as indicated by the first number) and the credits count at WWU, but not towards the major without Department approval. In this case students must provide a course syllabus and possibly additional course material for EECE program review. Once a transfer course from a specific Washington university or community college has been reviewed, generally through direct communication with the faculty at that Washington university or community college, the course is entered into the WWU system as an exact transfer, and that course shows up on a student's transfer report as an equivalent of the WWU class without further action on the part of the EECE program. Once a course is in the WWU system as an equivalent transfer course, the course will transfer smoothly for all students who have that course from that institution.

WWU Admissions will only change a course from another Washington university or community college to being equivalent to a WWU course at the direction of the department that owns that area, so only the Engineering and Design Department can designate transfer of engineering courses as true equivalents. A department may, however, elect to accept a course from another area as an equivalent transfer as well as courses in its own area. This is often done for Math classes, primarily differential equations classes, that were deemed not sufficient for Math majors, but can be verified as sufficient for engineering majors. Students and faculty members from any institution can review course equivalencies on the WWU Admissions website.

Courses from out-of-state universities and community colleges must be evaluated on a case-by-case basis by the EECE program, which is generally done by the EECE Program Director for major courses or the Department Chair for pre-major courses, unless they need the input of other members of the ENGD or EECE faculty. Review of a course from an out-of-state university or community college starts with review of the course syllabus. If the syllabus is sufficiently detailed, no other information is required, but if it is not then the student is required to provide more information from the course, which might include assignments and labs. Once a course has been accepted as a transfer course for a student, it is indicated in the student's file in Degree Works.

In addition to accepting transfer courses, WWU grants credit for certain AP, IB, and Cambridge International Examinations. WWU generally grants credit for College Board Advanced Placement (AP) exams completed with a score of three (3) or higher, according to the posted equivalency chart. Credits are granted upon receipt of official scores (AP Transcript) from the College Board. WWU grants up to 15 credits for each approved standard level and higher-level International Baccalaureate (IB) subject examination passed. WWU generally grants 15 credits for approved A-level Cambridge International examinations and 7.5 credits for approved AS-level examinations with passing grades of A-E, subject to the 45 credit maximum. Approved exams will be given a Satisfactory, "S", grade. Credit will not be granted for both an A-level and an AS-level exam in the same subject area. Some exams may also apply to GURs. Students may receive credit for Math, Computer Science, and Science classes in these manners, but there are no approved equivalencies for required engineering courses.

D. Advising and Career Guidance

As mentioned in Section 1.B, students are advised by the EECE program faculty, the Department's Program Coordinator & Pre-major Advisor, and possibly the University's Academic Advising Center at different stages of their academic career, and students get career guidance from the EECE program faculty and through the University's Career Services Center.

Students who have an interest in the EECE major can get advising from the Department's Program Coordinator & Pre-major Advisor and the University's Academic Advising Center. Once students declare their pre-major the Department's Program Coordinator & Pre-major Advisor serves as the students' advisor until they are accepted into the EECE program. As mentioned in Section 1.B, advising is not mandatory, but the Department's Program Coordinator contacts all pre-majors each quarter to encourage them to get advising and also tracks their progress toward the major using the Navigate software. If a student is struggling in required classes, an extra effort is made to get that student to come in for advising. Once students have been accepted into the EECE major, they are assigned a faculty member as their primary academic advisor. Students who are struggling in their classes are advised more frequently and provided additional advising guidance. Students are encouraged to seek advising each quarter prior to registration but advising is not mandatory.

The primary advising tool is the EECE Program Planning Guide as shown in Appendix F. All of the fundamental advising information is also available on the EECE Advising web page.

Career Guidance starts in the course EECE 108 - Introduction to Electrical and Computer Engineering and continues throughout the program. Career guidance is accomplished through advising by program faculty, student club organized company tours and guest speakers, and the University's Career Services Center. The College of Science and Engineering, often in collaboration with student clubs, periodically holds student workshops devoted to STEM internships, permanent jobs, and applying to graduate school, and the EECE program is proactive about announcing these workshops to students. Additional resume and career guidance is given in the first courses in the capstone series, EECE 471 and EECE 491.

Career advising through Western's Career Services Center includes career counseling, job search guidance, workshops to help prepare students and alumni, on-campus recruiting opportunities, and special events such as career, internship, and graduate school fairs. They also maintain an on-line job database called Viking Career Link.

E. Work in Lieu of Courses

The EECE program does not allow majors to substitute work experiences, acquired either before being admitted, or while completing their program, for academic credit. The process for awarding AP, IB, and Cambridge International Examination credit is outlined in Section 1.C.

F. Graduation Requirements

The degree awarded is a Bachelor of Science in Electrical and Computer Engineering.

The graduation requirements for the program are documented in the Western Catalog. The program Degree Works is used to both document the requirements and track students' progress towards meeting those requirements. Students can access their own file on Degree Works and department advisors can access any students' file on Degree Works. In addition, the program advisors maintain a degree planning sheet for each advisee. An example of the 2021-22 degree planning sheet for the EECE program is shown in Appendix F.

The degree evaluation is completed in four steps: 1) students fill out a graduation application at least two quarters prior to graduation and set up a meeting with their faculty advisor to complete a graduation assessment. The students' plan indicates the courses they plan on taking during their remaining quarters. 2) A faculty advisor completes the degree evaluation using Degree Works. The program advisor confirms that all transfer classes and any exceptions that were granted are properly entered into Degree Works. The faculty advisor then adds a note that lists the students' remaining courses, including the plan to complete any outstanding technical elective requirements, and verifies that with the completion of these courses students meet all graduation requirements. 3) The Department Chair verifies that the student and advisor's plan satisfies the program requirements and adds a note to Degree Works verifying that the student will have met graduation requirements with the completion of the listed courses. 4) The Registrar's office credit evaluators verify that the students have met all University requirements for graduation.

A student cannot graduate without meeting the program requirements unless they appeal to the departmental exceptions committee as was outlined in Section 1.B.

G. Transcripts of Recent Graduates

The EECE program will provide transcripts from some of the most recent graduates to the visiting team along with copies of the same students' files from Degree Works, along with any needed explanation of how the transcripts are to be interpreted.

The program concentrations are designated on the official transcript as:

- Major/Field: Electrical & Computer Engineering
  Maj/Concentration: Electronics

- Major/Field: Electrical & Computer Engineering
  Maj/Concentration: Energy

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

Western Washington University Mission and Values:

Western Washington University is a public comprehensive institution dedicated to serving the people of the state of Washington. Together our students, staff, and faculty are committed to making a positive impact in the state and the world with a shared focus on academic excellence and inclusive achievement.

As a community, we uphold certain basic values. These include:

- Commitment to student success, critical thought, creativity, and sustainability
- Commitment to equity and justice, and respect for the rights and dignity of others
- Pursuit of excellence, in an environment characterized by principles of shared governance, academic freedom and effective engagement
- Integrity, responsibility and accountability in all our work

Engineering & Design Department Mission:

The Engineering & Design department at Western Washington University serves current students, industry, the University, and the citizens of Washington State by developing industry-ready graduates through a combination of creative problem-solving, analytical skills development, and experiential learning. The educational experience that we provide emphasizes critical thinking and an understanding of the impact of design, engineering, and manufacturing solutions in a global, economic, environmental, and societal context. We value and foster teamwork, communication, and a commitment to equity, justice, and the respect for the rights and dignity of others.

B. Program Educational Objectives

The objective of the Electrical and Computer Engineering Program is to prepare graduates who will be successful in their chosen career paths. Specifically, within five years of graduation, graduates of this program will be able to:

1. Strengthen the teams and communities they are part of by demonstrating leadership, effective communication, and cultivating a collaborative and inclusive environment.
2. Recognize and determine the ethical implications and societal impacts of engineering solutions.
3. Create value for society through innovation and design that transforms needs and opportunities into systems, products, and solutions.

4. Adaptively and independently extend their learning to excel in fields about which they are passionate.

The Electrical and Computer Engineering Program PEOs are available to the public on the Engineering & Design Department website.

C. Consistency of the Program Educational Objectives with the Mission of the Institution

All the Electrical and Computer Engineering Program Educational Objectives are “student-centered” and about developing the potential of the students in the program so that they will be strong contributors in their careers and communities after graduation. These are consistent with the “serves the people of the State of Washington” and “making a positive impact in the state and the world” portions of the University mission. Furthermore, a focus on “academic excellence and inclusive achievement” is a key component of preparing students for long-term success.

D. Program Constituencies

Program constituencies are:

1. *Students* – Who rely on the program to prepare them to become successful learners and to have success in their chosen career and/or continued studies.
2. *Employers* – Who depend on the value of our graduates as employees to achieve company goals.
3. *Alumni* – Who are forever tied to the program and its reputation through the success of its graduates.
4. *Faculty* – Who are committed to developing the appropriate outcomes and curriculum that leads to students achieving the educational objectives and who, themselves, rely on the success of the program to achieve their career goals.

E. Process for Review of the Program Educational Objectives

The Program Educational Objectives are reviewed, at least, every five years. Responsibility for the review and documentation is with the ECEE program director and final approval is with the ECEE program faculty.

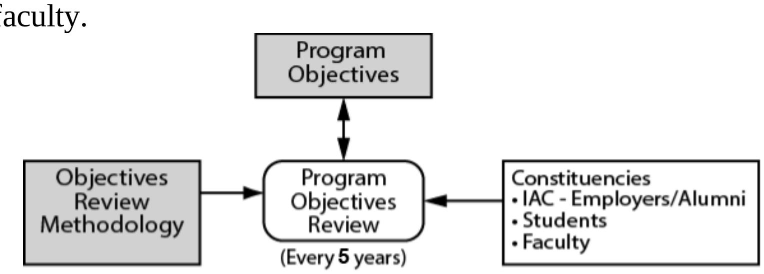


Figure 2.E.1 PEO Review Process

Review of PEOs is handled through surveys and meetings with the constituents.

Students – Students meet to discuss the program objectives at least once every five years as part of the senior project course. Survey forms are used to provide feedback from the student's perspective. This data is made available in the display materials.

Employers – The ECEE program's Industrial Advisory Committee, IAC, is shown in Figure 2.E.2. It is made up of the primary employers of the program's graduates. The IAC reviews the PEOs at least every five years during an IAC meeting. Meeting minutes include feedback from the IAC and these minutes are available in the display materials at the time of the visit.

Alumni – The IAC consists primarily of alumni so feedback from IAC members also represents the Alumni.

Faculty – Faculty review the PEOs at least every five years during the program evaluation meeting in the spring. During this review, the faculty also review the latest WWU institutional mission statement and the latest ABET criteria to make sure that the PEOs are consistent. Additional discussion may occur any time an issue with the PEOs is raised, for example a change in ABET definition of PEOs. This would trigger an improvement with the PEOs and subsequent review by the IAC outside the five-year cycle.

Any changes to the PEOs will potentially result in a modification of the student outcome to PEO mapping.

A major revision of the Program Educational Outcomes was conducted by the faculty in Spring 2018, which resulted in the PEOs listed above. These were ratified by the IAC in June 2018, at which point feedback from alumni and employers was collected. Subsequently, the Class of 2021 EECE students were surveyed in May 2021 and invited to provide feedback on the PEOs. After a review of all feedback, the PEOs were left as is, though "Computer Engineering" was added to reflect the new degree name.

Member	**Company**	**Position**	**Alumni**
Tom Newberry	EnerSys	VP Broadband Engineering	N
Brian Booker	Infineon	Senior Applications Engineering Director for ppSoc MCUs	N
Sarah Caudill	Port of Seattle	Design Engineer III	Y
Tim Jackson	Boeing	Engineer – LDS/CMC	Y
Mike Jamieson	Fluke Corp.	Engineering Manager - Everett Operations Engineering and the New Product Group	Y
Tyler Marshall	Stryker Medical	Staff Electrical Engineer	Y
Patrick Prendergast	Deako	Manufacturing Manager	Y
Chris Rudell	Univ. of Washington	Associate Professor	N

Kevin Schneider	Pacific Northwest National Laboratory	Principal Research Engineer	N
Chuck Swart	PACCAR Technical Center	Advanced Vehicle Development Manager	N
Trevor Wilcox	Readybit Labs	Principal Engineer	Y

Figure 2.E.2 Industrial Advisory Committee

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The current Student Outcomes for the Electrical and Computer Engineering Program are:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

These outcomes were adopted in spring 2018 and took effect in fall 2018. They are publicly available at https://engineeringdesign.wwu.edu/assessment-and-accreditation Up through spring 2018, the Student Outcomes were:

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, societal, 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 ability to engage life-long learning;
j) a knowledge of contemporary issues; and
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Post-graduation success requires attainment of all student outcomes, including technical, business, communication, professionalism, and individual outcome categories. The relationship between student outcomes and PEOs is shown in Table 3.B.1.

B. Relationship of Student Outcomes to Program Educational Objectives

Program Education Objectives	**Student Outcomes**
Strengthen the teams and communities they are part of by demonstrating leadership, effective communication, and cultivating a collaborative and inclusive environment.	3, 5 (d, g)
Recognize and determine the ethical implications and societal impacts of engineering solutions.	2, 4 (c, f, h, j)
Create value for society through innovation and design that transforms needs and opportunities into systems, products, and solutions.	1-7 (a-k)
Adaptively and independently extend their learning to excel in fields about which they are passionate.	7 (i)

Table 3.B.1 Outcomes Support of PEOs

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

The continuous improvement process used to regularly assess student outcomes is shown in Figure 4.A.1.

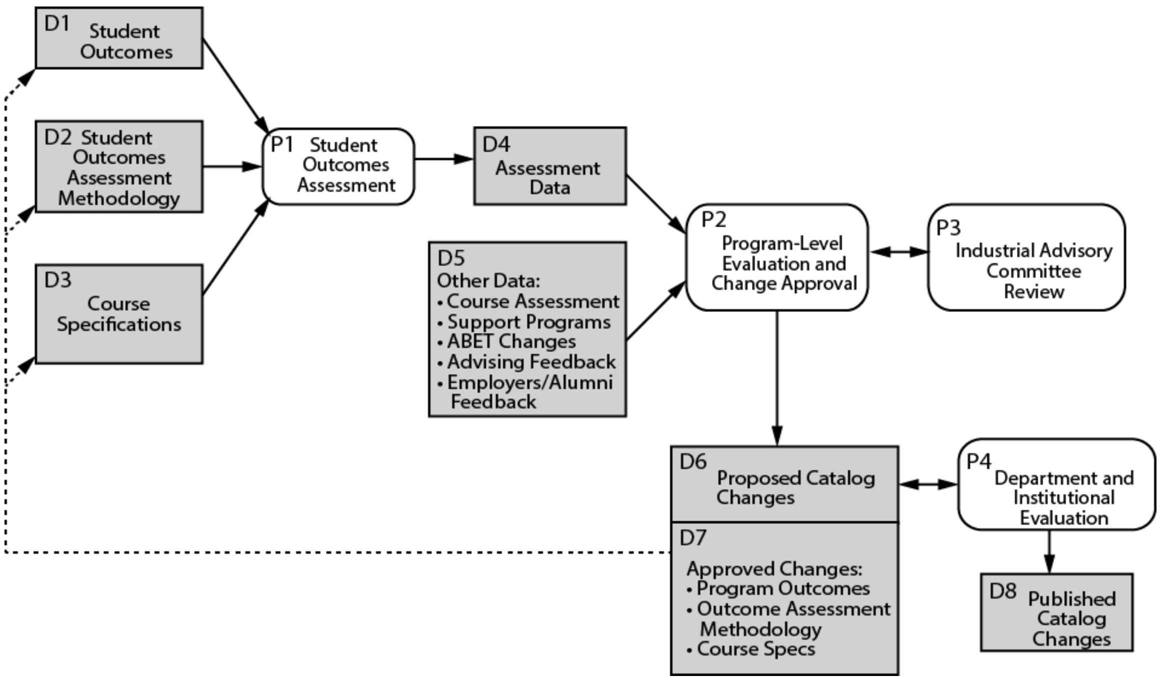


Figure 4.A.1 Continuous Improvement Process – Student Outcome Assessment

A.1. Student Outcome Assessment Process

The assessment process, P1, is used to measure the attainment of each student outcome (D1).

Each student outcome from Criterion 3 is measured using various methodologies (D2). A set of methodologies is defined for each student outcome as shown in Table 4.A.2. The following is a short description of each methodology.

> **Selected Coursework.** A homework question(s), quiz, exam question(s), or laboratory activity is selected that directly measures the attainment of the student outcome. Sample coursework used in the assessment process are shown in Appendix E.
>
> **Capstone Project.** The capstone project courses provide multiple opportunities for direct measures of student outcomes. Typically, these involve the project proposals, descriptions, and design reviews. The capstone project course numbers are: EECE 491, EECE 492, and EECE 493 for the Electronics concentration, and EECE 471, EECE 472, and EECE 473 for the Energy concentration.

Grade Distributions. The grades received in some courses, or set of courses, provide a direct measure of the attainment of a student outcome(s).

The EECE program director and program faculty share the responsibility of measuring student outcomes. If the assessment is made in a specific course, the responsibility is normally assigned to the faculty member that is teaching the course during the quarter when the assessment is made. This is normally the course coordinator. If not, the course coordinator works with the faculty member teaching the course to develop and coordinate the assessment.

The *Course Specifications* (D3) are the 'official syllabi' for each course. They contain all information required for Appendix A including the mapping of course outcomes of instruction to the student outcomes, which helps guide in the selection of the assessment methodologies. In addition, most program changes for continuous improvement are course changes so these changes are reflected in the course specifications. All course specifications can be found in Appendix A.

The assessment data along with other data are evaluated by the EECE program faculty during a program evaluation meeting (P2). This meeting occurs at least once a year at the end of spring quarter. The program director is responsible for holding the meeting. The program director and the EECE faculty evaluate the assessment results and propose changes to assessment methodologies or changes to the program to improve the attainment of the student outcomes.

Proposed changes are presented to the Industrial Advisory Committee for feedback (P3). This feedback is contained in the IAC meeting minutes, which will be made available in the displayed materials during the visit. The program faculty then make the final decision of the changes to be made for improvement.

If the change involves a catalog change, which includes the course number, title, description, and prerequisites, the proposed changes must be approved by the department faculty, the College of Science and Engineering Curriculum Committee, and the University's Academic Coordinating Committee. This whole process is managed with a rigorous approval chain using the Curriculog software suite. If a proposed change to the EECE program does not result in modification of the University's course catalog, the changes are made in the appropriate documents and the loop is complete.

A.2. Frequency of the Assessment Processes

The assessment processes are carried out every year based on the schedule shown below in Table 4.A.2. This table is modified each year based on the results of an assessment and if a measure needs to be re-assessed. At minimum, each student outcome is assessed every three years. As can be seen in Table 4.A.2, there are occasional deviations from the three-year plan. For example, the program chose not to assess all measures for some of the laboratory-intensive outcomes in cases where laboratory activities were significantly modified due to remote learning during the COVID-19 pandemic. Brought on in part by the transition from ABET (a)-(k) to (1)-(7), as well as our own continuous improvement process, we "retired" a number of measures (shown in red in Table 4.A.2) over the course of this review cycle, and replaced these measures with other, more effective measures of assessment.

In addition, we had hoped to implement the FE Exam as an assessment measure by now, but this was postponed due to a combination of the pandemic and logistical challenges in making the new electronic FE exam accessible to our students. We expect to add the FE Exam as a measure in AY2023-24 and will collect data every year to help assess student outcomes 1, 2, and 4.

A.3. Expected Level of Attainment

The expected levels of attainment for the measures vary and are always being evaluated and improved. The current targets are described in the summaries in Section A.4. As part of visualizing the attainment of the outcome, a 'colored light' system is used. This allows for a range of results rather than simply 'Yes' or 'No'. Table 4.A.1 shows the meaning of each color and a typical example metric. In the metric, N_E is the proportion of students that achieved the measure at an exemplary level, N_S is the proportion of students that achieved the measure at a satisfactory level, N_D is the proportion of students that achieved the measure at a developing level and, N_U is the proportion of students that achieved the measure at an unsatisfactory level. Note that $N_E+N_S+N_D+N_U=1$. This system can be seen in the summary of recent results in Table 4.A.2.

Color	Meaning	Example Metric
(green)	The outcome is attained for the given target. Action is not required.	$(N_S+N_E > 70\%)$
(yellow)	The outcome is marginally attained at the targeted level. Action may be required.	$(N_U>10\%)$ OR $(N_D>20\%)$
(red)	The outcome is not attained at the targeted level. Action is required	$N_U + N_D > 30\%$
(blue)	The outcome is attained but at such a high level that it may not be a valid measure.	$N_E = 100\%$

Table 4.A.1 Color System for Showing the Level of Attainment

A.4. Summaries of the Results of Student Outcomes Assessment

For the majority of this review cycle (2016 through 2019), the program conducted student outcomes assessments under the older (a)-(k) outcomes, but since 2019 we have completed outcomes assessments under the new (1)-(7) outcomes. Because of our roughly three-year cycle, we have conducted one complete round of student outcomes assessments under the new outcomes.

The assessment schedule with a description of the measures for each student outcome is shown in Table 4.A.2. Though assessments conducted in 2016-2019 were under the older (a)-(k) outcomes, we have mapped them to new (1)-(7) outcomes in Table 4.A.2. This table shows the results of the assessment during the 2016-17 year to present using the color system described above. It also shows the schedule for the next three years as determined each year and revised most recently during the June 2022 program evaluation meeting. Again, while our intent is to

Outcome	Assessment Methodology	'16-17	'17-18	'18-19	'19-20	'20-21	'21-22	'22-23	'23-24	'24-25
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Selected Coursework in EECE310					A			A	
	Selected Coursework in EECE220	R	R			A			A	
	Selected Coursework in EECE233					A			A	
	Selected Coursework in EECE360					A			A	
	Selected Coursework in EECE444	R				A			A	
	EECE491 Description, EECE493 System Software and Code Review (ELEC)	R	R							
	Selected Coursework in EECE378 (ENRG)									
	Selected Coursework in EECE372									
	Selected Coursework in EECE460 (ELEC)	R								
	FE Exam*								A	
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	EECE491-EECE493 Description (ELEC)	R	R		A			R	A	
	EECE471-EECE473 (ENRG)					A			A	
	FE Exam*								A	
3. an ability to communicate effectively with a range of audiences	Grade Distribution in ENG302 Technical Writing	R			A			A		
	EECE491-493 Proposal, System Software Presentation, Code Review Presentation				A			A		
	EECE471 Proposal and Description (ENRG)				A			A		
	EECE473 Design Reviews (ENRG)				A			A		
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	EECE111 Plagiarism Scan of Contemporary Issue Papers	R			A					A
	EECE111 Contemporary Issues Paper	R			A		A			A
	EECE491, EECE471 Ethics Quiz	R	R		A					A
	EECE378, EECE492 Essay on Contemporary Issues (ENRG,ELEC)						A			A
	FE Exam*									A
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	EECE109 Teamwork				A			A		
	EECE444 Team project(s)				A			A		
	EECE493 Teamwork Questionnaire, Course Participation, Code Review Teamwork (ELEC)				A			A		
	EECE473 Student Teamwork Survey (ENRG)				A			A		
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Selected Coursework in EECE360					A			A	
	Selected Coursework in EECE480					A			A	
	EECE471/473 Verification (ENRG)						A		A	
	EECE493 Verification (ELEC)	R	R			R			A	
	Selected Coursework EECE333		R							
	Selected Coursework EECE444	R								
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	EECE491 Proposal Bibliography (ELEC)				A			A		
	EECE493 New parts/technology used for project (ELEC)				A			A		
	EECE492 Initial design report introduction (ELEC)				A			A		
	EECE471 Proposal Research (ENRG)				A			A		
	EECE473 Final Project Demonstration(ENRG)				A			A		
	EECE472 investigation/report (ENRG)				A			A		

* FE Exam has yet to be implemented.
A - Assess and evalaute
R - Re-Assess and Evaluation
Red indicates a measure that is no longer used and was replaced.

Table 4.A.2 Assessment Schedule and Methodologies

assess and evaluate each student outcome every three years, there are some deviations from this schedule due primarily to the fact that some measures were not able to be assessed during the pandemic, and we did not do any student outcomes assessments during the 2018-19 year as we navigated the transition in ABET criteria from (a)-(k) to (1)-(7).

Next, we present some of the most recent assessments of measures for each outcome (1) through (7). As the table shows, some of these measures had been assessed previously under the (a)-(k) criteria; these are not discussed below, as everything has also been assessed more recently under the (1)-(7) criteria, but the data for these older assessments is present in the display materials. The corresponding assessment materials and data can be found in Appendix E.

Finally, the following discussion uniformly refers to courses by their EECE prefix for consistency, though some of the assessments were conducted while the courses still had the older EE prefix. The EE and EECE course numbers and titles are identical, regardless of differences in course prefix at the time of assessment.

A.4.1. Student Outcome 1

As shown in Table 4.A.2 five measures were assessed for outcome (1) during the 2020-21 year. A summary of the evaluation meeting for outcome (1) can be found in Appendix E.

In EECE 220, student use mathematical descriptions of diodes and transistors to predict the behavior of these devices in the lab and are evaluated for those abilities in the lab reports, homework, and exams. As a measure for this student outcome, one question was used from the Winter 2021 final exam which required students to represent a transistor using the small signal model and then use circuit analysis techniques to calculate the input, the output resistance, and the voltage gain. For this measure, 71% of students demonstrated exemplary performance, 21% demonstrated satisfactory performance, 4% demonstrated developing performance, and 4% of students demonstrated an unsatisfactory performance; this meets the target of 70% or more of students demonstrating satisfactory or exemplary performance. Data for this measure is included in Appendix E.

In EECE 233, two complex engineering problems were used as a measure. To partially evaluate this use of discrete mathematics, one question was used from the midterm exam and one from the final exam in the Winter 2021 offering. The first required the student to use Karnaugh Maps to reduce a canonical representation of a logic design to the minimum standard form representation. The second problem, presented in two parts, repeats the use of Karnaugh Maps for logic minimization and then requires the use of algebraic manipulation of a standard form equation to further modify it. For this measure, 100% of the students attained the outcome, with 65% of students demonstrating exemplary performance. This measure is above the target of 70%. Data for this measure is included in Appendix E.

In EECE 310, Problem 4 of the final exam given spring 2021 was selected. Students were given the transfer function of a second-order system and asked to analyze the system stability by obtaining and evaluating the poles of the transfer function. The second part of the problem asked students to obtain the system impulse response by conducting inverse Laplace transform. For this measure, 97% of the students attained the outcome. This meets the target of 70% and far exceeds a similar measure from EECE 310 used in prior years. Possible explanations for the high score include the fact that this class of students is particularly strong in mathematics (based on incoming math grades), and that unlike prior years this exam was given in the take-home format. Data for this measure is included in Appendix E.

In EECE 360, final exam question #2 was selected as a measure in the Winter 2019 offering. This question included many component parts and sub-problems, including the ability to apply LTI system theory, sampling, signal theory, and communication system theory. In this multi-part final exam question, students are given a block diagram of a quadrature transmitter and receiver and are asked to select the receiver carrier phase to maximize signal-to-noise ratio in the presence of various impairments such as: oscillator drift, variable propagation delay, channel-induced phase offsets, etc (impairments vary from year to year). In addition, students are asked to write the expressions for various intermediate signals in the block diagram, in both the time- and frequency-domains. Since 61% of students demonstrated exemplary performance, 36% demonstrated satisfactory performance, and 0% demonstrated unsatisfactory performance, the target for this outcome is met. Data for this measure is included in Appendix E.

In EECE 444, a portion of Lab 3 was used as a measure for assessing SO1 from Winter 2021. This part of the lab required students to generate a sinewave with an amplitude controlled by an ADC result and the frequency controlled by the user input and a fixed sample rate. These inputs have different data types. The output is scaled and passed on to a DAC. The design must meet amplitude, frequency, and distortion requirements, and requires students to use discrete-math concepts such as fixed-point arithmetic. The solution was formulated by small teams of 2 or 3 students, and 83% of the teams demonstrated satisfactory or exemplary performance with no teams demonstrating an unsatisfactory performance. While this meets the target of 70%, this measure was deemed to not be ideal due to the use of teams, and in the future will be modified to move this portion of the lab to an individual assignment so this measure includes every student. Data for this measure is included in Appendix E.

Collectively, these five measures indicate that students are attaining this outcome at the targeted level. Any changes described will be made and this outcome will be assessed during the 2023-24 year.

A.4.2. Student Outcome 2

As shown in Table 4.A.2 six measures were assessed for outcome (2): one from each of the three capstone courses in the Electronics concentration (EECE 491, 492, 493) during AY2019-20, and one from each of the three capstone courses in the Energy concentration (EECE 471, 472, 473) during AY2020-21. A summary of the evaluation meeting for outcome (2) can be found in Appendix E.

In EECE 491, the project proposal and description required in fall 2019 was selected. The proposal requires the students to identify realistic constraints and the description requires the students to incorporate the constraints into specifications and standards. The data can be found in

Appendix E. For this measure, 88% of the students attained the outcome. This meets the target of 70%. During the evaluation, it was decided no action was required at this time.

In EECE 492, the student's meeting the hardware design and fabrication specifications was selected, including assessment of their schematic, layout, stencil, and other project-related milestones. This data can be found in Appendix E. For this measure, 82% of the students attained the outcome. This meets the target of 70%.

In EECE 493, the code review was selected as a measure. The data can be found in Appendix E. For this measure, only 50% of the students attained the outcome, all of them at the satisfactory level. This falls below the target of 70%, and was undoubtedly due to the impact of COVID-19 starting in February 2020 with an inability of students to receive their PCB designs due to southeast Asia supply issues. This was compounded by students losing access to test and measurement equipment by the time their hardware designs were available. Because of the disruption in quality assessment and student potential to demonstrate mastery, major changes based on these observations were not recommended, though the program will re-assess this outcome again once pandemic-era disruptions are minimal.

In EECE 471, the project proposal and description required in fall 2019 was selected. The proposal requires the students identify realistic constraints and the description require the students to incorporate the constraints into specifications and standards. The rubric evaluates components including the technical requirements, features and constraints, initial design and hardware planning, project budget and cost considerations, ethical and professional considerations, Gantt chart and project planning. The data can be found in Appendix E. For this measure, 100% of the students attained the outcome at the exemplary or satisfactory level. This meets the target of 70%. During the evaluation, it was decided no action was required at this time.

In EECE 472, the student's final presentation and the proof-of-concept was selected as the measure, and includes components such as hardware research and development, test and measurement design and planning, and design alternatives. The data can be found in Appendix E. For this measure, 100% of the students attained the outcome. This meets the target of 70%.

In EECE 473, the project demonstration was selected as the measure. The data can be found in Appendix E. For this measure, 100% of the students attained the outcome, though the project had to be significantly modified due to the COVID-19 pandemic, and the grading rubric was subsequently altered. The project demonstration measure included an assessment of technical soundness and testing results, final product functionality, and ethical and professional considerations. While the outcomes met these modified rubric and expectations during the pandemic, a re-assessment of this outcome without COVID restrictions is necessary to consider the regular expectations of final physical products in fully functional conditions.

Collectively, these six measures indicate that students are attaining this outcome at the targeted level, though near-term reassessment is recommended due to the impact of the pandemic. Any changes described will be made and this outcome will be assessed during the 2023-24 year.

A.4.3. Student Outcome 3

As shown in Table 4.A.2, four measures were assessed for outcome (3), all from AY2019-20. A summary of the evaluation meeting for outcome (3) can be found in Appendix E.

The first measure selected is students' grade distribution for ENG302 – Technical Writing. The course syllabus can be found in Appendix A, and the data can be found in Appendix E. For this measure, 91% of the students attained the outcome. This meets the target of 70%. During evaluation, it was decided that no changes were needed at this time.

In EECE 491 the proposal and description were selected for written communications and in EECE 493, the code review reader presentation and system software presentation were selected. The data can be found in Appendix E. For this measure, 89% of the students attained the overall outcome. This meets the target of 70%. During evaluation, it was decided that no changes were needed at this time, though a teamwork questionnaire may be added in the future.

In EECE 471, the midterm and final presentation scores were selected to measure this outcome, and the data can be found in Appendix E. For this measure, 100% of students attained the outcome, which meets the target of 70%. During evaluation, it was decided that no changes were needed at this time.

The fourth measure selected, from EECE 473, was the design review and final presentation scores, and the data can be found in Appendix E. For this measure, 100% of students attained the outcome, which meets the target of 70%. During evaluation, it was decided that no changes were needed at this time.

These four measures indicate that students are attaining this outcome at the targeted level. Any changes described will be made and this outcome will be assessed during the 2022-23 year.

A.4.4. Student Outcome 4

As shown in Table 4.A.2, six measures were assessed for outcome (4). A summary of the evaluation meeting for outcome (4) can be found in Appendix E.

The first measure, which is part of the first course in the capstone project courses for students in the Electronics concentration, EECE 491, consists of an ethics quiz. Ethics instruction in EECE 491 consists of students watching a 10-part video series by Michael Loui from University of Illinois. Each video is approximately 10 minutes long, covering a different topic of engineering ethics. Evaluation of student understanding of ethics topics is assessed by a quiz on ethics topics graded on completion from the Fall 2019 offering. Since 82% of students performed at the exemplary or satisfactory levels, the target of 70% was met. However, an increasing number of students earned a "developing" score which is a trend that will be monitored. No changes were needed at this time.

While the first measure above only assesses students in the electronics concentration, the second measure conducts the assessment in EECE 471 for students in the energy concentration, and data was collected during Fall 2021. In this case, 100% of students performed at the exemplary or satisfactory levels, the target of 70% was met. No changes were needed at this time.

The third measure was selected from EECE 111 from an assignment where students write a "contemporary issues" paper that prompts students to consider economic, environmental, and societal issues. The data can be found in Appendix E for the Spring 2022 offering. This outcome had been previously assessed in 2019, but was reassessed in 2022 since in the prior assessment, a significant number of students did not complete the assignment due to it being assigned so late in the quarter. This time, 90% of the students performed at the satisfactory or exemplary levels, and the target was met upon reassessment. No changes were recommended.

In EECE 111, the results of a plagiarism scan on the student contemporary issues paper was selected as the fourth measure, also from Spring 2022. The data and rubric can be found in Appendix E. For this measure, 100% of the students attained the outcome, thus meeting the target of 70%. During evaluation, it was decided that no changes were needed at this time.

In EECE 378, a more advanced "contemporary issues" paper is assigned that prompts students in the energy concentration to consider economic, environmental, and societal issues. In particular, students were tasked to research and write a summary paper on a topic related to the electric power grid (e.g., emerging technologies, historical development, energy economics, etc.), and their report is assessed on the degree to which it addresses the impact their selected topic has in global, economic, environmental, and societal contexts. The data can be found in Appendix E for the Spring 2022 offering. 100% of the students performed at the satisfactory or exemplary levels, and the target was met. No changes were recommended.

In EECE 492, a more advanced "contemporary issues" paper is assigned that prompts students in the electronics concentration to consider economic, environmental, and societal issues. In particular, students were tasked to research and write a summary paper on an alternative replacement part for their capstone project design. The report is assessed on the degree to which the report considers public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. The data can be found in Appendix E for the Winter 2022 offering. 80% of the students performed at the satisfactory or exemplary levels, and thus the target of 70% was met. No changes were recommended.

These six measures indicate that students are attaining this outcome at the targeted level. Any changes described will be made and this outcome will be assessed during the 2024-25 year.

A.4.5. Student Outcome 5

As shown in Table 4.A.2, four measures were assessed for outcome (5). A summary of the evaluation meeting for outcome (5) can be found in Appendix E.

In EECE 109 (formerly called EE110), the teamwork effectiveness for the final project was selected from the Winter 2020 offering. The rubric can be found in Appendix E. For this measure, 100% of the students attained the outcome. This again meets the target of 70%. No specific changes were made, though the instructor will explore the possibility of using 2nd-year students as mentors.

In EECE 444, the final lab activity from Winter 2020 was selected. Students are divided into teams, and each team is responsible for developing hardware, software, and requirement modifications for a designated project. The project is organized as an Agile project where students may make weekly changes to requirements and individual responsibilities. The effectiveness of the project teams is assessed by a teamwork questionnaire submitted after the project due date by each individual student. There are five questions, each one has four answers that correspond to unsatisfactory through exemplary. Collectively, 100% of the students attained the target; however, on a team-level, there were indications that one team did not attain the target as discussed in detail in Appendix E. This was the only 3-person team, and in the future all teams will have 4 members. Otherwise, no changes were implemented other than a suggestion to consider using software such as Teammates.

EECE 493 is the third capstone project course for students in the Electronics concentration, and the course functions as a course-wide team as well as smaller teams for the software code reviews. From the Spring 2019 offering, a measure consisting of three components was used: a *course participation score* that is a measure of the course wide teamwork, the *code review score* that is a measure for the code review teamwork, and the *project completion score* which measures the team's ability of meeting objectives. The overall score resulted in 23.5% of students demonstrating exemplary attainment, and 76.5% demonstrating satisfactory attainment; thus, the target of 70% is achieved for this measure. A finer analysis of the individual components showed that the project completion score was only marginally attained, however this was the first time Project Completion was measured through verified requirements. This will be monitored in the future as it is suspected that this score will improve as the process for requirements writing and verification is improved.

EECE 473 is the third capstone project course for students in the Energy concentration. A measure consisting of a teamwork survey was selected from Spring 2019. Each of the 11 survey questions attempts to measure teamwork. Based on this measure, the outcome was only marginally attained as only 65% of student achieved a satisfactory level. However, in the review meeting for this outcome, faculty generally felt that the measure itself may be the issue, and the suggested change is to explore using the rubric adopted by the Manufacturing Engineering program.

These four measures indicate that students are attaining this outcome at the targeted level. Any changes described will be made and this outcome will be assessed during the 2022-23 year.

A.4.6. Student Outcome 6

As shown in Table 4.A.2, six measures were assessed for outcome (6), collected from AY2020-21 and AY2021-22. A summary of the evaluation meeting for outcome (6) can be found in Appendix E.

In EECE 360, the communication systems class required of all EECE students, a lab activity was selected as a measure for this outcome from the Winter 2020 offering. Student performance on an inquiry-based laboratory exercise is considered where students are asked to develop an experiment to characterize the frequency response of a very highly frequency-selective speaker. The students are given minimal guidance, and no procedural step-by-step instructions on how to conduct the frequency response characterization. Thus, they must themselves develop and conduct an experiment to characterize the speaker, and subsequently interpret the data. The data can be found in Appendix E. Nearly 68% of the class demonstrated an exemplary level of attainment, whereas 32% demonstrated a satisfactory level. As such, the target level of 70% at the satisfactory level or above has been attained. No changes were identified.

In EECE 480, the control systems course, a laboratory exercise was selected. In Lab 4 from Fall 2020, students are required to observe the influence of increasing the switching frequency of a dc-dc converter on the steady-state, the transient performance, and the harmonics of the output voltage. Students should observe that the high switching frequency improves the quality of the output voltage with no significant effect on the average value of the output. Then, students use Laplace transforms and transfer functions to design a PI controller for the output current using the zero-pole cancelation method. The controller parameters are used in a simulation model within Matlab/Simulink to verify the results and observe the output performance. For this measure, 85% of students demonstrated exemplary attainment, 12% demonstrated satisfactory attainment, whereas 3% demonstrated unsatisfactory attainment. This meets the target of 70%, and the corresponding data is found in Appendix E. No changes were made.

In EECE 493, the capstone project Verification Plan was selected during Spring 2021. The data can be found in Appendix E. For this measure, 73% of the students attained the outcome. This meets the target of 70%. A re-assessment will be conducted once the impacts of the pandemic subside, and the program will revise the requirements curriculum, primarily the requirements writing and process document and the requirements and verification forms.

In EECE 493, the capstone project Verification Execution was selected during Spring 2021. The data can be found in Appendix E. For this measure, it was also the case that 73% of the students attained the outcome. This meets the target of 70%. A re-assessment will be conducted once the impacts of the pandemic subside, and the program will revise the requirements curriculum, primarily the requirements writing and process document and the requirements and verification forms.

In EECE 471, the capstone project Verification Plan was selected during Fall 2021. The data can be found in Appendix E. For this measure, 100% of the students attained the outcome at a satisfactory level, though no students attained an exemplary level. This meets the target of 70%. A re-assessment will be conducted once the impacts of the pandemic subside.

In EECE 473, the capstone project Verification Execution was selected during Spring 2022. The data can be found in Appendix E. For this measure, 100% of the students attained the outcome at a satisfactory level, though no students attained an exemplary level. This meets the target of 70%. A re-assessment will be conducted once the impacts of the pandemic subside.

These six measures indicate that students are attaining this outcome at the targeted level. Any changes described will be made and this outcome will be assessed during the 2023-24 year.

A.4.7. Student Outcome 7

As shown in Table 4.A.2, five measures were assessed for outcome (7), all assessed during the 2019-20 academic year. A summary of the evaluation meeting for outcome (7) can be found in Appendix E.

In EECE 491, the proposal research was selected and in EECE 493 the use of new parts or technology used in the project was used. The rubric can be found in Appendix E. The results for these two measures were averaged together. For this measure, 94% of the students attained the outcome at a satisfactory or exemplary level. This meets the target of 70%. During evaluation, it was decided that no changes were needed at this time.

In EECE 492, the part selection investigation report was selected. In this written report, students are required to investigate alternatives for at least one component of their capstone design project. They are assessed on three elements, including the degree to which they: identify prominent newly-released alternative choices, weigh the pros and cons of the new solution versus a more traditional design solution, and from that new knowledge make an appropriate part selection. This assignment prompts students to acquire knowledge about hardware elements not covered in the curriculum, and to apply that knowledge to make a design decision. The data can be found in Appendix E. For this measure, 87% of the students attained the outcome at a satisfactory or exemplary level when averaging the three elements. While this meets the target of 70%, it was noted during the evaluation that the task testing a student's ability to assess the advantages and disadvantages of a component based on newly acquired knowledge about that component was borderline. It was recommended that additional details on the variability of part lifecycles be added to the course content for EECE 492.

In EECE 471, the Midterm and Final Proposal Introduction scores were selected as a measure. The students were assessed on the degree to which the proposal a) conducted thorough background research of existing technology and provided a justification of the need for the proposed project, and b) formulated a viable project design and plan. The rubric and data can be found in Appendix E. For this measure, 100% of the students attained the outcome at a satisfactory or exemplary level. This meets the target of 70%. During evaluation, it was decided that no changes were needed at this time.

In EECE 472, the Initial Design Report Introduction score was selected as a measure. The students were assessed on the degree to which the report a) conducted thorough background research of existing technology and provided a justification of the need for the proposed project, and b) formulated a viable project design and plan. The rubric and data can be found in Appendix E. For this measure, 100% of the students attained the outcome at a satisfactory or exemplary level. This meets the target of 70%. During evaluation, it was decided that no changes were needed at this time.

In EECE 473, final project demonstration was selected as a measure. The rubric and data can be found in Appendix E. For this measure, 100% of the students attained the outcome at a satisfactory or exemplary level. This meets the target of 70%. During evaluation, it was decided that no changes were needed at this time.

These five measures indicate that students are attaining this outcome at the targeted level. Any changes described will be made and this outcome will be assessed during the 2022-23 year.

A.5. Documentation and Maintenance

All student outcome evaluations are recorded on an evaluation form and are saved, along with supporting documentation, on a shared drive in the Display Materials folder.

A.6. Course Assessment

In addition to the student outcome assessment process the program has a systematic course-level assessment process to assure the courses' outcomes of instruction, and indirectly the student outcomes, are being attained. Figure 4.A.2 shows the course assessment process.

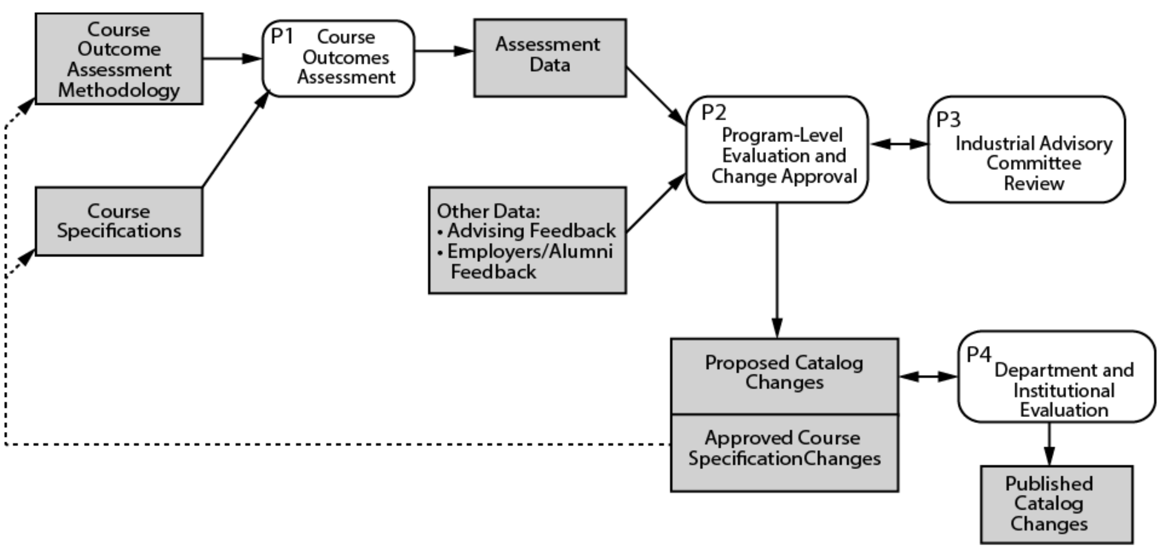


Figure 4.A.2 Continuous Improvement Process – Course Outcome Assessment

Course assessment follows a process very similar to the student outcomes process. Faculty are encouraged to informally conduct a course assessment every time the course is taught, however each course must be formally assessed every three years. During the pandemic, in particular, the goal of conducting reviews every three years was not maintained. However, except for the 3 new courses that were first taught in 2021 and 2022 (EECE 397A, 397B, and 397C), all courses have been assessed at least once since the last ABET review.

Table 4.A.3 shows the course review schedule for the coming three years, as well as the history of course reviews since the last ABET visit. Course assessment results and evaluation forms will be made available in the display materials at the time of the visit.

Course	*'16-17*	*'17-18*	*'18-19*	*'19-20*	*'20-21*	*'21-22*	*'22-23*	*'23-24*	*'24-25*
EECE 108/109 - Intro to EECE				A			A		
EECE 111 - Circuit Analysis I						A			A
EECE 210 - Circuit Analysis II				A				A	
EECE 220 - Electronics I	R					A			A
EECE 233 - Digital Electronics						A		A	
EECE 244 - Embedded Microcontrollers I						A			A
EECE 310 - Continuous Systems				A			A		
EECE 320 - Electronics II	R			A				A	
EECE 344 - Embedded Microcontrollers II						A			A
EECE 360 - Communication Systems				A			A		
EECE 361 - Signal Propagation						A			A
EECE 372 - Elec Power & Electromech Devices						A		A	
EECE 444 - Embedded Systems						A			A
EECE 480 - Control Systems					A			A	
EECE 311 - Discrete Systems			A				A		
EECE 321 - Electronic Systems	R							A	
EECE 333 - Digital System Design	R							A	
EECE 397A/362 - Wireless Networks Applications							A		
EECE 397B/383 - Machine Learning for Engineers							A		
EECE 397C/384 - AI and Reinforcement Learning							A		
EECE 433 - Digital Signal Processing			A					A	
EECE 460 - Digital Communication Systems						A			A
EECE 491 - Project Proposal	A					A			
EECE 492 - Project Hardware Design	A					A			
EECE 493 - Project Software & System Implm.	A					A			
EECE 374 - Energy Processing				A			A		
EECE 378 - Smart and Renewable Power						A			A
EECE 471 - Energy Project Proposal						A			
EECE 472 - Energy Project R&D	A					A			
EECE 473 - Energy Project Implementation						A			

A - Assessment and Review, R - Re-assess

Table 4.A.3 Course Assessment Schedule

B. Continuous Improvement

The major focus of the program's continuous improvement since the last ABET review has been increasing access to students while preserving the program's commitment to hands-on, experiential learning. The major changes to the program since the last ABET review are summarized here. Some of these changes have been informed by the established processes for student outcomes assessment, while others have been informed by other methods of data collection described below. Moreover, the impact of some of these changes has been assessed (i.e., closing the loop), while other changes are earlier in the process and their impact has not yet been assessed.

Below, the changes are presented starting with the broadest, most wide-reaching changes down to minor changes that have a more localized impact. There have been many minor course-level changes to course topics over the past 6 years that are not summarized here, but these changes can be found in the course assessments and "spec sheet" revisions within the display materials which provide evidence of how the topic and course content has evolved. The majority of these minor changes have arisen while conducting periodic course assessments as part of our established evaluation process, but these changes are too numerous and not sufficiently noteworthy to list here.

1. **Expansion of faculty and student capacity to improve student access.**

   Issue: At the last ABET review when there were just 4 tenured/tenure-track EECE faculty and 24 students per year accepted into the program, roughly 1 out of every 3 applicants to the program was turned away due to program capacity limits.

   Solution: The program has been aggressive about writing state budget proposals and pursuing state funding to hire additional faculty. In addition, the program has sought private partnerships to help alleviate the capacity issue, with one new faculty position funded in part by a corporate partner.

   Results/evidence/loop-closing: We have been fortunate to have secured the resources to conduct numerous faculty searches over the past 6 years and have successfully hired a very capable group of faculty members. Since the last ABET review, the program more than doubled the number of faculty and doubled the number of students accepted into the program each year. In fall 2022, the program will have 10 tenured/tenure-track faculty, 48 students per year accepted into the program, and the program will likely be able to accept nearly all students who apply to the major. This milestone is a major achievement for the program, resulting in increased access of the program to students, and an increase in trained engineers contributing to the workforce. In addition to the expansion itself, much of our focus has been on ensuring that the quality of education and learning during this period of significant expansion is maintained or enhanced, which is measured primarily through our established assessment process.

2. **New building to accommodate expansion of undergraduate program and planned addition of Master's program in EECE.**

   Issue: Coupled with the expansion of faculty and growth of the student body, the space needs of the EECE program are growing beyond the capacity of its current space in the Ross Engineering Technology building. In addition, the EECE program expects to add a Master's program in EECE within the next few years, which would not be possible with the currently available space.

   Solution: The program has been aggressive about reminding the University administration about the growing space needs of the EECE program. The university has been very supportive of this need and secured state and private funds to build a new $72 million facility which is expected to open in fall 2024 that will house the entire EECE program. This effort has required extensive work on the part of EECE faculty to provide input to the design process, helping to ensure that the new building will meet the needs of the EECE program, including teaching, laboratory, and collaborative spaces to support the program's mission. EECE faculty have done extensive planning by assessing the pros and cons of the current space to inform design decisions as the new space is designed, as well as forecasting the future space needs of the program in the coming decades.

Results/evidence/loop-closing: The building is still in the design phase, but the funding has been promised and all signs indicate that the project will proceed to completion, with construction set to begin in early 2023. The building appears to meet the needs of the EECE program and has design elements that will lead to an improved student learning experience. In addition, the new building includes space to accommodate a future Master's program in EECE, and the program will be co-located in the new building with the Computer Science department which will facilitate more cross-disciplinary interaction and collaboration.

3. **Improving diversity, equity, and inclusion (DEI) within the EECE program.**

Issue: In 2017, the EECE program assembled a focus group of students who identified as gender minorities. The focus group was moderated by staff in the Title IX office and was intended to assess the climate within the EECE program. The results of this focus group suggested that the program climate was relatively hostile to gender minorities and students from underrepresented groups. Moreover, the gender diversity of the student body was relatively low, even when compared to national averages within the discipline of electrical and computer engineering. Notably, there was just one student across the three EECE graduating classes of 2017, 2018, and 2019 who identified as a woman according to university records (1 woman out of 71 students).

Solution: The program has placed a strong emphasis on diversity, equity, and inclusion (DEI) during this review cycle, and the program instituted a number of initiatives designed to foster a more equitable and inclusive environment, including the following:

- The EECE program admissions process was modified from one based purely on GPA to include an admissions essay which provided a more complete picture of applicants' strengths and promise for success as engineers. The admissions questions were developed following a review of literature on equitable approaches to admissions policies. Consequently, the admissions process was modified to include both GPA and the essay in determining which students to accept into the major.
- Regular student "feedback" sessions with a DEI focus are conducted with EECE students, roughly every year. The faculty attend these sessions, as well, and prompt students with questions in a think/pair/share exercise to discuss ways that everyone can contribute to a more inclusive climate. The program has implemented numerous ideas that have emerged from these feedback sessions.

- All EECE faculty agreed to add language to their syllabi about equity, inclusion, and diversity, and to discuss this on the first day of class to establish norms around these issues.
- Most EECE faculty agreed to complete an 8-hour training series offered by the College of Science and Engineering that was devoted to fostering equity and inclusion in STEM fields.
- The faculty hiring process was modified to require applicants for faculty jobs in EECE to submit an essay discussing how they are committed to diversity, equity, and inclusion. These essays were evaluated by EECE search committee members and were considered when selecting finalists for faculty searches.
- The college and department added a requirement that faculty include a discussion of their efforts to foster diversity, equity, and inclusion when they are evaluated for tenure, promotion, or during the periodic post-tenure review.

Results/evidence/loop-closing: We have conducted additional student focus groups in 2019 and 2020, and while there is still room for continued work in the area of DEI, students generally report a positive climate. In addition, diversity of the student body and faculty has improved significantly since the last ABET review. For example, the proportion of women-identifying students is now on par with national averages across the discipline, and by fall 2022 the program will have added three women to its faculty (2 new tenure-track faculty, and 1 non-tenure-track faculty member) for a faculty comprised of 36% women (4 of 11).

4. **<u>Added three new courses in technical areas of importance to local industry.</u>**

Issue: The EECE program lacked significant content in the areas of wireless networking and artificial intelligence, and program faculty identified this as a weakness given the importance of these topics across the discipline of EECE. In addition, feedback from the Industrial Advisory Committee suggested courses in these areas would benefit the program as they would positively support the training of students hired by local companies.

Solution: Expertise in these areas was prioritized during the faculty hiring searches. Two faculty were successfully hired in these areas, and the program had the resources to permit these new faculty to offer new courses in these areas.

Results/evidence/loop-closing: The following three courses were developed and offered as experimental versions –

- EECE 397A – Wireless Networking and Applications (first offered in AY2020-21)
- EECE 397B – Machine Learning for Engineers (first offered in AY2021-22)
- EECE 397C – Artificial Intelligence and Reinforcement Learning (first offered in AY2021-22)

Permanent versions of these courses have been integrated into the curriculum in AY2022-23 as part of new concentrations and a curriculum restructuring (see below).

5. **Restructured curriculum to offer students more choice and flexibility in higher-level EECE courses.**

   Issue: Because the program has been quite small, the faculty have focused on consistently offering a high-quality set of required courses for the degree, with no EECE electives. This has led to a curriculum that offers students minimal choice in course selection.

   Solution: In parallel with the expansion described above, as well as the addition of courses in new areas and new faculty with new expertise, the EECE program initiated a curriculum restructuring set to take effect in AY2022-23 that offers students more choice in courses and more flexibility.

   Results/evidence/loop-closing: This careful, planned restructuring was conducted in consultation with the Industrial Advisory Committee, and seeks to preserve the strong EECE core of the existing curriculum. The number of credits will be unchanged but starting in AY2022-23 students will have more choice in selecting their higher-level EECE courses, and there will be two new concentration options for students to choose from: one in Wireless Networking and Signal Processing, and one in Artificial Intelligence and Machine Learning.

6. **PCB design moved earlier in the curriculum.**

   Issue: During the assessment of EECE 492 as well as period assessments of SO2, it emerged that some students were not capable of completing their PCB designs as part of the capstone project, primarily because it was deemed to be too much to introduce PCB design and actually conduct a full board design in a single course.

   Solution: PCB design was moved earlier in the curriculum, notably in EECE 320, using our established process of assessment and continuous improvement. This also provided students in the Energy concentration with exposure to PCB design.

   Results/evidence/loop-closing: The most recent review of EECE 492 conducted after the Winter 2022 offering (available in display materials) confirmed that introducing PCB design in EECE 320 has led to significantly improved attainment of course outcomes in EECE 492 and in attainment of student outcome 2 as measured by elements of the capstone project.

7. **More intentional integration of ethics content in capstone project via ethics-focused lectures and ethics quiz.**

   Issue: The Winter 2017 assessment of student outcome (f) resulted in a concern about student performance on an ethics quiz in EECE 492 (assessments available in display materials). A non-negligible number of students were unable to identify that the safety of the public is this highest ethical obligation of an engineer.

Solution: Starting in 2017-2018, the majority of the capstone project-related ethics content was moved one quarter earlier in the curriculum to EECE 491. This was done primarily because students are required to address ethical issues in their senior project proposal which is developed in EECE 491, so it made more sense to include ethics content in this course. The program also supplemented video lectures on ethics with an in-person lecture by a faculty member to discuss ethics issues in more detail.

Results/evidence/loop-closing: Student outcome 4 (formerly outcome 'f') was reassessed in Winter 2018, and the prior concerns were addressed by these changes.

8. **<u>Split introductory course (EECE 110) into two separate lab/lecture courses (EECE 108 and 109) to aid with student sense-of-belonging and retention in first-year.</u>**

Issue: Students who transfer to WWU at the start of their 2nd year in the program were required to take the introductory EECE 110 in their second year of study since the course is a degree requirement and it is not a course that has a transferable equivalent at other schools. At the time these transfer students take EECE 110, they have already had several lab intensive EECE courses and the lab content of EECE 110 is somewhat inappropriate by this stage because it is too introductory for them. Meanwhile, feedback collected informally from non-transfer students as well as feedback collected through surveys assessing sense-of-belonging showed that other students often felt intimidated by having these move advanced students in the introductory laboratory class, which led some students to question whether they "belonged" in EECE and may have negatively impacted first-year retention.

Solution: EECE 110 was comprised of two components: (i) a weekly lecture introducing the discipline from a broad perspective that also focuses on career paths and makes use of guest lecturers by practicing engineers, and (ii) a laboratory session that uses several introductory projects in part to excite students about the discipline of EECE. The program decided to split these two components into separate classes (lecture and lab), with the more advanced 2nd-year transfer students only required to take the lecture portion (EECE 108) so that they are exposed to that material. First-year students also take EECE 108 alongside the 2nd-year transfer students. Meanwhile, the lab course (EECE 109) is now only required by first-year students, and serves to help establish cohort cohesion among first-year students in EECE.

Results/evidence/loop-closing: Solid evidence that this change has proved beneficial is impossible to produce, but current students no longer share that they feel intimidated since the more advanced 2nd-year students are not in the class. Separately, the department has a project studying student sense-of-belonging, and the program will monitor these results.

9. **<u>Added online summer offering of EECE 111.</u>**

Issue: To complete the EECE degree within 4 years, students must begin calculus during their first quarter at WWU. Students who have taken precalculus in high school but are not able to earn a sufficiently high score on Western's Math Placement Assessment must first take a precalculus class at WWU, which in turn means that these students will need 5 years to complete the EECE degree. Even students who place into calculus but choose not to take it during their first quarter (e.g., if they have not yet chosen a major, or are not aware of the somewhat rigid math requirements of the EECE program) must also delay their studies and add a fifth year. Finally, students who do not pass MATH 124, 125, or 204 on the first attempt are also set back a whole year.

Solution: The gateway EECE course that results in this bottleneck for students who are 1 quarter "behind" in math is EECE 111. By additionally offering this course in the summer, this offers students the chance to "catch up", and a greater number of students are able to apply to the EECE major after the first year and complete their studies within four years. Additionally, by teaching the course fully remotely, student access is maximized as students may reside outside Bellingham during the summer.

Results/evidence/loop-closing: EECE 111 has been offered three summers over the years 2020, 2021, and 2022 with enrollments of 7, 9, and 9 students. Adding a summer offering of this class has permitted 25 students over the past 3 years to stay "on track" and avoid having to add an additional year of study to wait for the next offering of EECE 111. This clearly reduces time-to-degree, and likely improves first-year retention. Analysis of student grades has shown that these students who have completed the remote summer offering of EECE 111 perform as well as students who take the more typical in-person spring offering.

10. **<u>Added a more formal method of documenting requirements and verification to EECE 493.</u>**

Issue: The Spring 2017 assessment of student outcome (b) in EECE 493 resulted in a concern about student achievement on the verification testing used for the software system presentation and code reviews of capstone projects, as 29% of students were below the program's established cautionary threshold.

Solution: More instruction on writing testable requirements was added to EECE 491, and a separate deliverable was added that more directly measures the testing and results for each requirement.

Results/evidence/loop-closing: Student outcome 6 (formerly outcome 'b') was reassessed in Spring 2018, and the prior concerns were addressed by these changes. Both the Spring 2017 and Spring 2018 assessments are available in the display materials.

Planned future changes with rationale:

- In Spring 2023, the program plans to add a new EECE course in probability and statistics that may be taken in place of MATH 345. Initially this course will be an option for students in place of MATH 345, but the expectation is that this will eventually be a required course that replaces MATH 345. Prior course outcomes assessments (primarily those in EECE 460) have identified that students would benefit from a different emphasis on probability and statistics topics compared to what MATH 345 provides; for example, topics such as sums of random variables and conditional probability density functions should be emphasized in more detail. After the EECE program offers its own probability and statistics course in Spring 2023 (cross-listed as a MATH course), the program will assess its impact on student attainment of course outcomes at a later date as part of its regular assessment process.
- In Spring 2023, the program plans to offer a course in Cyber-Physical Systems. This course will broaden the course options available to students in a timely topic area while complementing the program's existing strengths in embedded systems, control systems, and artificial intelligence. We plan for the course to be offered on an experimental basis in Spring 2023, and to subsequently become a permanent course taken either as an elective or as part of the Artificial Intelligence and Machine Learning concentration starting in AY2023-24.
- In Spring 2023, the program plans to offer a 1-credit capstone project proposal course to third-year students as part of a broader plan to slightly restructure the capstone project sequence. Past reviews of the capstone project sequence have identified that it would likely lead to better outcomes if students began their fourth year with a project already identified so that the fourth year could be devoted to project design, research and development, construction, and test and verification. By introducing the capstone project one quarter sooner (i.e., in the final quarter of the third-year), the program expects this to lead to better outcomes for the capstone project.
- The EECE program plans to work with the English department to develop an offering of ENG 302 (Technical Writing) that is specifically tailored to the needs of EECE students. The current ENG 302 course is taken by majors across many STEM fields, and a more tailored course could improve student communication skills and directly support improvements in attaining student outcome 3.
- In the 2020 SO5 review of teamwork in EECE 444, the teamwork survey was changed based on work done by Google. SO5 will be reassessed next year to measure the impact and close the loop.

C. Additional Information

All supporting documentation for the continuous improvement processes can be found in Appendix E and the display materials at the time of the visit. This includes assessment instruments and materials, as well as minutes from assessment meetings.

CRITERION 5. CURRICULUM

A. Program Curriculum

1. **<u>Curricular Paths to Degree</u>**

The Electrical and Computer Engineering program has had two concentrations – Electronics and Energy. These two concentrations have different paths to the degree. The curriculum for the Electronics concentration is shown in Table 5.1a and the Energy concentration is shown in Table 5.1b. Western Washington University is on a quarter system.

Note that in the 2022-23 academic year, the program will implement several changes to the curriculum that will give students a bit more choice in course selection and that will add two new concentrations: one in Wireless Networks & Signal Processing, and the other in Artificial Intelligence & Machine Learning. These changes are not scheduled to be implemented until the coming academic year, however, and current students up through and including the Class of 2023 are not impacted by these planned changes; as such, the focus here is on the existing curriculum.

2. **<u>Alignment with Program Educational Objectives</u>**

The curriculum has been developed and continuously improved over the last 30 years with significant input from the program's constituency, especially the Industrial Advisory Committee (IAC). Since the time when the program was an EET program and up through the present, the program has always had an emphasis on preparing students to be successful in their chosen profession. IAC feedback informs the curriculum change decisions that prepare students for success in their career.

The Energy concentration was developed to meet the needs of local industry. Curriculum for the concentration was informed through both the EECE IAC and the Energy Advisory Board for the Institute for Energy Studies. This curriculum was developed to prepare students to be successful in Energy related careers.

Another strategy for student success in their careers is to teach topics important to the employers that hire our students. This includes strong topic threads in embedded systems, analog and digital electronics, communications, and control systems. The common core of classes taken by all students includes courses in these areas.

Finally, the curriculum additionally includes a focus on teamwork, significant practice communicating technical concepts, consideration of ethical issues in engineering, and for all of these reasons the curriculum aligns with the program educational objectives.

3. **<u>Alignment with Student Outcomes and Prerequisite Structure</u>**

Table 5.A.2 shows the mapping of program courses to student outcomes. The shaded blocks in the table indicate the level of contribution that the course makes towards each student outcome as follows:

Table 5.A.2 Course to Student Outcome Map

■ - Course contains significant instruction and opportunities for practice.

▒ - Course contains limited instruction and opportunities for practice.

□ - Course contains no instruction and opportunities for practice.

EECE Core Courses	**1**	**2**	**3**	**4**	**5**	**6**	**7**
EECE 108 Intro to Electrical & Computer Engr. Seminar				▒			▒
EECE 109 Intro to Electrical & Computer Engr. Lab		▒			▒		▒
EECE 111 Circuit Analysis I	■			▒		■	
EECE 210 Circuit Analysis II	■		▒			▒	
EECE 220 Electronics I	■					■	
EECE 233 Digital Electronics	■	▒				▒	
EECE 244 Embedded Microcontrollers I	■	▒				▒	
EECE 310 Continuous Systems	■					▒	
EECE 320 Electronics II	■	▒				■	
EECE 344 Embedded Microcontrollers II	■	▒				▒	
EECE 360 Communication Systems	■	▒	▒	▒		■	
EECE 361 Signal Propagation	■	▒	▒			▒	
EECE 372 Electrical Power & Electromagnetic Devices	■	▒	▒	▒		▒	
EECE 444 Embedded Systems	▒	■			▒	■	
EECE 480 Control Systems	■					▒	
Electronics Concentration Courses	**1**	**2**	**3**	**4**	**5**	**6**	**7**
EECE 311 Discrete Systems	■					▒	
EECE 321 Electronic Systems	■	▒				■	
EECE 333 Digital Systems	■	▒				■	
EECE 433 Digital Signal Processing	■					■	
EECE 460 Digital Communications	■			▒			
EECE 491 Project Proposal	■	■	■	■	■		■
EECE 492 Project Hardware Design	▒	■	■		■	▒	■
EECE 493 Project System Implementation	▒	■	■		■	■	■
Energy Concentration Courses	**1**	**2**	**3**	**4**	**5**	**6**	**7**
EECE 374 Energy Processing	■					▒	
EECE 378 Smart and Renewable Power	■	▒		▒			▒
EECE 471 Energy Project Proposal	■	▒	■	■	■	▒	■

EECE 472 Energy Project R&D							
EECE 473 Energy Project Implementation							
ENRG 320 Science of Energy Resources							
ENRG 386 Economics of Electricity Markets							
ENRG 380 Energy and Environment							
New Technical Elective Courses	**1**	**2**	**3**	**4**	**5**	**6**	**7**
EECE 397A / 362 Wireless Networking Applications							
EECE 397B / 383 Machine Learning for Engineers							
EECE 397C / 384 AI & Reinforcement Learning							
GURS							

The program has a strong prerequisite structure and, because each course is offered only one time per year, each cohort goes through the program in lock step.

4. **<u>Prerequisite Structure Flowcharts</u>**

Figures 5.A.3 and 5.A.4 show the flowcharts for the program's prerequisite structure.

Figure 5.A.3 Electronics Concentration Prerequisite Flow Diagram

Electrical and Computer Engineering - Electronics Concentration

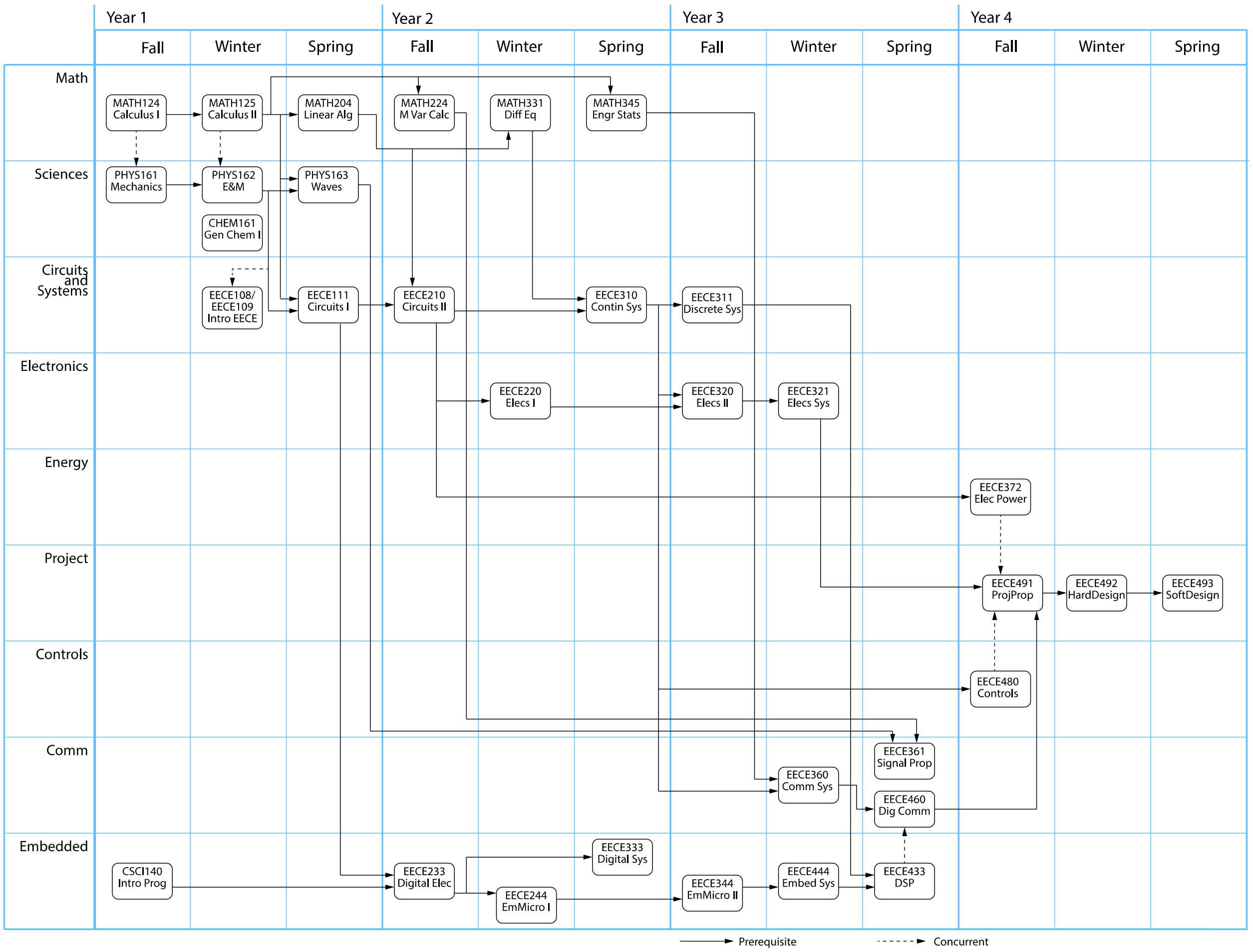
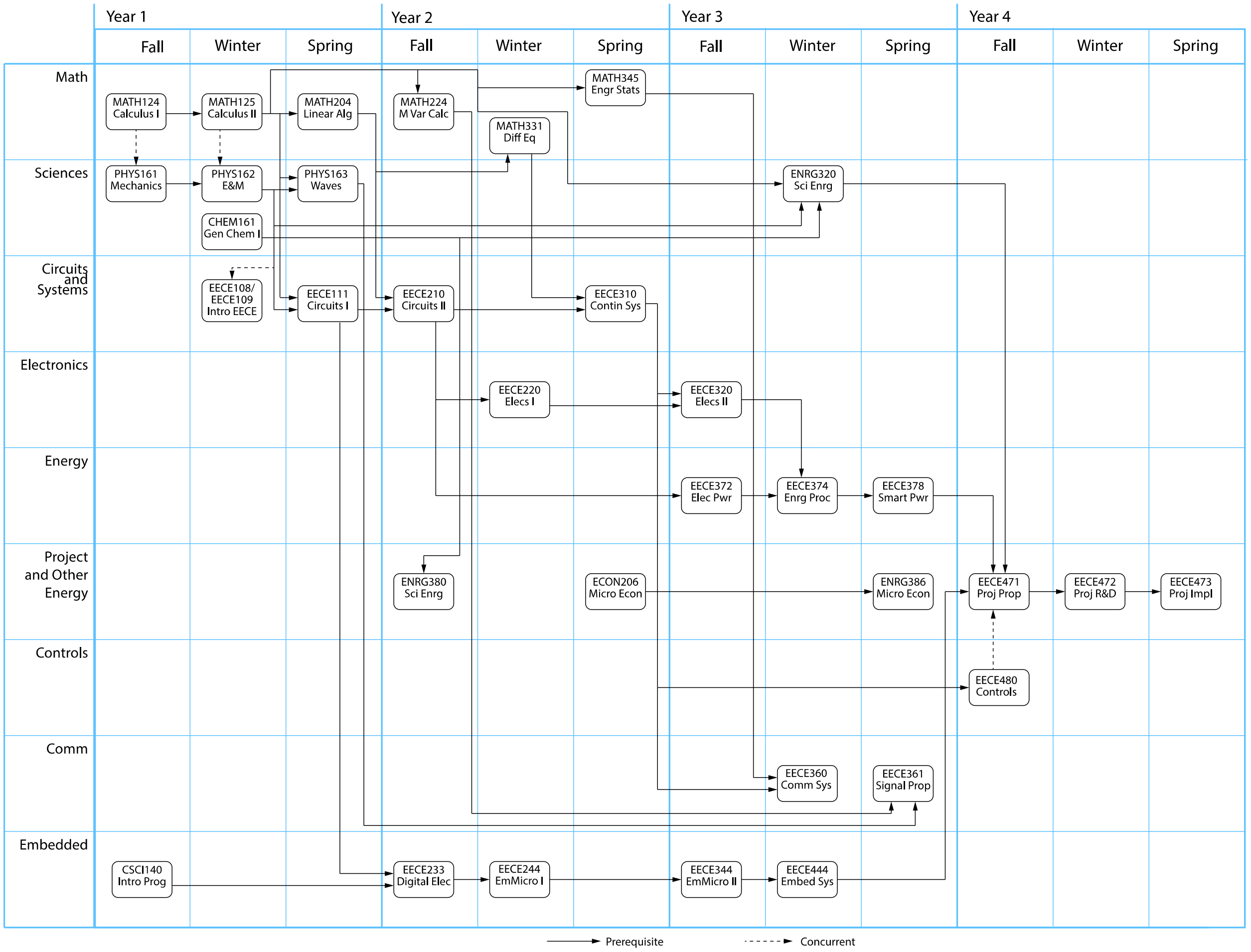


Figure 5.A.4 Energy Concentration Prerequisite Flow Diagram

Electrical and Computer Engineering - Energy Concentration



5. **<u>Meeting the ABET Requirements for Each Subject Area</u>**

Table 5.1a and 5.1b at the end of this section have been completed according to the requirements for this self-study. The curricular components for each subject area are summarized here, where units are in terms of quarter credit hours:

EECE – Electronics Concentration

- Total Credit Hours in EECE-Electronics Concentration = **184**
- Math and Basic Science Component Credit Hours= **47-53** (**25.5% - 28.8%** of total)
  - This exceeds the 30 semester credit hours (=45 quarter credit hours) required for accreditation.
- Engineering Content Credit Hours = **88-94** (**47.8% - 51.1%** of total)
  - This exceeds the 45 semester credit hours (=67.5 quarter credit hours) required for accreditation.
  - This includes a culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work.
- General Education Credit Hours = **43** (**23.4%** of total)

    - This provides the required broad education component that complements the technical content of the curriculum and is consistent with the program educational objectives.

EECE – Energy Concentration

- Total Credit Hours in EECE-Energy Concentration = **184**
- Math and Basic Science Component Credit Hours= **51-57** (**27.7% - 31.0%** of total)
    - This exceeds the 30 semester credit hours (=45 quarter credit hours) required for accreditation.
- Engineering Content Credit Hours = **76-82** (**41.3% - 44.6%** of total)
    - This exceeds the 45 semester credit hours (=67.5 quarter credit hours) required for accreditation.
    - This includes a culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work.
- General Education Credit Hours = **51** (**27.7%** of total)
    - This provides the required broad education component that complements the technical content of the curriculum and is consistent with the program educational objectives.

a. <u>Math and Basic Science Courses:</u>

The math courses required by EECE majors are three courses of calculus including multivariable calculus, as well as differential equations, linear algebra, and engineering probability and statistics (MATH 124, 125, 204, 224, 331, 345). The fundamental topics covered are used in the appropriate engineering courses that they feed into (see the prerequisite structure in Table 5.A.1). For example, the statistics covered in MATH 345 is an important tool that students use in Digital Communication Systems (EECE 460).

The basic sciences include the engineering physics series that covers mechanics, electromagnetism, waves, and geometric optics (PHYS 161, 162, 163) and the first general chemistry course (CHEM 161). All these courses have laboratory experiences, thus satisfying the requirement to "include physical or natural science with laboratory experiences as appropriate to the discipline." These courses also satisfy WWU's GUR requirement for the Natural Sciences.

The Energy concentration also has an Energy Sciences (ENRG 320) course requirement. This course covers the basic science of energy. It does not include a laboratory component.

b. <u>Core Electrical Engineering Courses</u>

The core electrical engineering courses are those taken by both concentrations.

A computer science introduction to programming in C++ (CSCI 140) as required by the program criteria. The program also accepts CSCI 141 as an alternate, as it covers the same material but uses the Python programming language.

The core curriculum is made up of four topic threads – Circuits and Systems, Electronics, Communications, and Embedded Systems – along with the core topics of controls, and electric power. These threads and core topics provide most of the depth and breadth in the program and include both hardware and software topics as required by the program criteria.

As required by the program criteria, applications in probability and statistics can be found in several places, most notably the communications sequence EECE 360, EECE 460, and EECE 374. Discrete mathematics is covered primarily in EECE 233, with additional coverage in EECE 244, 344, and 444.

c. Electronics Concentration Courses
In addition to the EECE core courses, the electronics concentration includes more depth in the areas of electronics, digital systems, digital communications, and digital signal processing.

d. Energy Concentration Courses
The energy concentration adds a thread in electrical energy along with interdisciplinary energy topics in environment science and economics.

e. General Education Courses
See section 6 below.

f. Culminating Major Design Experience
Finally, each concentration includes a three-quarter sequence during the last year for the culminating major design experience as required by the general criteria. They are separate sequences because the Energy projects are intended to be multi-disciplinary projects with other Institute for Energy Studies faculty and students. These are described in more detail below.

6. Broad Education Component

The general education component in both concentrations is primarily made up of the General University Requirements, GURs. The GURs include six areas – Natural Sciences, Comparative, Gender, and Multicultural Studies, Social Sciences, Humanities, Quantitative and Symbolic Reasoning, and Communication. The EECE program courses satisfy the Natural Sciences and Quantitative and Symbolic Reasoning GUR areas. Thus students must complete the GUR requirements in the other four areas. This requires at least an additional 38 credits. In addition, all students are required to take a technical writing course (ENG 302). Students in the Energy concentration are also required to take ENRG 380 and ECON 386. The GUR courses support the development of effective communication skills, social and cultural awareness which aids in cultivating collaborative and inclusive environments, and these courses provide an opportunity for students to extend their learning in fields about which they are passionate. As such, the GURs complement the technical content of the curriculum and are consistent with the program educational objectives.

7. Major Design Experience

The culminating major design experience is contained in the three-quarter senior project sequence (EECE 491, 492, 493 for the Electronics concentration and EECE 471, 472, 473 for the Energy concentration.) By design, these courses are modeled after a typical development process found in industry. The students choose their project and choose whether to work on a team or individually. Because of the prerequisite structure, students must have completed all other program courses by the second quarter of the project sequence. Projects must involve the prerequisite material but may also include new areas that the student must learn on their own.

While capstone meeting times in many programs elsewhere are often limited to delivery of expectations to the project groups, guest speakers, and special lecture topics, course meeting times within the senior project series in EECE at WWU are frequently used to delve into the technical details of individual project groups. Class meetings are structured as engineering team meetings and include collaborative activities that are highly structured such as formal design and code reviews as well as informal teamwork such as brainstorming possible solutions to specific engineering challenges. Project groups are encouraged to seek feedback from other groups during formal meetings, and collaborative participation is required and evaluated across the capstone course sequence.

In the first course, the students write a proposal for their desired project. This proposal requires that the students address the objectives and realistic constraints, and the impact on society.
In addition to the proposal, students must create a requirements document and development plan. The requirements document includes complete electrical specifications, and standards, and how these specifications relate to the project constraints. It also includes many system level design concepts including a user interface design and a development plan. This is also the point where students test proof-of-concept designs to help alleviate the risk involved in creating a successful project using new technology. Each of these steps relies on knowledge and skills acquired in earlier circuits, systems, and embedded courses.

The second course starts the process of detailed design of the project to meet the requirements. For the Electronics concentration, this quarter is focused on the hardware design and includes the design of a PCB that addresses manufacturing and other realistic constraints, and thus directly requires knowledge and skills acquired in earlier coursework. Students are also involved in project planning and design reviews. The Energy concentration also involves a design that meets realistic constraints; while a PCB is not generally required, student project rely heavily on knowledge acquired in earlier coursework, including the cross-disciplinary ENRG courses.

The third course is the final project design stage. In the Electronics concentration, this involves the software design at system and code level along with system integration and finally demonstration. In the Energy concentration, this is the final implementation stage and demonstration. Students also have numerous design experiences throughout the curriculum, including those that require team projects such as the final project in Embedded Systems (EECE 444).

The titles of the capstone projects for the AY2022-23 school year were as follows --

- "Bluetooth Multi-Effects Pedal" (2-student project)

- "Modular Digital Audio Signal Processor" (single-student project)
- "ADHD Accommodation Device" (2-student project)
- "Birth Control Smart Container" (single-student project)
- "Intelligent Edge Computing for Coordinated Perception in Connected Vehicles" (3-student project)
- "Multiple International Layout Keyboard" (single-student project)
- "Automated Sentry Turret" (single-student project)
- "Oiler Monitoring System" (single-student project)
- "Memory Improvement Platform" (single-student project)
- "Wireless Pulse Oximeter" (single-student project)
- "Portable Insulin Cooler" (single-student project)
- "Wildfire Early Detection System" (2-student project)
- "Voice Coach - Voice Estimation System" (single-student project)
- "Digital Environment Regulation Tool" (single-student project)
- "Well Water Tester" (single-student project)
- "Just Enough Essential Features Watch" (single-student project)
- "Motion Activated Sound Controlled Light Array Wearables" (single-student project)
- "Autonomous Photovoltaic Power Supply for Monitoring Terrestrial-Aquatic Interfaces" (3-student project)
- "Modular Solar Energy Storage" (3-student project)
- "Solar Powered Water Battery – A Small-Scale Pumped Hydro Application" (3-student project)

8. <u>Cooperative Education</u>

While students are strongly encouraged to complete internships and are provided some aid in finding them, the EECE program does not permit students to count internships toward EECE program curricular requirements.

9. <u>Displayed Materials</u>

All required materials will be made available during the visit in digital form through a Microsoft SharePoint folder. This includes course materials comprised of course syllabi, textbooks, example assignments and exams, as well as examples of student work. There will also be evidence that the program educational objectives stated by the program are based on the needs of the stated program constituencies, evidence of the assessment, evaluation, and attainment of student outcomes and evidence of actions taken to improve the program.

10. <u>Other Notes</u>

- The EECE program at WWU prides itself for its intensely hands-on, experiential curriculum. Except for the two signals and systems courses (EECE 310 and 311), every EECE course within the curriculum has a weekly laboratory section.
- EECE faculty are committed to using modern, evidence-based teaching and learning pedagogies throughout the curriculum, including active and student-centered learning.
- While the EECE curriculum has historically been offered exclusive as a face-to-face, in-person program, several modifications to the curriculum were made during the COVID-

19 pandemic, which impacted student learning and achievement of course learning outcomes.

- **Spring 2020:** All lectures and labs were taught remotely. Once faculty grew comfortable with remote teaching, lectures largely succeeded in replicating the in-person experience. In some cases, however, it was impossible to achieve all course learning outcomes, particularly those requiring an in-person laboratory experience. Senior capstone projects suffered since verification of designs was not possible to the same degree. And in all cases, the isolation and lack of access to industry-standard instrumentation caused by the pandemic resulted in a student learning experience that was inferior to the usual, in-person experience. The program tried its best to replicate the lab experience for students at home, for example by mailing hardware to students or by replacing experimentation with simulation.
- **Fall 2020:** Lectures continued to be offered online only, but EECE 233 and EECE 372 brought back in-person labs for students who were comfortable attending class in the teaching laboratories. Since the program had more time to prepare for Fall quarter, more hardware could be mailed to students, and more time was available for faculty to develop alternate learning activities that got closer to meeting all course outcomes.
- **Winter and Spring 2021:** With the arrival of the delta variant of COVID-19, all classes went back to remote mode, except for the senior capstone project. Senior students were granted access to the labs to work on their projects.
- **Fall 2021 and beyond:** Courses returned to fully in-person, for the most part, though many faculty have continued to allow students to participate in lectures remotely via Zoom. In addition, the University required a few weeks of the Winter quarter to be taught remotely due to the arrival of the omicron variant, and some faculty chose to continue teaching remotely for a few additional weeks. But, by Fall 2021, the program curriculum had largely returned to normal and was able to again offer its hands-on, experiential curriculum as designed.

B. Course Syllabi

Appendix A includes a course syllabus for every required EECE program, as well as each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5.

Table 5-1a Curriculum (Electronics Concentration)

Electrical and Computer Engineering – Electronics Concentration

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate whether course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)* Math & Basic Sciences	Engineering Topics; Check if Contains Significant Design (√)	Other	Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
FIRST YEAR – FALL QUARTER						
MATH 124 – Calculus 1	R	5			Winter 2022 Spring 2022	35 35
PHYS 161 – Physics with Calculus 1	R	5			Fall 2021 Winter 2022	20 20
CSCI 141 – Computer Programming I	SE	4			Winter 2022 Spring 2022	25 25
CSCI 140 – Programming Fundamentals in C++	SE	4			Spring 2022	25
FIRST YEAR – WINTER QUARTER						
MATH 125 – Calculus II	R	5			Winter 2022 Spring 2022	35 35
PHYS 162 – Physics with Calculus II	R	5			Winter 2022 Spring 2022	20 20
EECE 108 – Introduction to Electrical and Computer Engineering Seminar	R		1		Winter 2021 Winter 2022	72 72
EECE 109 - Introduction to Electrical and Computer Engineering Lab	R		1		Winter 2021 Winter 2022	72 72
CHEM 161 – General Chemistry	R	5			Winter 2022	24

					Spring 2022	24
FIRST YEAR – SPRING QUARTER						
MATH 204 – Elementary Linear Algebra	R	4			Winter 2022 Spring 2022	35 35
PHYS 163 – Physics with Calculus III	R	5			Fall 2021 Spring 2022	20 20
EECE 111 – Circuit Analysis I	R		4		Spring 2021 Spring 2022	72 72
SECOND YEAR – FALL QUARTER						
EECE 210 – Circuit Analysis II	R		4		Fall 2020 Fall 2021	50 48
EECE 233 – Digital Electronics	R		4		Fall 2020 Fall 2021	50 48
MATH 224 – Multivariable Calculus and Geometry I	R	5			Winter 2022 Spring 2022	35 35
SECOND YEAR – WINTER QUARTER						
EECE 220 – Electronics I	R		4		Winter 2021 Winter 2022	48 48
EECE 244 – Embedded Microcontrollers	R		4		Winter 2021 Winter 2022	48 48
MATH 331 – Differential Equations	R	5			Winter 2022 Spring 2022	35 35
SECOND YEAR – SPRING QUARTER						
EECE 310 – Continuous Systems	R		4		Spring 2021 Spring 2022	48 48
EECE 333 – Digital System Design	SE		4		Spring 2021 Spring 2022	36 36
MATH 345 – Engineering Statistics	R	4			Winter 2022 Spring 2022	35 35
THIRD YEAR – FALL QUARTER						
EECE 311 – Discrete Systems	R		4		Fall 2020 Fall 2021	24 36

EECE 344 – Embedded Microcontrollers II	R		4		Fall 2020 Fall 2021	38 48
EECE 320 – Electronics II	R		4		Fall 2021 Spring 2022	48 48
THIRD YEAR – WINTER QUARTER						
EECE 360 – Communication Systems	R		4		Winter 2021 Winter 2022	36 48
EECE 444 – Embedded Systems	R		4		Winter 2021 Winter 2022	36 48
EECE 321 – Electronic Systems	SE		4		Winter 2021 Winter 2022	24 36
EECE 397B – Machine Learning for Engineers	SE		4		Winter 2022	24
THIRD YEAR – SPRING QUARTER						
EECE 433 – Digital Signal Processing	R		4		Spring 2021 Spring 2022	24 36
EECE 460 – Digital Communication Systems	R		4		Spring 2021 Spring 2022	24 36
EECE 361 – Signal Propagation	SE		4		Spring 2021 Spring 2022	36 36
EECE 397A – Wireless Networking and Applications	SE		4		Spring 2021 Spring 2022	36 36
EECE 397C – AI & Reinforcement Learning	SE		4		Spring 2022	24
FOURTH YEAR – FALL QUARTER						
EECE 491 – Project Proposal	R		2		Fall 2020 Fall 2021	24 24
EECE 480 – Control Systems	R		4		Fall 2020 Fall 2021	36 36
EECE 372 – Electromechanical Devices	R		4		Fall 2020 Fall 2021	35 36
FOURTH YEAR – WINTER QUARTER						
EECE 492 – Project Hardware Design	R		4		Winter 2021 Winter 2022	28 24

ENG 302 – Technical Writing	R			5	Winter 2022 Spring 2022	20 20
FOURTH YEAR – SPRING QUARTER						
EECE 493 – Project System Implementation	R		4		Spring 2021 Spring 2022	22 24
Technical Electives (at least 6 credits, distributed throughout)	SE	0-6	0-6			
General University Requirements not in major (distributed throughout)	SE			38		
Add rows as needed to show all courses in the curriculum.						
TOTALS (in terms of semester credit hours)						
Total must satisfy minimum credit hours	Minimum Semester Credit Hours	30 Hours	45 Hours			

1. **Required** courses are required of all students in the program, **Elective** courses (often referred to as open or free electives) are optional for students, and **Selected Elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For Selected Elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

Table 5-1b Curriculum (Energy Concentration)

Electrical and Computer Engineering – Energy Concentration

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate whether course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)* Math & Basic Sciences	Engineering Topics; Check if Contains Significant Design (√)	Other	Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
FIRST YEAR – FALL QUARTER						
MATH 124 – Calculus 1	R	5			Winter 2022 Spring 2022	35 35
PHYS 161 – Physics with Calculus 1	R	5			Fall 2021 Winter 2022	20 20
CSCI 141 – Computer Programming I	SE	4			Spring 2022	25
CSCI 140 – Programming Fundamentals in C++	SE	4			Winter 2022 Spring 2022	25 25
FIRST YEAR – WINTER QUARTER						
MATH 125 – Calculus II	R	5			Winter 2022 Spring 2022	35 35
PHYS 162 – Physics with Calculus II	R	5			Winter 2022 Spring 2022	20 20
EECE 108 – Introduction to Electrical and Computer Engineering Seminar	R		1		Winter 2021 Winter 2022	72 72
EECE 109 - Introduction to Electrical and Computer Engineering Lab	R		1		Winter 2021 Winter 2022	72 72

CHEM 161 – General Chemistry	R	5			Winter 2022 Spring 2022	24 24
FIRST YEAR – SPRING QUARTER						
MATH 204 – Elementary Linear Algebra	R	4			Winter 2022 Spring 2022	35 35
PHYS 163 – Physics with Calculus III	R	5			Fall 2021 Spring 2022	20 20
EECE 111 – Circuit Analysis I	R		4		Spring 2021 Spring 2022	72 72
SECOND YEAR – FALL QUARTER						
EECE 210 – Circuit Analysis II	R		4		Fall 2020 Fall 2021	50 48
EECE 233 – Digital Electronics	R		4		Fall 2020 Fall 2021	50 48
MATH 224 – Multivariable Calculus and Geometry I	R	5			Winter 2022 Spring 2022	35 35
SECOND YEAR – WINTER QUARTER						
EECE 220 – Electronics I	R		4		Winter 2021 Winter 2022	48 48
EECE 244 – Embedded Microcontrollers	R		4		Winter 2021 Winter 2022	48 48
MATH 331 – Differential Equations	R	5			Winter 2022 Spring 2022	35 35
ENRG 380 – Energy and Environment	R			4	Fall 2021 Winter 2022	6 6
SECOND YEAR – SPRING QUARTER						
EECE 310 – Continuous Systems	R		4		Spring 2021 Spring 2022	48 48
MATH 345 – Engineering Statistics	R	4			Winter 2022 Spring 2022	35 35
EECE 397A – Wireless Networking/Applications	SE		4		Spring 2021 Spring 2022	36 36

THIRD YEAR – FALL QUARTER						
EECE 372 – Electromechanical Devices	R		4		Fall 2020 Fall 2021	35 36
EECE 344 – Embedded Microcontrollers II	R		4		Fall 2020 Fall 2021	38 48
EECE 320 – Electronics II	R		4		Fall 2020 Fall 2021	36 48
THIRD YEAR – WINTER QUARTER						
EECE 360 – Communication Systems	R		4		Winter 2021 Winter 2022	36 48
EECE 444 – Embedded Systems	R		4		Winter 2021 Winter 2022	36 48
EECE 374 – Energy Processing	R		4		Winter 2021 Winter 2022	12 12
EECE 397B – Machine Learning for Engineers	SE		4		Winter 2022	24
THIRD YEAR – SPRING QUARTER						
EECE 378 – Smart & Renewable Power	R		4		Spring 2021 Spring 2022	15 15
ECON 386 – The Economics of Electricity Markets	R			4	Spring 2021 Spring 2022	18 18
EECE 361 – Signal Propagation	SE		4		Spring 2021 Spring 2022	36 36
EECE 397C – AI & Reinforcement Learning	SE		4		Spring 2022	24
FOURTH YEAR – FALL QUARTER						
EECE 471 – Energy Project Proposal	R		2		Fall 2020 Fall 2021	12 12
EECE 480 – Control Systems	R		4		Fall 2020 Fall 2021	36 36
ENG 302 – Technical Writing	R			5	Winter 2022 Spring 2022	20 20
FOURTH YEAR – WINTER QUARTER						
EECE 472 – Energy Project Research and Development	R		4		Winter 2021	12

					Winter 2022	12
FOURTH YEAR – SPRING QUARTER						
EECE 473 – Energy Project Implementation	R		4		Spring 2021 Spring 2022	12 12
Technical Electives (at least 6 credits, distributed throughout)	SE	0-6	0-6			
General University Requirements not in major (distributed throughout)	SE			38		
TOTALS (in terms of semester credit hours)						
Total must satisfy minimum credit hours	Minimum Semester Credit Hours	30 Hours	45 Hours			

1. **Required** courses are required of all students in the program, **Elective** courses (often referred to as open or free electives) are optional for students, and **Selected Elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For Selected Elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

CRITERION 6. FACULTY

A. Faculty Qualifications

The EECE program has eight full time tenure-track or tenured faculty (Dr. Xichen Jiang, Dr. Junaid Khan, Dr. Andrew Klein, Dr. Ying Lin, Dr. John Lund, Professor Todd Morton, Dr. Amr Radwan, and Dr. Bhaskar Ramasubramanian), plus two full time tenure-track faculty members who will start Fall 2022 (Dr. Wala Saadeh and Dr. Yuzhang Zang), and two regular contributing non-tenure track (NTT) faculty (Steve Sandelin and Tina Smilkstein). This faculty has a combined 70 years of experience teaching in ABET-EAC programs and a total of more than 100 years of teaching in ABET-EAC and ABET-ETAC programs.

Dr. Xichen Jiang has been at Western since Fall 2016. He is a tenured Associate Professor. He has a PhD in Electrical and Computer Engineering from University of Illinois – Urbana-Champaign. His expertise is in power system reliability. He generally teaches the program's power systems courses and the Energy senior projects.

Dr. Junaid Khan has been at Western since Fall 2020. He is a tenure-track Assistant Professor. Previously, he was a postdoctoral associate at New York University. He has a PhD in Computer Science from Université Paris-Est, France. His expertise is in Internet of Things (IoTs), Connected Automated Vehicles (CAVs), and machine learning. He generally teaches the program's networking and machine learning courses, as well as the senior project courses.

Dr. Andrew Klein has been at Western since Fall 2014. He is a tenured Professor and is the current Program Director of the EECE Program. Previously he held a tenure-track position at Worcester Polytechnic Institute. He has a PhD in Electrical and Computer Engineering from Cornell University. His expertise is communications and signal processing. He is currently teaching the communications courses for the program.

Dr. Ying Lin has been at Western since Fall 2010. She is a tenured Associate Professor. Previously she held a tenure-track position at SUNY-New Paltz. She has a PhD in Electrical Engineering from Syracuse University. Her expertise is in wireless sensor networks and statistical signal processing. She generally teaches the introductory lab and seminar courses, the signals and systems courses, and the digital signal processing course.

Dr. John Lund has been at Western since Fall 2013. He is a tenured Associate Professor. Previously he held a tenure-track position at University of Alaska - Anchorage. He has a PhD in Electrical Engineering from University of Washington. His expertise is in a wide range of electronics applications. He is currently teaching the service courses for other engineering students, the circuit's courses, controls, and the hardware portion of the senior project.

Professor Todd Morton has been at Western since 1988. He is a tenured Professor. Previously he was a Design Engineer at Physio-Control and worked for 5 summers as an ASEE Faculty Fellow at NASA's Jet Propulsion Laboratory. Professor Morton's primary area of expertise is in

Embedded Systems but he also has experience in analog and digital electronics. His teaching responsibility is primarily in Embedded Systems and the senior project courses.

Dr. Amr Radwan has been at Western since Fall 2018. He is a tenure-track Assistant Professor. Previously, he worked in industry at MPP Engineering Inc. He has a PhD in Electrical Engineering from University of Alberta. His expertise is in power electronics and power conversion. He generally teaches the program’s power electronics courses and the Energy senior projects.

Dr. Bhaskar Ramasubramanian has been at Western since Fall 2021. He is a tenure-track Assistant Professor. Previously, he was a postdoctoral research associate at University of Washington – Seattle. He has a PhD in Electrical and Computer Engineering from the University of Maryland – College Park. His expertise is in cyber-physical systems, with an emphasis on using techniques from control, reinforcement learning, formal methods, and game theory. He generally teaches the program’s control systems and artificial intelligence courses.

Dr. Wala Saadeh will join the faculty in Fall 2022. She is currently a tenure-track Assistant Professor at Lahore University of Management Sciences. She has a PhD in Interdisciplinary Engineering from Masdar Institute of Science and Technology. Her expertise is in wearable biomedical devices, low-power DC-DC Converters, and energy efficient digital/analog circuits. She will teach courses in electronics, embedded systems, and likely develop new courses in the area of VLSI.

Dr. Yuzhang Zang will join the faculty in Fall 2022. She is currently a visiting Assistant Professor at Valparaiso University. She has a PhD in Electrical Engineering from University of Wisconsin - Madison. Her expertise is in antenna arrays, including array decoupling and self-interference reduction techniques. She will teach courses in electronics, signal propagation, and E&M.

Steve Sandelin is a non-tenure track instructor and has been a regular contributor to the program since 2012. He has 16 years of industry experience. His latest is as a Senior Member Technical Staff at Maxim Integrated Circuits. He has a BSEE from Washington State University. He brings a wealth of knowledge in microprocessor and digital systems. He primarily teaches the two digital courses but also occasionally teaches courses in electronics, microcontrollers, and other service courses. He does not plan on teaching for the program in AY2022-23.

Dr. Tina Smilkstein is a non-tenure track instructor who joined Western in January 2022. Previously, she was a tenured Associate Professor at California Polytechnic State University – San Luis Obispo. She has a PhD in Electrical Engineering and Computer Science from University of California – Berkeley. Her expertise is in VLSI, including analog and digital circuits and systems, and medical technology. She generally teaches the program’s electronics courses as well as service courses.

Both non-tenure-track instructors provide an important industry perspective to the students. This perspective contributes to the professional and modern outcomes – 2, 3, 4, and 7.

All faculty vitae are included in Appendix B.

B. Faculty Workload

Table 6-2 shows the faculty workload summary. The standard load for T/TT faculty in the Engineering and Design Department is 5 courses per year, which includes laboratory contact hours. If a course has more than one lab section or exceeds 24 students, an Undergraduate Laboratory Assistant is typically assigned to the course for assistance in the lab and, optionally, grading. Larger lab courses in the program core that can have as many as 48 students, multiple weekly lab sections, and 7 or more faculty contact hours per week typically count as one-and-a-half or two courses.

New faculty are typically given a reduced teaching load in their first two years to allow them to establish a research program; they generally teach 3 courses in their first year, 4 courses in their second year, and the standard load of 5 courses every year thereafter.

C. Faculty Size

As of June 2022, the EECE program has eight full-time faculty members, five tenured and three tenure-track. Combined with the NTT instructors, the faculty size meets the requirement of the program without needing faculty to teach more than the standard load. In September 2022, the program expects to have ten full-time faculty members, six tenured and four tenure-track. Rarely, if one or more faculty are on leave, a faculty member may be asked to teach an additional course for additional compensation as an "overload", though this has only happened one time in the past 6 years.

As described in Criterion 1, section D, all faculty are involved in advising, with each faculty member serving as an academic advisor to approximately 15 students at a time. Other than the classroom, academic advising, and involvement of students in faculty research, the members of the faculty interact with the students through advising student clubs, including the local chapters of IEEE and HKN. All faculty are involved in service to the university and EECE program, primarily by serving on committees as described in detail on the faculty CVs in Appendix B. Interactions with industrial and professional practitioners primarily take place through two avenues: the Industrial Advisory Committee, and industry-sponsored capstone projects.

The program goal is to have a graduating student to T/TT faculty ratio of at most six. This assures that the program can improve and the students have close interaction with the faculty. We currently accept 48 students into the program each year, at the beginning of the students' sophomore year. Combined, this quantity of faculty and students allows for adequate levels of faculty advising, service, professional and curriculum development, and industry interactions as described above. It also allows faculty to assess, evaluate, and improve the program.

D. Professional Development

All tenured and tenure-track faculty are very active in their professional development as can be seen in the Faculty Vitae in Appendix B. Examples include research and scholarship, teaching and learning workshops, accreditation symposiums, industry technical and education conferences, workshops, seminars, and webinars.

The new faculty have a reduced teaching load to allow additional time in their first two years to focus on professional development, including establishing a sustainable research program.

Faculty development funding is available from the Department, College as well as from University-wide programs administered by the university's Research and Sponsored Programs (RSP). Department funding for tenure-track untenured faculty is $1500 and for tenured faculty is $1000. During the COVID pandemic, most faculty voluntarily declined their departmental travel allotments so that these funds could be recaptured by the department for other, more pressing needs during the pandemic. College funding up to $1000/year is available for conference registration at which faculty are presenting their work, plus an amount for travel and lodging which ranges from $700 to $2,400 and depends on location. In addition, if approved, up to $600/year is available from the college for conference related expenses if faculty are not presenting. The Research and Sponsored Programs has several programs to support faculty development and scholarship, including Summer Research and Summer Teaching grants of $6000 each, Faculty Development grants of up to $1500, as well as research grant programs with maximums ranging from $500 to $10,000.

Sabbaticals are supported by the University to the extent that state law allows. Sabbatical proposals are submitted by faculty to the Department Chair. The Chair then writes a recommendation to the Dean. The proposal is evaluated and prioritized by the College Personnel committee. At this point, a recommendation may be made to change the number of quarters requested for the leave. The personnel committee makes their recommendations to the Dean who then makes recommendations to the Provost, who makes the final decision.

Table: Professional Development Activities for Each Faculty Member

Faculty Name	**Professional Development Activities**
Xichen Jiang	• Regular attendee and author/presenter at conferences, including both technical and engineering education conferences • Technical papers reviewer for IEEE journals and conferences • NSF panelist, reviewing proposals • Implicit Bias Training at Western Washington University • Student-Centered Learning Workshop at Western Washington University

Junaid Khan	• Regular attendee and author/presenter at conferences with focus on networking, Connected Autonomous Vehicles and IoT • Technical paper reviewer for IEEE journals and conferences • 2021 NSF Networking Technology and Systems (NeTS-ECI) Early Career Investigators Workshop • 2021 Student-Centered Learning Workshop at Western Washington University
Andrew Klein	• Regular attendee and author/presenter at conferences, including both technical and engineering education conferences • NSF panelist, reviewing proposals • CSE STEM Equity & Inclusion Workshops (ISMs) • 2021 ABET Symposium • Numerous virtual workshops from NSF, ASEE, etc. • Technical paper reviewer for IEEE journals and conferences
Ying Lin	• Regular attendee and author/presenter at conferences with a focus on engineering education conferences in recent years • Paper reviewer for ASEE annual conference every year since 2011 • WWU CSE STEM Equity & Inclusion Workshops • Engineering Inclusive Classrooms – Guiding Principles and Strategies", webinar by University of Michigan • Various virtual workshops from ASEE and IEEE, etc.
John Lund	• Regular reviewer and attendee of ASEE conferences • Active participant in SAE and advisor to FSAE Formula student club including attendance at FSAE competitions • Reviewer for multiple IEEE journals including Nano, Sensors, and Journal of Oceanic Engineering
Todd Morton	• 2021 Embedded On-line Conference • Multiple webinars for developing video and on-line assignment submission and grading – Zoom, Camtasia, GradeScope • Multiple webinars and documentation for new embedded microcontrollers – NXP, Renesas, SEGGER • Multiple webinars and documentation on GitLab Issues and using GitLab for Agile development
Amr Radwan	• Regular attendee and author/presenter at conferences with a focus on power electronics and renewable energy integration.

	• Technical papers reviewer for IEEE journals and conferences. • 2021 Women and STEM workshop at Mediterranean Conference on Control and Automation. • 2020 Inclusion and Social Mindfulness in STEM at Western Washington University. • 2019 Implicit Bias Training at Western Washington University. • 2018 Student-Centered Learning Workshop at Western Washington University.
Bhaskar Ramasubramanian	• Regular attendee and author/presenter at conferences with a focus on control systems, cyber-physical systems, machine learning, and multi-agent systems. • Program Committee Member: International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS) 2022, International Conference on Decision and Game Theory for Security (GameSec) 2021. • Member, IEEE Control Systems Society Technical Committee on Security and Privacy. Participated in annual meetings at the Conference on Decision and Control. • Reviewer of papers submitted to IEEE journals and conferences. • Panelist to review proposals submitted to NSF for possible funding. • 2021 Student-Centered Learning Workshop at Western Washington University.
Tina Smilkstein	• Implicit Bias Training at California Polytechnic State University • Reviewer of papers submitted to IEEE conferences. • Member IEEE Engineering in Medicine and Biology Society (EMBS), Society of Women Engineers Institute of Electrical and Electronics Engineers (IEEE), IEEE Solid-State Circuits Society (SSC), Women in Computer Science and Engineering (WICSE), and IEEE Technology and Society. • Attendee and author/presenter at conferences (virtually in recent years) with a focus on engineering education conferences, engineering in medicine and biology, and circuits. • Service learning fellow at California State University.

E. Authority and Responsibility of Faculty

The processes for continuous improvement covered in Criterion 4 are all faculty-centered. Faculty members are involved in the assessment, evaluation, action formulation, and implementation of the accepted actions. Program objectives and program outcomes are developed by the program faculty as a whole, while course outcomes are normally developed by the individual faculty member for that course, and subsequently reviewed and approved by the EECE program faculty.

Curricular revision is initiated by the faculty. The creation or modification of a course generally begins with one or more members of the program faculty bringing the idea forward for consideration. After program consideration, the idea will be discussed with the EECE IAC. If the program faculty and the EECE IAC agree that a change to a course or the program is appropriate, then the idea is brought to the Department Curriculum for consideration and approval. Once the proposal leaves the department it must be approved by the College Curriculum Committee and the Academic Coordinating Council (ACC), a standing committee of the Faculty Senate. The Dean or an appointed representative sits on the College Curriculum Committee, and the Provost or an appointed representative sits on the ACC.

The modification of student outcomes, course outcomes of instruction, and of program objectives follows the procedures outlined earlier in Criterion 4. The need to make changes to program outcomes and/or objectives may be recognized by the faculty, or it may come out of discussions with the EECE IAC, however, once there is an understanding that changes are appropriate, the new program outcomes and/or objectives are drafted by the program faculty, discussed with the EECE IAC, and agreed upon by all. Changes to course outcomes would also be drafted by the faculty. Whether or not other program faculty and the EECE IAC are involved in the development of course outcomes depends upon whether the course is shared by multiple programs or only required for students in the EECE program and the magnitude of the change. For a new course or a significant modification to a course, the course outcomes would be discussed with the EECE IAC as part of the normal discussion of curricular change, but minor changes might be undertaken by the program faculty alone. The Administration is not involved in the development or revision of outcomes and objectives, although there is an obvious need to make sure that the program outcomes and objectives are consistent with and support the Mission of the University.

Table 6-1. Faculty Qualifications

Electrical and Computer Engineering

Faculty Name	Highest Degree Earned- Field and Year	Rank[1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration/Certification	Level of Activity[4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/ summer work in industry
Xichen Jiang	PhD ECE 2016	ASC	T	FT		6	6		High	High	Low
Junaid Khan	PhD CS 2017	AST	TT	FT		2	2		Med	High	High
Andrew Klein	PhD ECE 2006	P	T	FT	3	15	8		High	High	Med
Ying Lin	PhD EE 2007	ASC	T	FT	3	14	12		High	High	Low
John Lund	PhD EE 2009	ASC	T	FT	3	13	9		High	High	Low
Todd Morton	MS EE 1983	P	T	FT	6	34	34		High	High	Low
Amr Radwan	PhD EE 2016	AST	TT	FT	3	4	4	PEng	High	High	Low
Bhaskar Ramasubramanian	PhD ECE 2018	AST	TT	FT		3	1		High	High	Low
Steve Sandelin	BS EE 1995	I	NTT	FT	17	10	10		Low	Low	Low

Tina Smilkstein	PhD EE 2007	I	NTT	PT	7	16	0.5		Med	Med	Low

Table 6-2. Faculty Workload Summary

Electrical and Computer Engineering

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research or Scholarship	Other[4]	
Xichen Jiang	FT	EECE 372 (4) Fall 2021 EECE 472 (4) Winter 2022 EECE 361 (4) Spring 2022 EECE 378 (4) Spring 2022	50	40	10	100
Junaid Khan	FT	EECE 491 (2) Fall 2021 EECE 397B (4) Winter 2022 EECE 397A (4) Spring 2022 EECE 493 (4) Spring 2022	50	40	10	100
Andrew Klein	FT	EECE 360 (4) Winter 2022 EECE 460 (4) Spring 2022	30	35	35	100
Ying Lin	FT	EECE 210 (4) Fall 2021 EECE 311 (4) Fall 2021 EECE 108 (1) Winter 2022 EECE 109 (1) Winter 2022 EECE 310 (4) Spring 2022	50	40	10	100
John Lund	FT	EECE 320 (4) Fall 2021 EECE 492 (4) Winter 2022 EECE 111 (4) Spring 2022	55	40	5	100

Todd Morton	FT	EECE 344 (4) Fall 2021 EECE 491 (2) Fall 2021 EECE 444 (4) Winter 2022 EECE 493 (4) Spring 2022	50	10	40	100
Amr Radwan	FT	EECE 471 (2) Fall 2021 EECE 220 (4) Winter 2022 EECE 374 (4) Winter 2022 EECE 473 (4) Spring 2022	50	40	10	100
Bhaskar Ramasubramanian	FT	EECE 480 (4) Fall 2021 EECE 433 (4) Spring 2022 EECE 397C (4) Spring 2022	35	45	20	100
Steve Sandelin	FT	EECE 233 (4) Fall 2021 EECE 351 (4) Fall 2021 EECE 244 (4) Winter 2022 EECE 352 (4) Spring 2022	95	0	5	80
Tina Smilkstein	PT	EECE 321 (4) Winter 2022 EECE 351 (4) Winter 2022 EECE 320 (4) Spring 2022 EECE 351 (4) Spring 2022	90	0	10	50

CRITERION 7. FACILITIES

A. Offices, Classrooms and Laboratories

General: The Engineering and Design department is housed in the Ross Engineering Technology (ET) Building, built in 1987. This building contains seven classrooms, with the largest accommodating 60 students, a small seminar room, two computer labs, a lab suite for each of the engineering programs, and a lab suite to support long-term projects. The largest engineering classes have enrollments under 50, so most years all engineering classes are taught in the Ross ET Building, and all engineering labs are held in the Ross ET Building as well. None of the facilities in the Ross building are used in support of basic science instruction. Those programs are located in different buildings on campus and have sufficient laboratory space of their own.

1. **Offices**

   All tenured and tenure-track faculty members have individual offices with a computer and the necessary software to support the courses they teach and their scholarship. Non-tenure track (NTT) faculty members have offices, but most share their office with at least one other NTT faculty member. NTT faculty members also have computers and the necessary software to support their teaching. The main administrative office, ET204, houses the Department's administrative staff and the offices of the Chair, and two senior faculty members. All faculty offices are on the second floor of the Ross ET building. The EECE Electronics Technician, Reza Afshari, uses ET 332 as an office (see Figure 7.A.1), so that he is close to the laboratories.

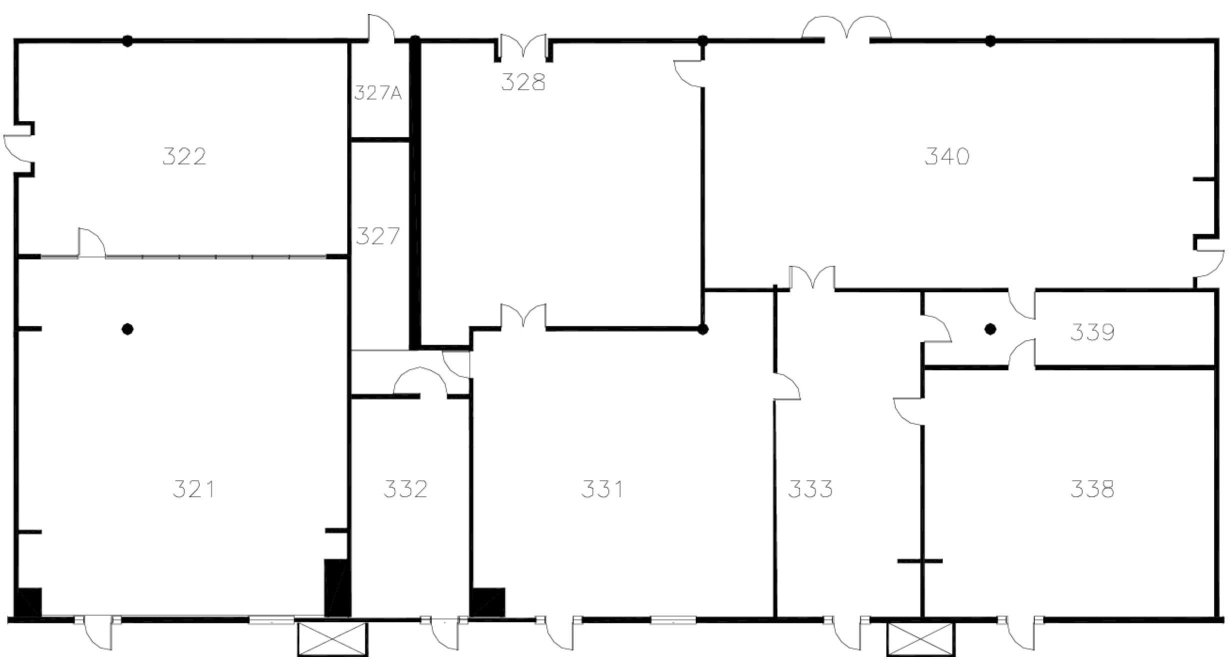


Figure 7.A.1: Classrooms, labs and storage rooms for the EECE program in the Ross ET building

2. **Classrooms**

EECE classes are generally taught in the Ross ET Building in ET 321 or ET 322, or sometimes in ET 333, which is a seminar room, when the class is small enough. All classrooms have whiteboards, a projector, and an instructor station with a networked computer with all of the program software, connections for a laptop, and a document camera. The computer labs also have an instructor station, but without the document camera. The ENGD department maintains cameras that faculty can check out to be able to simulcast a class when there is the need to do so. On some occasions a scheduling conflict results in a program class being taught in a General University Classroom (GUC) in another building. GUCs all have the same equipment as Ross ET classrooms, but they have integrated simulcasting systems. Depending upon the class, it may also be necessary to make arrangements for program software to be available in a GUC, though that has not been an issue during this review period. Starting with the 2022-23 academic year, to accommodate program growth, ET 322 is going to be converted into an additional EECE lab, so more EECE courses will be taught in GUCs. ET 322 is expected to remain a lab until the EECE program moves into its new building, which is scheduled to occur in fall 2024.

3. **Laboratory facilities**

ET332 is an undergraduate research space and the primary working space for the program's electronics technician. There are four workstations with oscilloscopes, multimeters, function generators, and power supplies. This equipment is varied as it is handed down from the primary labs when they are upgraded. ET327 is a storage and fabrication space. The primary EECE laboratory facilities consist of rooms: ET328, ET331, ET338, and ET340. These labs along with the associated storage room, ET339, are shown in Figure 7.A.1.

ET331 is a general-purpose electronics lab. It is typically used for the freshman and sophomore EECE courses along with the service courses, EECE351 and EECE352 (which will be renamed ENGR 351 and ENGR 352, effective AY2022-23). There are 18 workstations for a lab capacity of 36 students. Each workstation includes an Agilent DSO-X Digital Storage Scope with built in Function Generator, a Dell Optiplex 7460 All-in-One PC, Fluke 8808A Multimeters, Fluke 87 Handheld Multimeters, Tektronix AFG 1022 Function generators, and Keithley 2231A Triple Channel DC Power Supplies. In addition, the lab includes two Tektronix 577 Curve Tracers. The computers have the standard EECE software image installed, which includes NI MultiSim, Altium Designer, Freescale/NXP MCU Development Systems, Cypress Semiconductor MCU Development Systems, MicroChip PIC Development System, TI Code Composer, Microsoft Office, Xilinx Vivado, MATLAB, LABVIEW, Adobe Acrobat, Eclipse, Cygwin, and more. Note that Altium has been used through AY2021-22, but will be replaced by KiCAD starting in AY2022-23. EECE students have 24/7 access to this space. Other engineering students taking the service courses have access for 10 hours each weekday.

ET328 is the Alpha Technologies Energy Lab, used primarily by the Energy concentration students or for courses focused on energy systems and power electronics such as EECE 372, 374, and 378. There are 10 workstations, each with several LabVolt (FESTO) modules including motors, generators, loads, dynamometers, and meters, and each with a Dell Optiplex PC. EECE student access is restricted for safety to be used only during class times, or with faculty or staff supervision.

ET338 is another general electronics lab. It is used primarily for the upper-division electronics course, EECE 321, along with the controls course, EECE 480, and the communications and E&M courses, EECE 360, 361 and 460. There are 12 workstations for a lab capacity of 24 students. Each workstation includes a Dell Optiplex 7460 All-in-One PC, Tektronix MSO2024, 4-channel, Mixed-Signal Oscilloscope, an Agilent 33210A Function Generator, a Keysight E3630A Triple Output Power Supply, and Fluke 8808A Multimeters. In addition, the lab includes a soldering station and two spectrum analyzers – an HP35660A Signal Analyzer, and an HP 8590A Spectrum Analyzer.

ET340 is the embedded systems lab is primarily used for the upper division digital and embedded systems courses (EECE 344, EECE 333, EECE 444 and EECE 433) and the senior projects. There are 18 workstations for a capacity of 36 students. Each workstation includes a Dell Optiplex 7460 All-in-One PC, an Agilent DSO-X 3012A Digital Storage Oscilloscope w/built in Function Generator, a Keithley 2231A Triple Channel DC Power Supply, Fluke 8808A Multimeters, a Tektronix AFG 1022 Function generator, and a handheld Fluke 87 multimeter. Four of the workstations have a Keysight DSO-X 3012T Digital Storage Oscilloscope w/built in Function Generator instead of the Agilent DSO-X 3012A. In addition, there is a soldering/reflow station that is also equipped with an oscilloscope and power supply. The computers have the standard EECE image installed. EECE students have 24/7 access.

These laboratories are more than adequate to support the scholarly and professional activities of the students and faculty in the program. The licensed and open-source software used in these facilities is industry standard, as is the instrumentation. The program maintains utilization statistics of the laboratories, and the number of available workstations for 24/7 student use has been sufficient given the number of students and the number of classes held in these spaces.

B. Computing Resources

The ENGD department has 61 computers for the EECE program located in ET 331, ET 338, and ET 340. There are an additional 72 computers for the MFGE, PCE and ID programs located in ET 262 and ET 308. The 22 computers in ET 262 also contain the software for EECE. These computers are available for local use during building hours of 7am-9pm Monday through Thursday and 7am-6pm Friday through Sunday, except for ET 262 which is closed on weekends. Except for ET 262, students are not kicked out of the building or computer labs when the building is locked, so they can continue to work in the computer labs after the building is closed. In addition, all of these computers are available for remote access through Microsoft Remote Desktop 24/7.

The following software is used by the programs in ENGD and available on the lab computers: Altair Simulation Suite, Adobe Creative Cloud, AutoDesk (Fusion360, MoldFlow, SketchBook), CATIA, CGTech Vericut, ChemDraw, Cura, Dassault 3DExperience, DFMA, Keyshot, MATLAB, MestReNova, Minitab, Origin, RoboDK, RoboGuide, Solidworks, Microsoft Project, Altium Designer, Anaconda, Click PLC, Eagle Layout Editor, Energia, Git, TourtiseGit, MCUXpresso, MultiSim, PLECS, PowerWorld Simulator, Microsoft Visio. Some of this software is professional versions, while others are more restrictive student editions through our license agreements with vendors.

In addition to the ENGD computer labs there are approximately 400 general university lab computers available for student use. These labs are in various buildings around campus and having varying building hours with some being open 24/7. The University also has some laptops available for checkout by students. Students in the dorms also have access to the lab computers provided by university residences.

File storage is primarily through Microsoft 365 (OneDrive, SharePoint, Teams), however some legacy content is hosted on the ENGD department's file server. The server is a 16 core Windows server with 256 GB ram and 11 TB of storage. It hosts faculty and staff home directories, GT-Suite and CATIA license servers, some departmental files, research data, and the Formula SAE student club files.

The computing facilities are more than adequate to support the scholarly and professional activities of the students and faculty in the program. The licensed and open-source software used in these facilities is industry standard. Students additionally have remote access to the lab PCs, and in many cases the software licenses permit students to install software on their own PCs, if they desire; this has resulted in much lower utilization of our computer labs during the COVID-19 pandemic.

C. Guidance

The EECE faculty are present and engaged in all laboratory instruction, so they provide guidance regarding the use of the labs. In addition, the program's electronics technician provides excellent guidance on the specialized equipment and software that is not covered in class along with projects students working outside normal lab hours.

When students first enter the EECE major, they participate in an orientation that review the program's Lab Policy document. In addition, the early courses in the curriculum (e.g., EECE 111, EECE 210, and EECE 233) are designed to provide students with an introduction to lab procedures, protocols, and instrumentation, and also address such topics as lab safety, establishing an inclusive and professional atmosphere, and logistics such as how to find electronic parts or how to obtain additional help.

D. Maintenance and Upgrading of Facilities

The electronics technician, Reza Afshari, is responsible for the maintenance of the electronic instrumentation, while Colin Hanson, the IT specialist, is responsible for the computer systems.

Upgrading equipment has been funded primarily through the equipment replacement fee paid by the students. This fee funds the instrumentation upgrades on a 20-year cycle and the PCs on a five-year cycle. Each year the faculty members analyze the equipment replacement plan and reprioritize the equipment needs based on the program curriculum needs. From time to time, the program also receives corporate gifts and equipment donations which are used to upgrade laboratory equipment. For example, gifts from Alpha Technologies and Fluke have been used to equip and upgrade the lab equipment in ET 328 and ET 340, respectively.

E. Library Services

Engineering and Design is supported by the library with journals, books, standards, and a reference collection. Notably, the library has had a subscription to IEEE Xplore since 2014, which our program has identified as a critical resource. Otherwise, the traditional book collection is adequate though somewhat dated, but access to several electronic databases containing many technical references and e-books fills in the gaps. Access to journal articles is good. Journals are available online, many e-books are online, and several reference items are online also. The library purchases materials on demand. An online form is used by faculty to submit purchase requests. Journal subscriptions are considered when requested and ordered when usage merits the purchase. Databases purchased by the library to support Engineering include:

- IEEE Xplore
- SAE Standards
- EBSCO Academic Search Complete
- ACM Digital Library
- Computer Abstracts International
- SPIE Digital Library
- Engineering Index and INSPEC are available by appointment

The library catalog is connected to Summit, a local union catalog of 40 academic libraries, and WorldCat, the OCLC union catalog of libraries around the world. To obtain information the library does not own, the library provides an inter-library loan service. Journal articles are delivered online, books are delivered to faculty departmental offices.

In addition, it is worth noting that the staff at the library includes a “subject librarian” who is designated as a liaison to support the needs of the Engineering and Design department.

Overall, the library has been more than adequate for the EECE program needs. There is one concern worth mentioning, however: every year or two, the “Western Libraries Subscription Task Force” repeatedly threatens to cancel the IEEE Xplore subscription due to cost. To date, the department and program has been able to avoid cancellation of this critical resource, though the future is uncertain.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

The primary program leadership is shared between the Program Director and Department Chair. The Program Director reports to the Department Chair, who reports to the Dean of the College of Science and Engineering, who reports to the Provost and Vice President for Academic Affairs, who reports to the University President.

The Program Director shares responsibility for the program curriculum and resources with the Department Chair. For the EECE program, the Program Director is Dr. Andy Klein and the Department Chair is Dr. Jeff Newcomer. Dr. Klein has been a faculty member in the EECE program since 2014, has been the EECE Program Director since summer 2021. As Program Director, Professor Klein is responsible for the curriculum, the EECE program's seven other tenured and tenure-track faculty, limited-term faculty, the electronics technician, approximately 140 EECE majors, and the program laboratory suite. Appointment of the Program Director is based on a joint recommendation of the Chair and the program faculty.

The Engineering and Design (ENGD) Department Chair, Dr. Jeff Newcomer, who has been the Chair since fall 2012, shares responsibilities with Program Directors for curriculum and facilities for five programs – Electrical and Computer Engineering, Manufacturing Engineering, Plastics and Composites Engineering, First-Year Programs, and Industrial Design. These programs comprise a total of over 400 majors and pre-majors. The Chair, with appropriate consultation with Department faculty and staff, is responsible to the Department, the College, and the University for leadership in matters effecting the Department including, but not limited to:

- Faculty teaching assignments and workloads;
- Course scheduling;
- Curricular planning;
- Recommending appointment of new faculty and staff, including opportunity hires;
- Administering the space and equipment allocated to the Department;
- Budget management and authority;
- Addressing student and faculty concerns by using the relevant university procedures;
- Administering faculty and staff development and performance reviews;
- Reviewing and evaluating faculty tenure and promotion cases;
- Managing the Department's resources;
- Management of assessment and accreditation efforts;
- Management of lab safety programs, including maintaining compliance and training;
- Working with the Foundation to obtain donations for the Department; and
- Other duties assigned by the Dean.

The Chair is also responsible for the development and maintenance of departmental records, for facilitating the harmonious functioning of the Department, for management of the Department's resources, and for providing information to the Dean in a timely manner for use in personnel and departmental resource decisions.

The Dean, Dr. Brad Johnson, is responsible for the leadership of all departments and centers in the College of Science and Engineering (CSE), including the:

- Biology Department,
- Chemistry Department,
- Computer Science Department,
- Engineering & Design Department,
- Geology Department,
- Mathematics Department,
- Physics & Astronomy Department,
- Science, Mathematics and Technology Education (SMATE) program,
- Internet Studies Center, and
- Advanced Materials Science and Engineering Center (AMSEC).

The Dean also has an Associate Dean, Dr. Jackie Caplan-Auerbach, who primarily handles curriculum, assessment, and student considerations such as academic honesty violations and grievances. Dean Johnson started as Dean fall 2017 and Dr. Caplan-Auerbach started as Associate Dean during fall 2017 as well. College-wide decisions are made by the Dean in consultation with several advisory committees including the:

- Policy, Planning, and Budget Council (PPBC),
- Curriculum & Assessment Committee,
- Diversity, Equity, and Inclusion Committee,
- Personnel Committee,
- Technical Operations Committee, and
- Dean's Advisory Committee (DAC).

Each of these committees has a representative from each department. DAC is made up of department Chairs and the SMATE and AMSEC Directors

The Provost, Dr. Brent Carbajal, is responsible for all academic affairs at Western including eight colleges/schools:

- College of Business and Economics,
- College of Fine and Performing Arts,
- College of Humanities and Social Sciences,
- College of Science and Engineering,
- Fairhaven College of Interdisciplinary Studies,
- Graduate School,
- The College of the Environment, and
- Woodring College of Education.

The Dean of each of these colleges reports to the Provost, as does the Dean of the Libraries and five Vice Provosts. The Provost is one of five Vice Presidents that report the President, Dr. Sabah Randhawa, who in turn reports to the Board of Trustees.

Leadership is involved in program decisions in proportion to the impact of the change on the Department and other academic units. Proposals for program changes, ranging from small course changes to program expansion, originate in the program. The Chair ensures that changes that impact multiple programs have input from all of the effected programs, and the curricular change process ensures that programs external to the Department are aware of and approve academic changes that impact them.

All academic course and program changes are reviewed and approved by the ENGD Curriculum Committee, the Department Chair, the CSE Curriculum Committee, and the Academic Coordinating Commission (ACC), which is the university-level curricular body.

All proposals for program expansion are discussed in the ENGD department, by both the PPBC and DAC committees at CSE, at the University Planning and Resources Council (UPRC), and by the Council of Deans run by the Provost, before going to the President and the Vice Presidents for final consideration. Successful proposals are either funded by the Provost or included in the University's operating budget request to the State. The First-Year Programs Director position, four EECE faculty positions and a EECE staff position have been funded through this process during this review period.

Due to the COVID-19 pandemic, the University put in place a hiring freeze from March 2020 to July 2021.

- EECE: Despite the hiring freeze, the Dean and Provost recognized the growing interest in EECE and authorized faculty searches for two positions during the 2020-21 academic year.
- MFGE: Since MFGE did not have any open faculty or staff positions during this period, the MFGE program was unaffected by the hiring freeze.
- PCE: The PCE program was in the middle of a faculty search when the hiring freeze went into effect, and that search was cancelled. The tenure-track line still exists, but because the University's enrollment is down almost 10% compared to pre-pandemic levels, the search for a new PCE faculty member was not authorized for the 2021-22 academic year. The search has been authorized for the 2022-23 academic year.

Leadership has been more than sufficient for maintaining program quality and continuity. The ENGD leadership group, made up of the Chair and the five Program Directors, has a good mix of experienced members and relatively new members with fresh perspectives. The Dean, who was a department chair for nine years and Associate Dean for three years before becoming Dean, is very experienced and has been very supportive of program needs. The Provost and the Associate Vice President for Academic Affairs, Dr. Brian Burton, have been in their positions for nine years and have also been very supportive of the program and its needs. The only concern is that both Provost Carbajal and Associate Vice President Burton are retiring summer 2022, Dean Johnson has been appointed as the new Provost, a position he will begin on August 1, 2022, and Dr. Janelle Leger, the current Chair of Physics and Astronomy, has been named the Interim Dean of CSE.

B. Program Budget and Financial Support

1. The EECE program's budget is a subset of the ENGD Department's budget. The Department's annual recurring budget includes funding for twenty-three permanent, full-time faculty positions and eleven permanent, full-time staff positions (salary and benefits), including nine faculty positions and one staff position exclusively for the EECE program. There are also three permanent, full-time faculty positions in the Department that are funded through the Institute for Energy Studies (IES), one of which is fully in the EECE program, and a permanent, full-time faculty position in Chemistry that is 0.333 FTE in the PCE program. Staff positions and their role in support of the EECE program are briefly discussed in Section 7.C below. During this review period, the Department has added five faculty positions, and both staff positions that were part-time at the last review are now full-time positions.

   The Department has a $75,000 operating budget. The Department's operating budget has increased by $2,000 for each new faculty position added to the Department, but otherwise has been steady for many years. The Department's operating budget is divided into a portion for each program, funding for faculty travel ($1,500/yr for tenure-track faculty members and $1,000/yr for tenured faculty members), funding for equipment repair, and a small amount to support the main office. The current breakdown of the Department operating budget is:

   - EECE: $4,000
   - FYP: $1,600
   - ID: $1,600
   - MFGE: $3,200
   - PCE: $3,200
   - Travel: $24,000
   - Technicians: $4,500
   - Repair: $13,000
   - Chair/Office: $19,900

   Because the College supports faculty travel, including registration fees, for up to two trips per year, a portion of the money budgeted for Travel in the Department operating budget is often used for repairs or to support programs. The Department budget allocations are reviewed every few years, most recently during the 2021-22 academic year due to the addition of FYP and the cancellation of the Industrial Technology-Vehicle Design program, and adjustments to allocations are made if they are warranted by changes in programs.

   For the 2022-23AY (FY2023), the Engineering and Design Department is giving more budgetary control to the Program Directors, including control over the travel funding that is allotted to program faculty members. Since most travel costs end up being covered by the College, this will give the programs more flexibility. The new program allotments for the engineering programs are:

   - EECE: $19,750
   - FYP: $5,350
   - MFGE: $11,450

- PCE: $11,450

Beyond its recurring budget, the Department has multiple funding sources, including annually requested recurring funds and numerous self-sustaining funds:

- The College of Science and Engineering provides annual funding for non-tenure track faculty members (NTTs) on an as-needed basis and 1,000 hours of funding per quarter for undergraduate teaching assistants (UTAs). The annual request is prepared by the Chair and submitted to CSE during winter quarter of the previous fiscal year. The request the 2021-22AY (FY2022) was funded at is usually initially funded at ~$183,000 for salary with $50,000 set aside for UTAs and an additional ~$50,000 set aside for benefits, and the Dean's Office approved additions of $25,000-$30,000 to that request as things changed during the academic year (most of which impacted the Industrial Design program, not engineering). This funding has always been sufficient to meet Department needs, and the Dean's Office has always provided full funding for all requested NTT sections. However, requests for UTAs during the 2021-22 academic year exceeded the 1,000 hrs/qtr that had been sufficient in previous years, so the 2022-23 academic year request was increased to ~$187,000 for salaries with $80,000 set aside for UTAs. The reduction in funding for NTT salaries is due to a reduction in need for NTT led sections due to new hires in the EECE program, so all of the requested sections were funded.
- The Department maintains seven lab fee funds for consumables, including one that specifically support the EECE lab suite. Fees are set based upon expected materials use and other costs, such as specialized software licenses, and attached to each class that uses the lab or lab suite supported by the fund. These funds are supposed to be at or near zero balance at the end of each academic year, and they rarely exceed $5,000 at any given moment.
- The Department maintains three lab fee funds for equipment and computers: 1) a fund to support computers, equipment, and software for EECE, 2) a fund to support computers, annual software costs, and 3D printing for MFGE, PCE, ID, and First-Year Programs (FYP), and 3) a fund to support major equipment purchases in MFGE, PCE, and ID. Computers are replaced on a five-year cycle and major equipment is replaced on a twenty-year cycle. More information is given about the computer and equipment replacement approach in Section 7.D.
- The Department maintains two self-sustaining funds, one related to fees accrued through use of equipment by external users and one general fund. These funds are used for infrastructure improvements and occasionally used for repairs if operating budget funds and funds from the Dean's Office are insufficient. The two funds currently have a combined balance of ~$150,000.
- The PCE program has a fund that is supported by project fees. This fund is used to pay the salary and benefits of the PCE Research Associate and costs associated with projects paying into the fund.
- The Department has a general Foundation fund. This fund is used for program enhancements and to support faculty professional development. The current balance of the Foundation fund is ~$121,000.

- Each engineering program has a Foundation fund. These funds are used for program enhancements at the discretion of the Program Directors for each program. The current balance of the EECE, MFGE, and PCE funds are ~$3,200, ~$36,000 and ~$19,000 respectively. While these funds are not frequently used, the MFGE program spent ~$46,000 on laboratory equipment from its fund in summer 2021.
- The Department is building an equipment endowment. When the principal value reaches $1,000,000, the intent is to spend interest from that fund on major equipment purchases, which should allow for the reduction in what students pay in lab fees for the equipment replacement funds. The current balance of the equipment endowment is ~$630,000.

2. As a primarily undergraduate institution, Western is focused on high-quality teaching, and there are many programs to support teaching. The College funds undergraduate teaching assistant (UTA), the Center for Instructional Innovation and Assessment (CIIA) sponsors events, and provides resources and support for implementation, the Office of Research and Sponsored programs (RSP) supports summer teaching grants, and the Science, Math, and Technology Education (SMATE) program has been offering grant funded curriculum development workshops and teaching orientation workshops for new faculty for the last two years. In addition, the Department will send faculty to workshops or classes to improve teaching and/or content knowledge. This is generally done on an as-needed basis, and it has not been needed recently.

   As mentioned above in Section 8.B.1, the College has been providing funding for 1,000 hours of UTA support each quarter. UTAs are used primarily to support lab activities, and sometimes as graders as well. Priority is given to lab support followed by classroom support and then grading, so as demand for UTA hours has increased, support for grading has been rare, but all requests for lab and classroom support have been accommodated.

   While the College provides support for laboratories and grading, the CIIA provides support for innovation. The mission of the CIIA is:

   > [D]edicated to the enhancement of teaching and learning on the campus of Western Washington University. The Center promotes discussion and debate about teaching and learning, provides support to faculty in instructional innovation and course development, and helps nurture a culture of educational innovation and instructional excellence across disciplines.

   The CIIA realizes its mission through: 1) sponsoring events including workshops, webinars, and summer grant opportunities, 2) serving as a clearinghouse for teaching, learning, and assessment resources, and 3) providing support for implementation of new teaching and assessment methods. The CIIA ran a number of paid workshops to support faculty members switching to online teaching during the pandemic, which was greatly helpful for engineering faculty members, most of whom had never taught an online class before.

   Although it is primarily a research support office, RSP overlaps with the CIIA a bit in that it offers grants to support teaching innovation. RSP provides a competitive grant opportunity for Western faculty to get $6,000 of summer salary to “to provide faculty with time to engage in projects that will result in significant enhancement of instruction." An individual faculty member is eligible to receive a summer teaching grant every other summer.

A different sort of grant support is provided by SMATE. While SMATE's primary focus is preparation of K-12 teachers, SMATE's mission is:

> [T]o improve teaching and learning of science, mathematics, engineering, and computer science by all and for all. We accomplish this through teaching, research, professional development, and partnerships with people and communities in the university, the state, the region and throughout the world. Ultimately we expect to see the results of our work in the healthy and socially just communities around us.

In addition to its grant and workshop activities, SMATE sponsors a paid, three-day teaching workshop for new faculty members before the academic year begins, and almost all new faculty members in engineering participate in this workshop.

3. Maintenance and upgrade of infrastructure and facilities and acquisition, maintenance, and upgrade of equipment are different processes at Western. While general maintenance of infrastructure and facilities is completed by Facilities Management (FM), upgrade of infrastructure and facilities is run through the University's capital budget process. In contrast, acquisition, maintenance, and upgrade of equipment is primarily a Department process that uses a combination of lab fees, grants, in-kind donations, working with industry partners, and sometimes includes the College, the Western Foundation, and University's Student Technology Fee (internal) grant process.

   General infrastructure and facilities maintenance is conducted by FM based primarily upon their campus-wide plan, which is regularly updated. Upgrade of infrastructure and facilities is part of the University's capital budget process. Major capital projects, such as building construction, building renovation, and building expansion are part of the University's ten-year capital plan. Classroom and laboratory renovations and improvements, both programmatic and infrastructure, are part of the University's minor capital project process. This process begins with the submission of a proposal, which can be done by any individual or group on campus. The proposals are then separated into programmatic proposals and preservation proposals, the latter of which includes anything that is related to safety as well. Preservation proposals are assessed and prioritized by FM. FM completes projects in that order as funding allows.

   Programmatic proposals all go to the college or division level where they are all prioritized. The Provost's office then prioritizes all projects from the colleges. The project lists from the Provost and the other Vice Presidents are reviewed by UPRC, which may recommend changes, and then ultimately reviewed and approved by the President. The faculty have input at the College through PPBC and DAC, and at the university level through UPRC. Once the proposed projects are all prioritized, they are scheduled and completed as funding allows. Funding for programmatic projects has been limited recently, but the ENGD Makerspace was funded for an upgrade during the 2021-22 academic year, with the work due to take place during summer 2022.

Unlike infrastructure and facilities, the University does not have a general equipment acquisition, maintenance, and upgrade process, so this is managed by the Department. As mentioned above in Section 8.B.1, the primary source of regular funding is student lab fees. To make sure that these funds are used well and expediently, the Department maintains and annually updates an equipment priority list and acquisition plan.

Whenever possible, lab fee funds are supplemented by grant funds, donations, and University funding sources. Another source of equipment funding has been the University's Student Technology Fee (STF) program. This program is funded by the university-wide student technology fee, and a portion of the funds are set aside to fund equipment acquisition through a proposal process. During this review period, the Department received electronics simulation software for the EECE Energy program; a Universal Cobot for MFGE labs suite; a twin-screw extruder, two microscopes, a Selective Laser Sintering 3D printer, a universal test stand, and a sheet press for the PCE lab suite; and equipment for the Makerspace through the STF program.

During this review period, the EECE program has refreshed some of the lab instrumentation, has replaced and upgraded all lab PCs, and has acquired hardware to enable remote labs during the pandemic. Specifically, the following hardware has been acquired –

- (49) Dell Optiplex 7460 All in one PCs
- (18) Tektronix AFG 1022 Function generators
- (36) Keithley 2231A Triple Channel DC Power Supplies
- (16) Tektronix MDO3024 Mixed Signal Oscilloscopes
- (3) Keysight DSOX1102G Oscilloscopes
- (3) Keysight DSOX3012T Oscilloscopes(35) Saleae Logic 8
- (65) Analog Discovery 2 Pro
- (5) Ettus USRP software-defined radios
- (12) Jetson Nano 2GB developer kits
- (3) dSpace Advanced Control Education Kits 1104 (includes DS1104 R&D Controller Board)
- (3) dSpace 3-Inverter Assemblies

4. Resources have been and remain adequate to attain student outcomes. There are three facets to resources required to attain student outcomes: 1) salaries sufficient to hire and retain appropriately qualified faculty and staff, 2) sufficient operating funds to support annual activities, and 3) consistent funding for the acquisition, maintenance, and upgrade of equipment. While there is room for improvement, especially in the equipment funding situation, there is and has been sufficient support to meet student outcomes.

   As is discussed below in Sections 8.C, 8.D, and 8.E, salaries and benefits are competitive enough to have allowed the Department to attract and retain faculty and staff. While faculty searches have been complicated by the pandemic recently, we have had only one top candidate turn down Western for a job at another university during this review period, and no faculty members have left for other faculty positions. The faculty contracts have had consistent salary increases, and the compression and equity adjustments have raised salaries for senior faculty members to appropriate levels when compared to national averages for engineering. Staff positions are a bit more challenging, due to the rigidity of the State classification system, but almost all of ENGD staff positions have been reviewed and reclassified to higher levels during this review period, so staff retention has been consistently good as well, though there has been some turnover among the classified staff.

As was discussed above in Section 8.B.1, the Department operating budget has been sufficient for operation as it is well supplemented by College and one-time funds. The additional funds from the College for faculty and staff travel and professional development essentially expand the Department operating budget by ~30% each year. The one drawback of this funding model, as opposed to the funds being in the Department, is that it makes long-term planning for professional development more difficult because funding must be requested for each specific event. Fortunately, the Department has sufficient one-time funds to supplement funding for activities that the College will not or cannot fund. The University was also very good about supporting the additional costs incurred from the switch to online instruction due to the pandemic, so the Department did not have to bear those costs out of its operating budget or one-time funds.

Finally, as was discussed above in Section 8.B.3, funding for acquisition, maintenance, and upgrade of equipment has been sufficient, but there is not as large of a regular funding stream as is desirable. Ideally the student lab fees would be about one third of the funding for equipment rather than the largest share. When the Department's equipment endowment gets large enough, and it is getting close, it will be able to provide some regular funding for equipment acquisition, maintenance, and upgrade. For this reason, the equipment endowment is one of the fundraising priorities at this point and time. It would be ideal if the University were also able to consistently contribute to the planned replacement of equipment, but while there have been discussions about doing so, no plans have ever emerged from those discussions.

C. Staffing

The Department currently has three permanent, full-time office classified staff people, seven permanent, full-time technical classified staff people, and one full-time soft-money technical professional staff person. The office staff support all five programs in the Department. Six of the eight technical staff have primary focus areas for supporting labs and programs, while the last two support all five programs in the Department. Below is a brief description of each staff person's responsibilities:

Administrative Services Manager B (ASM), Amy Lazzell – The ASM serves as both the Department Financial Manager and Office Manager. The ASM maintains and tracks budget information for all Department funds including operating, lab fee, foundation, grant, start-up for new faculty hires, and self-sustaining. The ASM also manages payroll, purchasing, hiring procedures including all personnel forms, and serves on the Department Resources Committee. Finally, the ASM supports academics directly by managing the lab fee change process. The ASM is a 1.0 FTE position.

Program Coordinator (PC), Lisa Ochs – The PC serves as the pre-major advisor for all five programs in the Department, designs and manages the Department website, maintains advising and outreach materials such as program planning guides, and supports assessment activities. The PC also supports academics by managing the entering of the course schedule into the University's system. At any given time the PC has 150-300 pre-major advisees, of whom 100-150 are pre-majors in the EECE program. The PC is a 1.0 FTE position with a 0.083 FTE temporary reduction.

Office Assistant 3 (OA), Jodie Permen – The OA serves as the first point of contact for the Department and does several jobs that are important to program support. She orders lab badges for all majors, collects and files syllabi for all classes, and manages textbook orders for classes. The OA is a 1.0 FTE position.

Electronics Technician 4 (ET) for EECE, Reza Afshari – The ET for EECE is responsible for maintaining the EECE labs, supporting the lab activities in them, and enforcing lab rules, including all safety rules. In this role, the ET for EECE also orders parts, and designs and fabricates equipment to support labs and other faculty activities. The ET for EECE is assigned to the EECE program, but does support other areas in the Department when electronics work is needed, as long as such work does not interfere with EECE program needs. The ET for EECE is a 1.0 FTE position.

Instructional and Classroom Support Technician 4 (ICST) for MFGE, Ben Kaas – The ICST for MFGE is responsible for maintaining the MFGE labs, supporting the lab activities in them, and enforcing lab rules, including all safety rules. In addition to working with students in the labs on class and senior projects, the ICST for MFGE maintains equipment, orders parts for the lab, and prepares materials for the lab activities. The ICST for MFGE also runs biweekly meetings of the technical staff so that they may are aware of what is going on in all of the labs and are able to support each other. The ICST for MFGE is a 1.0 FTE position. Because this job has gotten more complicated with time, it is currently being reviewed for possible reclassification or conversion to a Professional Staff position.

Instructional and Classroom Support Technician 4 (ICST) for PCE, Currently Open – The ICST for PCE is responsible for maintaining the PCE labs supporting the lab activities in them, and enforcing lab rules, including all safety rules. The ICST for PCE is also the Chemical and Material Safety Officer. In this role the ICST for PCE maintains inventories of materials, makes sure that all new materials and chemicals are properly logged and have Safety Data Sheets on file, and makes sure that all disposals of materials and chemicals are done properly. The ICST for PCE is a 1.0 FTE position. The ICST for PCE position has been open since January 2022, so the work has been covered by a part-time temporary ICST person (0.67 FTE), extra support for the PCE faculty from CSE, and extra UTAs. A new ICST for PCE is expected to start on July 5, 2022. Because this job has gotten more complicated with time, it is currently being reviewed for possible reclassification or conversion to a Professional Staff position.

Instructional and Classroom Support Technician 3 (ICST) for Project Lab and Evenings, Mark Dudzinski – The ICST for Evenings is responsible for the Projects labs and works until 9:00 p.m. Monday through Thursday during the academic year to provide students supervised access to certain labs, including the Projects labs, the ID Model Making Shop, and portions of the PCE labs, but not the MFGE labs. The ICST for evenings is a 1.0 FTE position.

Instructional and Classroom Support Technician 3 (ICST) for Industrial Design, Lisa Collander – The ICST for ID primarily supports the ID program and labs, but also supports the Makerspace. The ICST for ID is a 1.0 FTE position.

Research Associate 2 (RA) for PCE, Sean Ryan – The RA for PCE works with students and faculty on funded industry sponsored research projects and senior projects. His responsibilities vary with each project, but always involve acting as a liaison with the sponsoring companies, ordering supplies and equipment, and supervising student work on the projects. The RA for PCE is a 1.0 FTE soft-money position.

Information Technology Customer Support – Journey (ITCS) Colin Hanson – The ITCS provides computer and general IT support for faculty, staff, classrooms, computer labs, and general labs for the Department. The ITCS works with other ITCS people in support of the College, but he is fully assigned to support the Department. The ITCS is a 1.0 FTE position.

Engineering Technician Lead (ETL), Stephen James – As the senior technician in the Department, the ETL oversees overall lab safety and organization for the ET building. The ETL also coordinates major building and lab projects, maintains and updates the Department's Emergency Response plan, and coordinates the lab badge program, including the annual lab safety lectures all majors must attend. The ETL is a 1.0 FTE position.

Staff have access to on-campus training through Academic Technology User Services (ATUS), Human Resources (HR), and University courses, which may be taken on a space-available basis. For off-campus training, the College provides $600/year to each member of the staff for staff travel, and staff may request additional funding from the Department as well. For retention, the state classification system does not allow for salary adjustments outside of the proscribed increases, but as staff get more experience and take on additional responsibilities it is common to request that they be moved to a higher classification.

In addition to staff who work exclusively for the Department, there are a number of administrative offices that support the Department. Along with standard university offices such as Academic Advising, Admissions, the Office of Civil Rights and Title IX Compliance (CRTC), Financial Aid, HR, Public Safety, Purchasing, and the Registrar's Office, the following offices support the Department in the following manners:

- ATUS – Computer support for students and computer/software training for faculty, staff, and students.
- Career Services Center – Posting of job and internship opportunities, and the organization and management of three career fairs each year, one of which has an engineering focus.
- Counseling and Wellness Center – Support for students dealing with life problems and emotional concerns.
- Disability Access Center – Support and accommodations for differently-abled students to ensure that they get equal access to curricular and co-curricular activities.
- Environmental Health and Safety (EHS) – Support for technical staff and faculty to make sure that labs are safe and compliant with regulations, including material storage and disposal. EHS Collects and disposes of waste materials from Department labs. EHS

conducts safety related training for faculty, staff, and students. EHS conducts assessments of new procedures to assess risk and make sure that PPE is appropriate. EHS will, on request, audit labs for safety and compliance.

- Equity and Inclusion – The University has a number of offices that support students from diverse backgrounds, including:
    - Ethnic Student Center
    - LGBTQ+ Western
    - Lesbian Gay Bisexual Transgender Advocacy Council
    - Queer Resource Center
    - Womxn Center
- Facilities Management (FM) – In addition to general building maintenance and repair, FM works with technical staff to make modifications and improvements where needed. Recently FM made a number of improvements to electrical connections for equipment to improve safety in Department labs.
- Capital Planning and Development (CPD) – Works with faculty and staff to develop plans for space improvements. These may result in minor, intermediate, or major capital projects. CPD then oversees the implementation of funded plans.
- Foundation of WWU – Each college has a foundation officer. The foundation officer works with the Dean and the departments, usually through the Department Chair, to identify and pursue opportunities for philanthropic support from both individual and corporate donors. The foundation officer identifies potential donors, serves as point person for communication with them, and helps develop proposals for funding.
- Government Relations – Works with State and Federal governments to obtain resources for initiatives such as the Transition to Engineering decision package that resulted in funding for 4.0 FTE of faculty and 3.5 FTE of staff.
- Office of Research and Sponsored Programs (RSP) – Provides support for development and submission of external grants. Provides several different types of small internal grants for faculty and students.
- University Communications – Publicizes accomplishments of faculty and students and helps develop materials for external fundraising. Works closely with Government Relations to support their efforts.
- Veteran Services – Provides comprehensive services to veterans, service members, and their dependents as they pursue their education at WWU.

D. Faculty Hiring and Retention

1. The process for hiring new faculty involves the Program, the Department, the Dean's office, and the Provost's office. First the Program proposes a faculty search. Then the Department determines its hiring priorities and provides them to the Dean. Prior to the COVID-19 pandemic, the Dean, in consultation with the Dean's Advisory Council (DAC) and the Policy, Planning, and Budget Council (PPBC), would determine the hiring priorities for the College and then authorize searches as funding allowed. Since the beginning of the pandemic, the Dean is required to provide hiring priorities to the Provost, who has been authorizing searches based on priority of student access. Due to the reduction in enrollment due to the pandemic, a number of faculty searches have been deferred, but some have been authorized to occur during the 2022-23 academic year, including a PCE faculty search that

was cancelled in the 2019-20AY. Once the Dean approves a search, the Department selects a Chair for and members of a Search Committee for the position(s), and the Search Committee creates a position description and recruitment plan. The position description is reviewed, possibly amended, and approved by the Department faculty and the Chair. The position description and plan must then be approved by the Dean, the Provost, Human Resources (HR), and the Office of Civil Rights and Title IX Compliance (CRTC) before the position is posted.

Once recruitment begins, all applications are reviewed by the members of the Search Committee. Once the Search Committee has reviewed all of the applications, it develops a list of five to twelve candidates for phone interviews. A list of candidates for on-campus interviews, usually three, is developed from the phone interviews. On-campus interviews are two days long, and involve the candidate teaching a sample class, giving a research talk, and meeting individually with faculty and administrators, and in groups with students and staff. Once on-campus interviews are complete, the Search Committee makes a recommendation for hiring priorities to the Department. Once the Department has approved a hiring recommendation, the search process is reviewed by CRTC and then approved by the Dean, the Provost, and HR. Once all of the approvals are in place, the Search Committee Chair notifies the top candidate, and the Department Chair begins negotiation of terms and conditions of employment with that candidate. The Dean and Provost also review and approve the formal offer to the candidate before it is tendered.

A standard package for a new faculty hire includes at least one summer of funding, start-up funding to support the new hire's research, course release for the new hire's first year or two, and funds for relocation expenses. The Department Chair, with approval of the Dean, has some latitude to offer additional salary based upon the candidate's experience, additional summer support, additional start-up funds, or additional course releases. Before a formal offer can be tendered, the Dean, the Provost, HR, and CRTC must all approve the search process and outcome. During this review period, the Department conducted nine faculty searches to fill eight faculty positions, two replacement and six new, for engineering faculty members. Prior to the pandemic, four of six searches were successful, and the top candidate accepted the Department's offer. During one unsuccessful search no offer was tendered. During the other unsuccessful search, which was for two positions, one person turned us down and one accepted the position, but later had to withdraw due to complications due to the pandemic. Since the beginning of the pandemic, searches have been more difficult. One search was cancelled due to the hiring freeze the University imposed in March 2020; that search has now received authorization to restart, and it will occur during the 2022-23 academic year. One search for two positions was authorized despite the hiring freeze. That search resulted in one hire, one person turning us down to take another job, and one person turning us down due to complications due to the pandemic. The most recent faculty search, once again for two positions, resulted in two new hires who will be joining the EECE program in fall 2022.

2. Strategies used to retain current faculty include: 1) professional development funding for travel and webinars, which is described in Section E below, 2) a faculty mentoring program, 3) sections in the faculty contract that provide for merit and equity and compression raises, and 4) a retention fund for competitive counter offers maintained by the Provost. Salary increases are determined through negotiations between the University Administration and the United Faculty of Western Washington (UFWW), the faculty union. In addition to

general cost-of-living raises and raises associated with promotions, the contract has provided for merit raises based upon exceeding expectations on post-tenure review (PTR), and for equity and compression raises. PTR is conducted every five years. Faculty are reviewed for performance in teaching, research, and service, and required to meet expectations in all three areas. A faculty member who exceeds expectations in one or more areas receives a raise. Equity and compression raises are based upon comparison to the faculty member's field, so the salaries of engineering faculty members in the Department are compared to national averages, and adjustments to salaries are made accordingly. At this time University Administration and UFWW just negotiated a new contract and have agreed to revisit the equity and compression formula. The result of this revisiting is that there were no equity and compression raises during 2021-22 academic year, but the raises are expected to return during the 2022-23 academic year.

E. Support of Faculty Professional Development

Faculty professional development is supported by the Department, the College, the Office of Research and Sponsored Programs (RSP), and the University. The Department provides travel/professional development funds for all tenured and tenure-track (probationary) faculty members. Tenured faculty members have an annual Department travel/professional development allotment of $1,000, and tenure-track faculty members have an annual allotment of $1,500. In addition to travel for conference, workshops, and training sessions, these funds can be also be used for on-line development activities such as webinars. In addition, the department will contribute additional funds as needed for justified faculty development activities. These funds come from either indirect cost recovery, foundation funds, or other one-time funding sources.

The College provides funding for travel to conferences, symposia, and meetings. If the faculty member is presenting one or more papers, the College will fund registration fees up to $1,000 per event for up to two events, and also provides $700 to $1,400 for domestic travel, depending upon location, and $1,500 to $2,400 for international travel, depending upon location, for up to two events. The College will also provide these funds for travel to conferences where the faculty member is not presenting a paper and for other opportunities, such as training sessions, provided that there are funds available. Faculty members presenting papers have first priority for College travel funding, and support for a second trip is subject to the availability of funds. The College also provides the Department Chair with an additional $1,000 for travel to conferences.

RSP provides several internal funding programs that support faculty. RSP provides up to $5,000 for Pilot Projects to generate data for grant applications, $6,000 in salary for Summer Research grants, $6,000 in salary for Summer Teaching grants, a small grants program that provides up to $1,000, and manuscript preparation support for up to $2,200, and a New Initiatives Fund that will provide up to $25,000 to support preparation of major grant proposals (>$500,000) that involve multiple researchers. Prior to the pandemic, the Center for Instructional Innovation and Assessment (CIIA) provided faculty summer grants of $4,000 to attend a five-day workshop to acquaint faculty with models, open-source resources, and ideas for web-based course enhancements, after which the CIIA provides assistance and support for implementing the enhancements. Since the start of the pandemic, the CIIA has offered numerous paid workshops for faculty on online and hybrid instruction. It is expected that CIIA will return to summer workshops at some point in the near future.

Finally, the University provides sabbaticals (professional leave) for tenured faculty members to the extent that state law allows. Faculty are eligible for sabbatical after six years, and leave eligibility is accrued at the rate of one quarter of leave for every two years of service. Because state law limits the number of faculty who can be on leave at one time, professional leave is competitive. Sabbatical proposals for one, two, or three quarters of leave are submitted by a faculty member to the Department Chair. The Chair then writes a recommendation to the Dean. Sabbatical proposals are evaluated and prioritized by the College Personnel Committee. The Personnel Committee makes a recommendation to the Dean, who makes a recommendation to the Provost. All sabbatical applications are reviewed by the University Professional Leave Committee (UPLC), which makes a recommendation to the Provost. Based upon these recommendations and the amount of leave available under state law, the Provost awards sabbatical leaves. Due to State restrictions, the number of quarters of leave awarded to an individual faculty member may be lower than the number of quarters requested.

PROGRAM CRITERIA

The following sections briefly describe how the EECE program curriculum satisfies the relevant program criteria for Electrical and Computer Engineering programs. Syllabi for all these courses can be found in Appendix A.

A. General "Electrical and Computer Engineering" program criteria

- **Breadth and depth across the range of engineering topics within Electrical and Computer Engineering**
  All EECE students are required to take 58 quarter credits of courses which provide both breadth and depth across a range of engineering topics –
  - CSCI 140 - Fundamentals of Programming in C++ (4 cr)
  - EECE 108 - Introduction to Electrical and Computer Engineering Seminar (1 cr)
  - EECE 109 - Introduction to Electrical and Computer Engineering Lab (1 cr)
  - EECE 111 - Circuit Analysis I (4 cr)
  - EECE 210 - Circuit Analysis II (4 cr)
  - EECE 220 - Electronics I (4 cr)
  - EECE 233 - Digital Electronics (4 cr)
  - EECE 244 - Embedded Microcontrollers I (4 cr)
  - EECE 310 - Continuous Systems (4 cr)
  - EECE 320 - Electronics II (4 cr)
  - EECE 344 - Embedded Microcontrollers II (4 cr)
  - EECE 360 - Communication Systems (4 cr)
  - EECE 361 - Signal Propagation (4 cr)
  - EECE 372 - Electrical Power and Electromechanical Devices (4 cr)
  - EECE 444 - Embedded Systems (4 cr)
  - EECE 480 - Control Systems (4 cr)

  In addition, students in the electronics concentration are required to take these 20 quarter-credits of courses which provide additional breadth and depth –
  - EECE 311 - Discrete Systems (4 cr)
  - EECE 321 - Electronic Systems (4 cr)
  - EECE 333 - Digital System Design (4 cr)
  - EECE 433 - Digital Signal Processing (4 cr)
  - EECE 460 - Digital Communication Systems (4 cr)

  whereas students in the energy concentration are required to take these 8 quarter-credits of courses which provide depth and breath –
  - EECE 374 - Energy Processing (4 cr)
  - EECE 378 - Smart and Renewable Power (4 cr)

  With the exception of EECE 108, EECE 310, and EECE 311, all of these courses have a weekly laboratory section that provides additional hands-on learning. In addition, the capstone project sequence (10 additional credits) provides additional breadth and depth across a range of engineering topics. Students are also required to take 6 quarter-credits of “technical electives” which may include engineering courses in other disciplines, EECE courses that are not part of their chosen concentration, or more advanced math and science courses.

- **Probability and statistics, including applications**
  EECE students are required to take MATH 345 - Statistics for Engineering, which covers both probability and statistics with engineering applications. In addition, several courses within the EECE program apply probability and statistics to electrical and computer engineering topics, including EECE 460 Digital Communications and EECE 374 Energy Processing.

- **Mathematics through differential and integral calculus**
  The following 27 quarter-credits of mathematics courses are required as part of the EECE curriculum, which includes differential and integral calculus –
    - MATH 124 - Calculus and Analytic Geometry I (5 cr)
    - MATH 125 - Calculus and Analytic Geometry II (5 cr)
    - MATH 204 - Elementary Linear Algebra (4 cr)
    - MATH 224 - Multivariable Calculus and Geometry I (5 cr)
    - MATH 331 - Ordinary Differential Equations (4 cr)
    - MATH 345 - Statistics for Engineering (4 cr)

- **Sciences**
  The following 20 quarter-credits of science courses are required as part of the curriculum –
    - CHEM 161 - General Chemistry I (5 cr)
    - PHYS 161 - Physics with Calculus I (5 cr)
    - PHYS 162 - Physics with Calculus II (5 cr)
    - PHYS 163 - Physics with Calculus III (5 cr)

  Students in the energy concentration are also required to take these science courses in the energy sciences major:
    - ENRG 320 - Science of Energy Resources (4 cr)
    - ENRG 380 - Energy and Environment (4 cr)

- **Engineering topics (including computing science)**
  See first bullet above, which contains a list of courses with content sufficient for analyzing and designing complex electrical and electronic devices, software, and systems containing hardware and software components.

B. Specifically “Electrical Engineering” program criteria

- **Advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics**
  See above in Section A under the third bullet labeled “Mathematics through differential and integral calculus”. As shown in that list, all students are required to take courses in differential equations and linear algebra. Complex variables and discrete mathematics are covered within the EECE program. Notably, complex variables are introduced in

EECE 111 and EECE 210 and used throughout the EECE program, whereas discrete mathematics concepts are introduced in EECE 233, EECE 244, MATH 345, and used throughout the program (see below for further discussion).

C. Specifically "Computer Engineering" program criteria

- **Discrete mathematics**
  Discrete mathematics is introduced in EECE 233 (including coverage of binary algebra, hexadecimal and octal number base systems, signed and unsigned representations, Karnaugh mapping, truth tables, manipulating logic equations, fixed point arithmetic, DeMorgan's Law) as well as MATH 345 (set operations, partitions, counting principles, permutations and combinations, sample spaces, discrete probability). Discrete mathematics concepts are used extensively in more advanced courses such as EECE 244, EECE 344, and EECE 444.

Appendix A

Course Syllabi

Catalog Information

Course Number and Title: EECE 108 – Introduction to Electrical and Computer Engineering Seminar

Credit Hours: 1

Course Description:

A general overview of the fields of Electrical and Computer Engineering (EECE) through weekly guest talks by industry professionals. Topics include curriculum introduction, careers in EECE industry, and fundamental skills to be successful in the EECE program and in one's future career.

Prerequisites: N/A
Co-requisite: EECE 109 or upon instructor approval

Schedule Information

Meeting Times (per week): 1 hr lecture

Facilities, Hardware, and Software

Lab Equipment: N/A

Software: N/A

Lab Facility: N/A

Lab Size Limit: N/A

Lab Fee Type: N/A

Prerequisite Outcomes: N/A

Course Outcomes

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Describe a variety of possible career paths within the field of Electrical and Computer Engineering.	4
2.	Demonstrate an understanding of the EECE program curriculum	
3.	Demonstrate an understanding of fundamental skills helpful for pursuing an engineering degree and future engineering career.	7

Topics:

Overview of the EECE field and the EECE program curriculum
Career paths in EECE
Various topics covered by the guest speakers

Revision History

Revision Date	**Revised By**	**Revision Description**
01/21/2020	Ying Lin	EE program faculty have decided to create a new course EECE 108. This document describes the course specifications that map to the ABET student outcomes.

Catalog Information

Course Number and Title: EECE 109 – Introduction to Electrical and Computer Engineering Lab

Credit Hours: 1

Course Description:

An introductory Electrical and Computer Engineering (EECE) class. Through a series of hands-on lab activities, students will get exposed to common EECE lab instruments and selected software tools, and work on micro-controller (MCU) based team projects.

Prerequisites: PHYS162 or concurrent
Co-requisite: EECE 108 or upon instructor approval

Schedule Information

Meeting Times (per week): 2 hrs lab session

Facilities, Hardware, and Software

Lab Equipment: DMM, Prototype, power supply, MCU

Software: Matlab

Lab Facility: ET331

Lab Size Limit: 36

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes

Prerequisite Outcomes		Course
1.	Recognize the fundamental laws of electricity	PHY162

Course Outcomes

Outcomes of Instruction		Student Outcomes Addressed by Course
1.	Demonstrate appropriate use of electrical and computer engineering lab tools (instruments and selected software).	7
2.	Successfully design, construct, and program a simple microcontroller-based project.	2
3.	Demonstrate the ability to work as a team.	5

Topics:

Introduction to common EECE lab instrument and equipment
Introduction to Matlab and GUI programming
Introduction to Arduino
Various tutorials related to lab activities

Revision History

Revision Date	Revised By	Revision Description
01/21/2020	Ying Lin	EE program faculty have decided to create a new course EECE 109. This document describes the course specifications that map to the ABET student outcomes.

Course Number and Title: EECE 111 – Circuit Analysis I

Credit Hours: 4

Contact Hours: 3 hrs lecture, 2 hrs lab

Course Coordinator: John Lund
Textbook: Electric Circuits, Nilsson and Riedel, Pearson
Supplemental Materials: None

Course (Catalog) Description: Introduction to basic circuit analysis. Resistive circuits, RC and RL circuits, and network theorems

Prerequisites: MATH 125, PHYS 162

Program(s): Required – EECE-Electronics, Required – EECE-Energy

Outcomes of Instruction **Upon completion of this course, students will be able to:**		**Student Outcomes Addressed by Course**
1.	Apply standard electrical units and engineering notation.	1
2.	Describe the basic construction of practical resistors, capacitors and inductors and to interpret device markings.	1
3.	Apply circuit laws and theorems (such as ohms law, KVL, KCL, mesh current, node voltage, and superposition) to analyze DC circuits.	1
4.	Apply circuit analysis methods to create Thevenin and Norton equivalent DC circuits	1
5.	Apply circuit laws and differential calculus to solve the transient and steady state response of RC and RL circuits	1
6.	Analyze and apply basic amplifier circuits using the ideal op-amp model	1
7.	Demonstrate the use of appropriate tools to construct circuits, measure parameters, and to verify DC circuit laws and theories using real parts	6
8.	Employ the basic safety and usage rules for the lab and behave in a professional and responsible manner.	4

List of Topics

Units, Engineering Notation, Voltage, Current, and Power
Voltage and Current Sources, Resistance, Ohm's Law, Kirchhoff's Laws
Series and Parallel Circuits, Voltage and Current Dividers
Node Voltage Method, Mesh Current Method
Thevenin and Norton Equivalents, Max Power Transfer
Superposition,
Operational Amplifiers
Inductance and Capacitance
RL and RC Circuit Response

Facilities, Hardware, and Software

Lab Equipment: Prototype board, DMM, DC Power Supply, Oscilloscope, Function generator.

Software: MultiSim or equivalent (optional)

Lab Facility: ET 331

Lab Size Limit: 30

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes

Prerequisite Outcomes		Course
1.	Proficient at differential and integral calculus	MATH 125
2.	Be able to describe electricity and magnetism concepts	PHYS 162
3.	Be able to describe basic electrical concepts including voltage, current, resistance.	PHYS 162
4.	Be able to describe the basic concepts involved with capacitance and inductance.	PHYS 162

Revision History

Revision Date	Revised By	Revision Description
10/29/2013	Ying Lin	Initial spec for 2014 catalog
10/16/2014	Todd Morton	Remove EE 110 from prerequisite list
3/6/2015	John Lund	ABET mappings
06/18/2015	Todd Morton	Rewrite outcomes, and add textbook and list of topics
10/28/2015	Todd Morton	Change to new format
5/12/2021	John Lund	General ABET updates and minor wording revisions

EECE 210 Course Specifications

Course Number and Title: EECE 210 – Circuit Analysis II

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Ying Lin

Textbook: *Electric Circuits 11th Edition.* Nilsson J.W., Riedel S., Prentice Hall, 2014. ISBN: 978-0133760033

Supplemental Materials:

None

Course (Catalog) Description:

Continuation of basic circuit analysis. Op-amp circuits, AC circuits analysis, AC power, frequency response including Bode plots.

Prerequisites: MATH 204 or equivalent, EECE 111

Program(s): Required – EECE-Electronics, Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Analyze RL, RC, and RLC switching circuits with DC sources.	1
2.	Analyze RLC circuits with AC sources using phasors.	1
3.	Compute the power in AC circuits.	1
4.	Interpret circuit behavior from the frequency response and Bode plots.	1
5.	Analyze and design 3-phase circuits.	1
6.	Use appropriate instrumentation to test AC circuits for comparison with theoretical analyses.	6
7.	Write laboratory reports that are clear, concise, and that effectively communicate and interpret experimental results.	3

EECE 210 Course Specifications

Topics:

1. RL/RC circuit analysis
    a. Multiple time-separated switching events
2. RLC circuits and analysis
3. AC analysis
    a. Review of sinusoids
    b. Root-Mean-Squared (RMS)
    c. Phasors
    d. Impedance
    e. Combining phasors and impedances
    f. Analyzing AC circuits using phasors and impedance
4. Power
    a. Average power
    b. Reactive power
    c. Complex power
    d. Power for parallel and series loads
5. Polyphase circuits
    a. Wye-Wye
    b. Wye-Delta
    c. Single phase equivalent
6. Frequency analysis and selective circuits
    a. Low-pass filter
    b. High-pass filter
    c. Band-pass filter
    d. Cutoff frequencies and determination
    e. Decibel scales
        i. 3dB/6dB
    f. Bode plots
    g. Sketching Bode plots
    h. Filter analysis with Bode plots

EECE 210 Course Specifications

Lab Equipment: Prototype board, DMM, DC Power Supply, Oscilloscope, Function generator.

Software: Circuit analysis software such as Multisim

Lab Facility: ET331

Lab Size Limit: 36

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Proficient at linear algebra and have a working ability to apply linear algebra to solve circuit equations.	MATH 204
2.	Apply circuit laws and theorems (such as ohms law, KVL, KCL, mesh current, node voltage, and superposition) to analyze DC circuits.	EECE 111
3.	Apply circuit analysis methods to create Thevenin and Norton equivalent DC circuits.	EECE 111

Revision History

Revision Date	**Revised By**	**Revision Description**
10/29/2013	Ying Lin	Initial specs for 2014 catalog
3/6/2015	John Lund	ABET mappings
4/30/15	John Lund	Textbook and outline
06/18/2015	John Lund	Outcomes modification from course evaluation
10/20/2015	John Lund	Change to new format
10/28/2015	Todd Morton	Change to new format
06/18/2020	Ying Lin	Follow new ABET SO mappings to change from a-k to 1-7, Change course rubric from EE to EECE
05/21/2021	Ying Lin	Change the course coordinator to Ying Lin
11/12/2021	Ying Lin / Andy Klein	Minor update to course outcomes to align language with other courses

Course Number and Title: EECE 220 – Electronics I

Credit Hours: 4

Course Coordinator: Amr Radwan

Textbook: Behzad Razavi, Fundamentals of Microelectronics, Second Edition, ISBN: 978-1-118-15632-2, or Adel Sedra and Kenneth Smith, Microelectronic Circuits, Seventh Edition, ISBN: 978–0–19–933913–6.

Course Description:

A first course in electronic devices and circuits. Fundamental properties of semiconductor devices and their behavior in electronic circuits.

Prerequisites: EECE 210

Program(s): Required – EECE-Electronics, Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Apply and formulate diode models to design and analyze electronic circuits.	1
2.	Apply and formulate bipolar transistor models to design and analyze electronic circuits.	1
3.	Apply and formulate MOSFET transistor models to design and analyze electronic circuits.	1
4.	Use optoelectronic devices to design and analyze electronic circuits.	1
5.	Use appropriate instrumentation to characterize diodes and transistors and analyze electronic circuits.	1, 6

Topics:

1. Physics of Semiconductors
    a. Intrinsic and extrinsic Silicon and other materials of interest
    b. Doping to create N and P type materials
    c. Charge carrying mechanisms in semiconductors
2. Diode Models and Circuits
    a. Large and Small Signal Models and underlying assumptions
    b. Circuits – Construction and Analysis
3. Physics of Bipolar Transistors
    a. Device Theory and Operating Regions
    b. Device Parameters
    c. Large and Small Signal Models, development and assumptions
4. Bipolar Amplifiers and Switches
    a. Biasing for Proper Operation
    b. Amplifier Configurations – Common Collector, Emitter and Base
    c. Analysis of Each Configuration
    d. Bipolar Switch Biasing
5. Physics of MOS Transistors
    a. Device Theory and Operating Regions
    b. Device Parameters
    c. Large and Small Signal Models, development and assumptions
6. MOS Amplifiers and Switches
    a. Biasing for Proper Operation
    b. Amplifier Configurations
    c. Analysis of Each Configuration
    d. MOS Switch Biasing and CMOS
7. Physics of Optoelectronics Devices
8. Optoelectronics Devices
    a. LEDs
    b. Photodiodes and Phototransistors
    c. Optoisolators

Schedule Information

Meeting Times (per week): 3hrs lecture, 2hrs lab

Facilities, Hardware, and Software

Lab Equipment: Prototype Board, DMM, VOM, DC Power Supply, Oscilloscope, Function Generator.

Software: Circuit Analysis Software such as MultiSim

Lab Facility: ET 331 and ET 338

Lab Size Limit: 48

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes

Prerequisite Outcomes		**Course**
1.	Analyze RL, RC, and RLC switching circuits with DC sources.	EECE 210
2.	Compute the power in AC circuits.	EECE 210
3.	Use appropriate instrumentation to test AC circuits for comparison with theoretical analyses.	EECE 210
4.	Write laboratory reports that are clear, concise, and that effectively communicate and interpret experimental results.	EECE 210

Revision History

Revision Date	**Revised By**	**Revision Description**
10/28/2013	Todd Morton	Initial specs for 2014 catalog
10/28/2015	Todd Morton	Change to new format
04/27/2016	Todd Morton	Course Review
05/08/2017	Todd Morton	Remove prerequisite outcome 4. No longer needed.
01/12/2022	Amr Radwan	Revised class prefix, the outcomes of instruction, ABET mapping, and prerequisite outcomes.

Course Number and Title: EECE 233 - Digital Electronics

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Todd Morton

Textbook: *Digital Design Principles and Practices*, Wakerly

Course (Catalog) Description:

Introductory digital electronics with emphasis on basic digital concepts, Boolean algebra, digital devices, interfacing, and the major functional units from building block approach. Laboratory with applications, constructing, testing and troubleshooting of digital circuits.

Prerequisites: EECE 111, CSCI 140

Program(s): EECE-Electronics Required; EECE-Energy - Required

Outcomes of Instruction		Student Outcomes Addressed by Course
1.	Employ binary, hexadecimal and octal number base systems to represent and manipulate signed and unsigned decimal number values.	1
2.	Apply Boolean algebra and Karnaugh mapping techniques to manipulate logic equations to a desired standard form.	1,2
3.	Analyze and design standard and custom combinational and sequential logic blocks.	1
4.	Employ prototyping and common laboratory hardware to construct, verify and measure timing of digital circuits.	6
5.	Identify critical interface requirements to guarantee digital operation of logic devices with and without DC loading.	2,6

Topics

Datasheet AC and DC specifications
CMOS static and dynamic behavior
Number systems
Binary representation of signed and unsigned integers and fixed point real numbers
Binary addition, subtraction and shifting
Boolean algebra and application of DeMorgan’s laws
Standard forms
Karnaugh maps
Combinational analysis and design
Latches and flip-flops, behavior and timing
Sequential analysis
Counters and shift registers
Memories, RAM and ROM

Facilities, Hardware, and Software

Lab Equipment: Prototype breadboard for DIP packages, DMM, Oscilloscope, Waveform Generator.

Software: None

Lab Facility: ET331

Lab Size Limit: 30

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes

Prerequisite Outcomes		Course
1.	Apply standard electrical units and engineering notation.	EECE 111
2.	Apply circuit laws and theorems (such as ohms law, KVL, KCL, mesh current, node voltage, and superposition) to analyze DC circuits.	EECE 111
3.	Demonstrate the use of appropriate tools to construct circuits, measure parameters, and to verify DC circuit laws and theories using real parts	EECE 111
4.	Employ the basic safety and usage rules for the lab and behave in a professional and responsible manner.	EECE 111
5.	Apply basic programming concepts	CSCI 140/141

Revision History

Revision Date	Revised By	Revision Description
10/28/2013	Todd Morton	Initial specs for 2014 catalog
10/28/2015	Todd Morton	Change to new format
4/27/2016	Steve Sandelin	Re-worded and reduced outcomes. Expanded topics section. Increased class size limit to 30. Updated prerequisite outcomes from current EE111 spec sheet.
05/20/2021	Todd Morton	Map course outcomes to new SOs 1-7. Change course rubric from EE to EECE.
05/27/2022	Andy Klein	Removed outcome "Identify current digital integrated circuit devices and families."

Course Number and Title: EECE 244 Embedded Microcontrollers I

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Todd Morton

Textbook: *ARM Assembly Language*, Hohl/Hinds (optional)

Supplementary Materials: Vender Documentation, Course Notes

Course Description:

Introduction to microcomputers, microcontrollers, and programming concepts. Study of assembly instruction sets, structured programming using assembly language, and basic embedded debugging techniques.

Prerequisites: EECE 233

Program(s): EECE

Outcomes of Instruction		Student Outcomes Addressed by Course
1.	Identify and apply fundamental microcomputer system hardware architecture and components	1
2.	Employ MCU programming registers, assembly instructions, and addressing modes to construct assembly language programs.	1
3.	Specify required fixed-point, or floating point, number types and write assembly language programs to perform simple fixed-point, and floating-point, arithmetic.	1
4.	Employ hierarchical design and structured programming concepts to design and analyze assembly language programs.	1
5.	Apply MCUXpresso IDE, and SEGGER J-Link debugger to write and test assembly language programs.	6
6.	Design and document assembly language programs that meet given requirements, best practices, and conventions.	2

Topics

Microcomputers: CPU, Bus System, Memory Devices, IO Devices
A Survey of Current Microcontrollers
Software Development and Construction
Assembler Rules and Directives
Programming Model – CPU Operation and Register Set
Introduction to Assembly Instruction Set v7-M or v8-M
Data Transfer Instructions and Addressing Modes
Bitwise, Arithmetic, and Logic Instructions
General Purpose IO, GPIO
Program Flow Instructions, Structured Constructs
Subroutines and Stack Instructions, Parameter Passing, APCS
Program Structure, Data Objects
Software Delays
Basic Serial I/O

Fixed-Point and Floating-Point Arithmetic Programming

Facilities, Hardware, and Software

Lab Equipment: NXP Cortex M4 or Cortex M33-based microcontroller development board, Workstation, MSO, DMM

Software: MCUXpresso, SEGGER debugger

Lab Facility: ET331

Lab Size Limit: 30

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes

Prerequisite Outcomes		Course
1.	Employ binary, hexadecimal and octal number base systems to represent and manipulate signed and unsigned decimal number values.	EECE 233
2.	Analyze and design standard and custom combinational and sequential logic blocks.	EECE 233

Revision History

Revision Date	Revised By	Revision Description
10/28/2013	Todd Morton	Initial spec for 2014 catalog
04/01/2015	Todd Morton	Removed old outcomes 5 and 7.
10/28/2015	Todd Morton	Change to new format
04/14/2016	Todd Morton	Course revisions based on course review
05/20/2021	Todd Morton	Course outcome mapping change to new SO's 1-7. Rubric changed from EE to EECE.
11/11/2021	Andy Klein	Updated prereq outcomes to match new language on EECE 233 outcomes.
04/26/2022	Todd Morton	Course review

EECE 310 Course Specifications

Course Number and Title: EECE 310 – Continuous Systems

Credit Hours: 4

Contact Hours: 4hrs lecture

Course Coordinator: Ying Lin

Textbook: "Signal and Systems", 1st edition, by Mahmood Nahvi, McGraw Hill, ISBN: 9780073380704

Supplemental Materials:

None

Course (Catalog) Description:

Introduction to continuous-time signals and systems. Analysis of linear time-invariant (LTI) systems. Laplace transforms, Fourier transforms, and their applications to LTI system analysis.

Prerequisites: MATH 331 or equivalent, EECE 210

Program(s): Required – EECE-Electronics, Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1	Identify whether a system is linear and/or time-invariant (LTI).	1
2	Compute the Laplace transform given a continuous-time signal and apply the value limit theorem.	1
3	Obtain the inverse Laplace transform using the partial fraction expansion method.	1
4	Solve and analyze first and second order circuits using the Laplace transform method.	1
5	Obtain Fourier series and/or Fourier transform for a given continuous-time signal	1
6	Obtain linear convolution of two signals using both analytical and graphical approaches.	1
7	Given an input signal, compute the output of a continuous-time LTI system in both the time domain and frequency domain.	1
8	Interpret LTI system behavior from the system impulse and/or frequency response (magnitude and phase responses).	1,6

Topics:

Introduction to continuous-time signals
Linear and time-invariant systems and impulse response
Convolution
Solving 1st and 2nd order circuits using differential equations

EECE 310 Course Specifications

Laplace transform (definition, calculation, and the value limit theorem)
Solving 1st and 2nd order circuits using Laplace transform
Fourier series and Fourier transform
System transfer function and frequency response

EECE 310 Course Specifications

Lab Equipment: None

Software: Matlab

Lab Facility: N/A

Lab Size Limit: N/A

Lab Fee Type: Equipment replacement fee

Prerequisite Outcomes		**Course**
1	Solve 1st and 2nd order differential equations	MATH 331
2	Analyze RLC circuits with AC sources using phasors.	EECE 210
3	Interpret circuit behavior from the frequency response and Bode plots.	EECE 210

Revision History

Revision Date	**Revised By**	**Revision Description**
10/29/2014	Ying Lin	Initial specs for 2014 catalog
04/04/2015	Ying Lin	Add ABET mappings
04/23/2015	Ying Lin	Revise ABET mappings
04/28/2015	Ying Lin	Add textbook information and list of topics covered
10/26/2015	Ying Lin	Add more course outcomes, revise original outcomes by using appropriate verbs, and follow the new course spec format
11/02/2015	Ying Lin	Revise course outcomes to better serve upper level courses such as EE360 and EE480
06/18/2020	Ying Lin	Follow new ABET SO mappings to change from a-k to 1-7, removed outcome #1 per suggestions from EE faculty, and Change course rubric from EE to EECE
05/21/2021	Ying Lin	Recheck the course specifications and remove one of the prerequisite outcomes.

Course Number and Title: EECE 311 – Discrete Systems
Credit Hours: 4

Contact Hours: 4hrs Lecture

Course Coordinator: Ying Lin

Textbook: "Signal and Systems", 1st edition, by Mahmood Nahvi, McGraw Hill,
ISBN: 9780073380704

Supplemental Materials: Lecture Notes and Other References

Course (Catalog) Description:

Introduction to discrete-time signals and systems. z-transform, Discrete Fourier transform, introduction to sampling theorem.

Prerequisites: EECE 310
Program(s): Required – EECE-Electronics

Outcomes of Instruction		Student Outcomes Addressed by Course
1.	Identify and describe discrete-time signals.	1
2.	Apply sampling theorem to obtain the discrete-time signal for a given continuous-time signal and to specify the digital spectrum.	1
3.	Explain the effects of aliasing when sampling a continuous-time signal.	1
4.	Identify whether a discrete-time system is linear and/or time-invariant.	1
5.	Given an input signal, compute the output of a discrete-time LTI system in both the time domain and z-domain.	1
6.	Given a discrete-time signal, obtain the discrete Fourier transform (DFT) and apply the DFT results to analyze the frequency spectrum.	1
7.	Apply z-transform to obtain system transfer functions and to analyze discrete-time LTI system behaviors (such as stability).	1
8.	Use software tools (such as Matlab or LabView) to conduct simulations for discrete-time signals and systems.	6

Topics:

Discrete-time signals and sampling
Linear time-invariant systems
Discrete convolution
Difference equations
z-transform
Discrete Fourier transform
System function and frequency response

Lab Equipment: None
Software: Matlab and/or LabView
Lab Facility: N/A
Lab Size Limit: N/A
Lab Fee Type: N/A

Prerequisite Outcomes		**Course**
1.	Identify whether a continuous-time system is linear and/or time-invariant.	EECE 310
2.	Obtain Fourier series and/or Fourier transform for a given continuous-time signal.	EECE 310
3.	Interpret LTI system behavior from the system impulse and/or frequency response (magnitude and phase responses).	EECE 310

Revision History

Revision Date	Revised By	Revision Description
10/29/2013	Ying Lin	Initial specs for 2014 catalog
04/04/2015	Ying Lin	Add ABET mappings
04/27/2015	Ying Lin	Revise ABET mappings
04/28/2015	Ying Lin	Add textbook information and list of topics covered
06/17/2015	Ying Lin	Revise course outcomes
10/26/2015	Ying Lin	Add course outcomes, revise course outcomes by using appropriate verbs and by following the new course spec format.
06/13/2019	Ying Lin	Map course outcomes to new SOs 1-7.
05/21/2021	Ying Lin	Change course rubric from EE to EECE. Revise the pre-requisite outcomes to be consistent with EECE310.

Course Number and Title: EECE 320 – Electronics II
Credit Hours: 4
Course Coordinator: John Lund
Textbook: *Fundamentals of Microelectronics*, Behzad/Razavi or,
Microelectronic Circuits, Sedra/Smith or
Design with Operational Amplifiers and Analog Integrated Circuits, Franco
Course Description:
A course in the analysis and design of electronic systems including amplifier building blocks, frequency response, and an introduction to switch-mode power supply and control circuits.
Prerequisites: EECE 220, EECE 310
Program(s): Required – EECE-Electronics, Required – EECE-Energy

Outcomes of Instruction		Student Outcomes Addressed by Course
1.	Design and analyze circuits using operational amplifiers with resistive feedback.	1
2.	Characterize, evaluate, and incorporate static and dynamic operational amplifier limitations.	1
3.	Identify the suitability of commercial amplifier offerings to meet design requirements based on static and dynamic limitations such as input offset/bias voltage/current, supply voltage, input voltage and differential range, output voltage swing, output current, slew rate, and gain-bandwidth product.	1,2
4.	Design and analyze circuits using contemporary power amplifier ICs.	1,2
5.	Design and analyze circuits using linear and switched mode voltage regulators.	1,2
6.	Design, assemble, and test circuit boards using modern design automation software.	2
7.	Use appropriate instrumentation to characterize and evaluate components and test electronic circuits.	6

Topics:

- Operational Amplifiers
  - Circuits with Resistive Feedback
    - The four main amplifier topologies (series-series, series-shunt, etc.)
    - Examination of operations using these topologies
      - Inverting amplifier
      - Non-inverting amplifier
      - Summing amplifier
      - Difference amplifier
      - Buffer
      - Floating load voltage to current converter
      - Howland pump
      - Improved Howland pump
    - Input and output impedance

        - Analysis with finite open-loop gain
        - Return ratio and Blackman's formula
        - Static Op Amp Limitations
            - Input current bias/offset
            - Input voltage bias/offset
            - Output swing
            - Output voltage
            - Supply range
            - Input differential voltage
                - Op-amp as a comparator?
                - Input protection resistors/diodes
            - Dynamic Op Amp Limitations
                - Slew rate
                - Gain-bandwidth product
                - THD
    - Design with Operational Amplifiers
        - Input/Output impedance management
        - Loading effects
        - Voltage to current converter
        - Instrumentation amplifier
        - Programmable gain amplifier
        - Calibration
        - Gain and offset with staged design
        - Reading datasheets
    - Power Amp ICs
        - Class A, B, AB, C, D
            - THD and carrier filtering
            - Class D Amplifier with feedback compensation
    - Voltage Regulators and References
        - Linear
        - Switching (Buck, Boost, Buck-Boost, Flyback, Ćuk)
        - Charge Regulators
        - Design from datasheets
    - EDA Software
        - Schematic design
        - Board design
            - Rules and best practices
            - Routing
            - Sensitive feedback path routing for DC/DC converters
            - ERC/DRC
            - Test procedure and test points
        - Fabrication export
        - Soldering and assembly
    - Example Project: LED Driver

Schedule Information

Meeting Times (per week): 3hrs lecture, 2hrs lab

Facilities, Hardware, and Software

Lab Equipment: Prototype Board, DMM, VOM, DC Power Supply, Oscilloscope, Function Generator, Soldering iron

Software: Circuit Analysis Software such as MultiSim, EDA software as anticipated for the class capstone project sequence (coordinate with relevant capstone instructor)

Lab Facility: ET331

Lab Size Limit: 30

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes

Prerequisite Outcomes		Course
1.	Apply and formulate MOSFET transistor models to design and analyze electronic circuits.	EECE 220
2.	Apply and formulate diode models to design and analyze electronic circuits.	EECE 220
3.	Solve and analyze first and second order circuits using the Laplace transform method.	EECE 310
4.	Obtain Fourier series and/or Fourier transform for a given continuous-time signal.	EECE 310
5.	Use appropriate instrumentation to characterize diodes and transistors and analyze electronic circuits.	EECE 220

Revision History

Revision Date	Revised By	Revision Description
10/28/2013	Todd Morton	Initial spec for 2014 catalog
04/01/2015	Todd Morton	Added program outcomes
05/27/2016	Todd Morton	Changed Format and Course Review
6/17/2020	John Lund	Updated for ABET and Prefix Changes
5/19/2021	John Lund	Mini-review update, updated coordinator, outcomes
1/12/2022	John Lund	Harmonized prerequisite outcomes with EECE 220 changes

Course Number and Title: EECE 321 – Electronic Systems

Credit Hours: 4

Course Coordinator: Todd Morton

Textbook: *Design with Operational Amplifiers and Analog Integrated Circuits*, Franco

Course Description:

Upper division treatment of active linear and nonlinear electronic circuits. Analysis, design and testing of electronic circuits and subsystems with primary emphasis on the application of integrated circuit components and modules including active filters, signal generation, and data convertors.

Prerequisites: EECE 310, EECE 320

Program(s): Required – EECE-Electronics, Elective – EECE-Energy

	Outcomes of Instruction	**Student Outcomes Addressed by Course**
1.	Use appropriate software and hardware tools to model, design, simulate, and test linear and non-linear circuits.	1, 6
2.	Formulate, design and test active filter circuits.	1, 6
3.	Design, analyze, and test nonlinear circuits.	1, 6
4.	Formulate design solutions to meet noise and stability requirements.	2
5.	Characterize and evaluate A-to-D and D-to-A convertors in order to design a mixed-signal system.	1
6.	Design, analyze, and test signal generator circuits	1, 6

Topics:

Active Filters
Noise
Stability
Non-Linear Circuits
A-to-D and D-to-A Convertors
Signal Generators
PLL

Schedule Information

Meeting Times (per week): 3hrs lecture, 2hrs lab

Facilities, Hardware, and Software

Lab Equipment: Prototype Board, DMM, VOM, DC Power Supply, Oscilloscope, Function Generator.

Software: Circuit Analysis Software such as MultiSim

Lab Facility: ET338

Lab Size Limit: 24

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes

Prerequisite Outcomes		Course
1.	Solve and analyze first and second order circuits using the Laplace transform method.	EECE 310
2.	Interpret LTI system behavior from the system impulse and/or frequency response (magnitude and phase responses).	EECE 310
3.	Use appropriate instrumentation to characterize and evaluate components and test electronic circuits.	EECE 320
4.	Design and analyze circuits using operational amplifiers with resistive feedback.	EECE 320

Revision History

Revision Date	Revised By	Revision Description
10/28/2013	Todd Morton	Initial spec for 2014 catalog
04/01/2015	Todd Morton	Added program outcomes
05/20/2021	Todd Morton	Change course outcome mapping to new SO’s 1-7. Changed rubric from EE to EECE.
11/11/2021	Andy Klein	Updated prereq outcomes to match new 310 and 320 preqreq outcomes.

Course Number and Title: EECE 333 - Digital System Design

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Todd Morton

Textbook: *Digital Systems Design Using Verilog,* Roth

Course (Catalog) Description:

An upper-division course in digital system analysis and design including the study of sequential/state machine design techniques and applications with an emphasis on writing HDL for design, simulation and testing of FPGA and SoC's.

Prerequisites: EECE 233

Program(s): EECE-Electronics Required; EECE-Energy - Elective

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Design and document flat and hierarchical combinational and sequential designs using a Hardware Description Language that meet given requirements, best practices and conventions.	2
2.	Identify the requirements for complete test coverage of a digital design and write HDL test code to validate behavior.	6
3.	Apply DC electrical specifications to interface digital components to other digital and non-digital components.	2
4.	Employ hardware and software tools to analyze, synthesize, simulate and verify HDL design descriptions in a programmable logic device.	1,6
5.	Employ Mean-Time-Between-Failure analysis to specify synchronization requirements for asynchronous inputs.	2
6.	Apply AC electrical specifications to quantify performance and meet timing requirements of synthesized combinational and sequential designs.	1

Topics

Programmable Logic Architectures
Modern Design Flows and Design Hierarchy
Verilog – Syntax, Lexical Description, Operators and Structure
Coding for Combinational and Sequential Circuits in Verilog
State Machine Analysis and Design
Global Signal Considerations – Clocks and Resets
Design Simulation
- Testbench – Use and Design of.
- Behavioral versus Timing Simulations
- Use of a Waveform Viewer to Assess Design Performance

Coding for Common Design Blocks
- Shift Registers – Coding for Structure and Shift Register Based Design
- Counters – Coding for Structure and Counter Based Design

Digital Encryption and Design/Data Security
Handling Asynchronous Inputs – Synchronizers and Metastability
Common Communication Protocols – I2C, SPI, USB
Non-logic Gates and Interfacing – Tristate gates, Open drain, Schmitt Triggers
Wired Logic
Linear Feedback Shift Registers and Cyclic Redundancy Checks

Facilities, Hardware, and Software

Lab Equipment: DMM, Mixed Signal Oscilloscope, FPGA Evaluation Board.

Software: Xilinx Vivado Design Suite

Lab Facility: ET340

Lab Size Limit: 24

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes

Prerequisite Outcomes		Course
1.	Employ binary, hexadecimal and octal number base systems to represent and manipulate signed and unsigned decimal number values.	EECE 233
2.	Apply Boolean algebra and Karnaugh mapping techniques to manipulate logic equations to a desired standard form.	EECE 233
3.	Analyze and design standard and custom combinational and sequential logic blocks.	EECE 233
4.	Identify critical interface requirements to guarantee digital operation of logic devices with and without DC loading.	EECE 233

Revision History

Revision Date	Revised By	Revision Description
10/28/2013	Todd Morton	Initial spec for 2014 catalog
3/22/2016	Steve Sandelin	Changed to new format
4/26/2016	Steve Sandelin	Reworded Student outcomes and assigned Outcome Codes. Updated Prerequisite outcomes to match new EE233 course spec. Changed textbook. Expanded topics section.
05/20/2021	Todd Morton	Changed course outcome mapping to new SO’s 1-7. Changed rubric from EE to EECE.
04/26/2022	Todd Morton	Fix SO6 mapping to SO 1

Course Number and Title: EECE 344 – Embedded Microcontrollers II

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Todd Morton

Textbook: None

Supplemental Materials: Course Notes, Vender Documentation

Course (Catalog) Description:

Upper-division study of analysis and design of electronic systems using embedded microcontrollers. This course focuses on using the C programming language for embedded microcontrollers, real-time programming techniques, and on-chip resources. Various hardware resources and interfacing techniques will be introduced and applied in laboratory design problems.

Prerequisites: EECE 244

Program(s): Required – EECE

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Develop C programs for resource constrained and safety critical embedded systems.	1
2.	Develop real-time embedded firmware that utilizes interrupts and simple cooperative multitasking.	1
3.	Develop low-level driver programs and interface hardware for common peripherals.	1
4.	Employ a Git revision control system to manage code revisions and distribution for projects with a single developer.	1
5.	Employ debugging tools and appropriate instrumentation to verify function and timing in real-time embedded firmware and hardware.	6
6.	Design and document C programs that meet given requirements, best practices, and conventions.	2

Topics:

- Microcontroller Review, ARM Cortex-M4 or M33
  - ARM Cortex-M4 or M33 NVIC Interrupt Controller
  - Kinetis K65 On-Chip Resources
- Programming Embedded Microcontrollers in C
  - C Programming Language
  - NXP, MCUXpresso IDE
    - IDE – Editor, Assembler, Compiler, Linker, Debugger
    - Segger BDM Pod
    - eGit Revision Control System
  - MISRA and other standards for safety critical C programs
- Real-time and Simple Multitasking Techniques
  - Interrupts
  - Cooperative Multitasking
  - CPU load and timing analysis
- On-chip Resource Drivers
  - GPIO
  - Timers
  - Serial Ports – UART, SPI, I2C
  - ADC and DAC
  - Touch Sensing
  - Watchdog Timer
  - DMA Controller

Lab Equipment: MCU Development Board, Windows PC with Serial port, Mixed-Signal Oscilloscope, DMM,TWR-K65

Software: MCUXpresso, , SEGGER debugging hardware and software, GitLab.

Lab Facility: ET340

Lab Size Limit: 30

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Identify and apply fundamental microcomputer system hardware architecture and components	EECE 244
2.	Employ MCU programming registers, assembly instructions, and addressing modes to construct assembly language programs.	EECE 244
3.	Specify required fixed-point, or floating point, number types and write assembly language programs to perform simple fixed-point, and floating-point, arithmetic.	EECE 244
4.	Employ hierarchical design and structured programming concepts to design and analyze assembly language programs.	EECE 244
5.	Apply MCUXpresso IDE, and SEGGER J-Link debugger to write and test assembly language programs.	EECE 244
6.	Design and document assembly language programs that meet given requirements, best practices, and conventions.	EECE 244

Revision History

Revision Date	**Revised By**	**Revision Description**
10/28/2013	Todd Morton	Initial specs for 2014 catalog
10/16/2014	Todd Morton	Remove EE 333 from prerequisite list
04/01/2015	Todd Morton	Added outcomes 2 and 3. They were removed from EE244
04/14/2016	Todd Morton	Update format and change outcomes based on course review
05/20/2021	Todd Morton	Changed course outcome mapping to new SO's 1-7. Changed rubric from EE to EECE.
04/12/2022	Todd Morton	Spring 2022 course review

Course Number and Title: EECE 360 – Communication Systems

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Andy Klein

Textbook: *Software Receiver Design,* by Johnson, Sethares, Klein, 2011, ISBN: 0521189446

Supplemental Materials:

Digital and Analog Communication Systems, by Leon W. Couch, Pearson/Prentice Hall, 2007.

Digital Communications, by John G. Proakis, Pearson/Prentice Hall, 1989.

Course (Catalog) Description:

This course introduces analog and digital communication systems with an emphasis on system level concepts. Fundamental principles underlying communication systems will be studied, including modulation and demodulation, radio architectures and receiver structures, bandwidth requirements, SNR, pulse shaping, and synchronization.

Prerequisites: EECE 310; MATH 345

Program(s): Required – EECE-Electronics, Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Derive expressions for transmitted signals in time and frequency domains (e.g. DSB, DSB-SC, SSB, PAM, PSK).	1
2.	Derive expressions for demodulated signals in time and frequency domains (e.g. DSB, DSB-SC, SSB, PAM, PSK).	1
3.	Describe the tradeoff between bit rate, noise, and bandwidth in communication systems.	1
4.	Describe and analyze the major practical impairments to reliable communication, such as fading channels, imperfect oscillators, and synchronization errors.	1
5.	Apply communication theory concepts to design, simulate, and build a communication system.	1, 2, 6
6.	Design an experiment to determine the frequency response of a system.	6
7.	Describe contemporary and ethical issues in spectrum management and regulation.	4
8.	Prepare well-written technical design reports and laboratory reports consisting of observations, analysis, and discussion.	3, 6

Topics:
Introduction, overview of a transceiver.
Modelling corruption/non-idealities, review of signals, frequency domain, sampling.
Oscillators, mixers, nonlinearities.
Amplitude modulation, DSB-SC AM, suppressed carrier, SSB.
Quadrature modulation.
Heterodyne architectures.
Adaptivity via stochastic gradient descent algorithms.
Review of digital filtering, DFT. Converting bits to symbols.

Lab Equipment: Oscilloscope, function generator, RTL-SDR USB dongle, acoustic mic/speakers.

Software: Simulation software such as Matlab

Lab Facility: ET338

Lab Size Limit: 36

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Given an input signal, compute the output of a continuous-time LTI system in both the time and frequency domains.	EECE 310
2.	Interpret LTI system behavior from the system impulse and/or frequency response.	EECE 310

Revision History

Revision Date	**Revised By**	**Revision Description**
10/29/2013	Ying Lin	Initial specs for 2014 catalog
10/23/2014	Andy Klein	Updated course description and outcomes.
03/20/2015	Andy Klein	Added program outcomes
04/30/2015	Andy Klein	Added numbers to outcomes (indicating initial exposure, reinforcement, mastery). Added list of topics. Added textbook.
06/18/2015	Andy Klein	Added and revised course outcomes.
10/20/2015	Andy Klein	New course spec format.
6/16/2020	Andy Klein	Updated a-k to be 1-7, changed to EECE

Course Number and Title: EECE 361 – Signal Propagation

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Andy Klein

Textbook: *Fundamentals of Applied Electromagnetics*, by Ulaby, 2014, ISBN: 0133356817

Supplemental Materials:

Antenna Theory, Analysis and Design, 3rd Edition, by C.A. Balanis, Wiley 2005.

Physics for Scientists and Engineers, 3rd Edition, by R.D. Knight, Addison-Wesley 2012.

Engineering Electromagnetics, by W.H. Hayt, McGraw-Hill.

Essentials of Electromagnetics for Engineering, by D.A. De Wolf, Addison-Wesley.

Introductory Engineering Electromagnetics, by B.D. Popović, Cambridge Univ Press.

Course (Catalog) Description:

Signal transmission through both guided and unguided media. Distributed-circuit concepts, transmission line theory, and RF impedance matching. RF signal propagation, wireless channel modeling, and basic concepts in antenna theory. Emphasis on applications to communication systems.

Prerequisites: MATH 224, PHYS 163

Program(s): Required – EECE-Electronics, Required – EE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Use differential calculus to derive the telegrapher's equations, and apply them to the compute the voltage and current waveforms in a transmission line.	1
2.	Use equations to compute reflection coefficients, input impedances, and transient responses of transmission line circuits.	1
3.	Use a Smith chart to compute reflection coefficients, input impedances, and transient responses of transmission line circuits.	1
4.	Design an RF impedance matching network.	1
5.	Model RF path loss, and compute link budgets for transmission through unguided media.	1
6.	Evaluate the antenna gain, input impedance, radiation pattern, and polarization of dipole antennas.	1
7.	Compare antennas in terms of basic properties such as radiation pattern, beamwidth, field regions, directivity, gain, effective aperture, bandwidth, and polarization.	1
8.	Conduct experiments on practical transmission lines such as coaxial cable or PCBs, and relate measured behavior to theory.	1, 6
9.	Conduct experiments on path loss in wireless communication systems, and relate measured behavior to	1, 6

	theory.	
10.	Construct an antenna to meet given design parameters, and design experiments to measure performance and behavior.	1, 2, 3, 6

Topics:

Guided media / transmission lines

- Telegrapher's equations
- Steady state waves on transmission lines
- Open and short circuited lines
- Reflection coefficients, input impedances, transient responses
- RF impedance matching
- Smith chart

Unguided media / wireless transmission

- RF signal propagation
- Wireless channel models and path loss
- Link budget analysis

Antennas

- Analysis of dipole antennas
- Radiation patterns, gain, bandwidth, polarization, and other antenna parameters
- Comparison of common antenna types
- Design guidelines for antennas

Lab Equipment: Oscilloscope, function generator, cable meter, SWR meter, RTL-SDR USB dongle.

Software: Simulation software such as Matlab

Lab Facility: ET338

Lab Size Limit: 24

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Demonstrate proficiency in multivariate calculus.	MATH 224
2.	Apply differential equations to engineering problems.	MATH 331
3.	Compute electrostatic and time-varying electromagnetic fields induced by a charge.	PHYS 162
4.	Demonstrate understanding of electromagnetic waves, superposition, oscillations, and standing waves.	PHYS 163

Revision History

Revision Date	**Revised By**	**Revision Description**
10/29/2013	Ying Lin	Initial specs for 2014 catalog
10/23/2014	Andy Klein	Removed EE 360 as prerequisite, updated prerequisite outcomes.
03/20/2015	Andy Klein	Added program outcomes
04/30/2015	Andy Klein	Added numbers to outcomes (indicating initial exposure, reinforcement, mastery). Added list of topics. Added textbook.
10/09/2015	Andy Klein	Major overhaul, including new course title, new course description, new course outcomes, new preqreq outcomes.
5/19/2021	Andy Klein	Changed EE to EECE, new ABET outcomes

Course Number and Title: EECE 372 – Electrical Power and Electromechanical Devices
Credit Hours: 4
Contact Hours: 3 hours lecture, 2 hours lab
Course Coordinator: Xichen Jiang
Textbook:

P.C. Sen, "Principles of Electric Machines and Power Electronics", Wiley, 2014.

M. Pai, "Power Circuits and Electromechanics", Stipes, 2007.

Supplemental Materials: Course Notes, IEEE Papers

Course (Catalog) Description:

A study of electrical power concepts and electomechanical devices' theory, operation and analysis. Topics covered include circuit analysis review, basic electromagnetic theory, three phase power systems, dc machines, synchronous generators, power transformers and induction machines. Also offered as ENRG 372.

Prerequisites: EECE 210

Program(s): Required – EECE-Electronics, Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Evaluate and analyze three-phase circuits and perform real and reactive power calculations.	1
2.	Calculate power factor and apply power factor correction.	1, 2
3.	Construct a magnetic component satisfying given design parameters, and conduct experiments to assess whether the performance and behavior match theoretical analyses.	1, 2, 6, 7
4.	Apply single and three-phase transformer models in electrical power analysis.	1, 2
5.	Evaluate, analyze, and use DC machines.	1, 6
6.	Conduct and analyze experiments with synchronous machines.	1, 6
7.	Conduct and analyze experiments with induction machines.	1, 6

Topics:

Single-phase power
- Real, reactive, and complex power
- Power factor and power factor correction

Three-phase power
- Per-phase analysis
- Delta and wye configurations
- Line and phase voltages and currents
- Delta-wye transformation

Magnetic circuits
- Toroid with and without airgap
- Hysteresis
- Magneto motive force, flux, and reluctance

Transformers
- Dot notation
- Single-phase transformer equivalent circuit
- Three-phase transformers

DC Machines
- Theory and operation
- Equivalent circuit

Synchronous Machines
- Theory and operation
- Equivalent circuit

Induction Machines
- Theory and operation
- Equivalent circuit

Power Lab Safety

Lab Equipment: LabVolt (FESTO) System
Software: MatLab
Lab Facility: ET328
Lab Size Limit: 16
Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Analyze RLC circuits with AC sources using phasors.	EECE 210
2.	Compute the power in AC circuits.	EECE 210

Revision History

Revision Date	**Revised By**	**Revision Description**
10/28/2013	Todd Morton	Initial specs for 2014 catalog.
10/16/2014	Todd Morton	Remove EE 333 from prerequisite list.
04/14/2016	Todd Morton	Update format and change outcomes based on course review.
06/19/2016	Todd Morton	Changed to new format.
10/6/2021	Xichen Jiang	Course outcome mapping changed to new SO's 1-7. Rubric changed from EE to EECE. Updated Course Coordinator, Textbook, Supplemental Materials, Outcomes of Instruction, Topics, Software, Prerequisite Outcomes.

Course Number and Title: EECE 374 Energy Processing
Credit Hours: 4
Contact Hours: 3hrs lecture and 2hrs lab
Course Coordinator: Amr Radwan
Textbook: Power Electronics, Fourth Edition, Rashid, M.H., Pearson, ISBN: 978-0133125900.
Supplemental Materials: LabVolt Handouts

Course (Catalog) Description:

A study of power electronics devices and circuits applied to power conditioning. Topics covered include switching characteristics of power semiconductor devices, power converter topologies, control techniques in power converters and practical applications of power electronics converters in motor drives. Also offered as ENRG 374.

Prerequisites: EECE/ENRG 372, EECE 320
Program(s): Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Understand the scope and application of generic power conversion (ac to dc, dc to dc, dc to ac and ac to ac)	1
2.	Understand the theory and operational characteristics of diodes, thyristors and controllable switches	1
3.	Design and test line commutated power electronics circuits	1, 6
4.	Design and test buck, boost and buck boost converters.	1, 6
5.	Use controllable switches for voltage and frequency control	1, 6

Topics:

Module 1: Introduction

- Evolution
- Scope and applications
- Power semiconductor devices

Module 2: Single-Phase Rectifier Circuits

- Fourier analysis of electric power, active power
- Single phase uncontrolled rectifiers: half-wave, full-wave
- Phase control: firing angle, extinction angle
- Single phase controlled rectifiers: inductive load, freewheeling diode

Module 3: Three-phase rectifiers

- Three phase diode rectifiers
- Three phase rectifiers: half-wave, semi-controlled, full-bridge
- Applications and technologies

Module 4: DC-to-DC Converters

- Step Down (Buck Converter)
- Step Up (Boast Converter)
- Buck Boast Converters
- Applications and technologies

Module 5: DC-to-AC Converters

- Switch mode DC-to-AC converters
- Pulse width modulation
- Applications and Technologies

Lab Equipment: LabVolt power laboratory consoles (or equivalent) with a selection of ac and dc motors and components, power meters and voltmeters

dSPACE 1104 Advanced Control Kit with 3phase power inverters and a selection of dc loads

Software: Power electronics circuits analysis software such as Matlab, Simulink SimPowerSystems toolbox, spreadsheet software, and dSPACE Control Desk.

Lab Facility: ET328

Lab Size Limit: 14

Lab Fee Type: Equipment replacement, Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Design and analyze circuits using linear and switched mode voltage regulators.	EECE 320
2.	Evaluate and analyze three-phase circuits and perform real and reactive power calculations.	EECE/ENRG 372
3.	Calculate power factor and apply power factor correction.	EECE/ENRG 372
4.	Conduct and analyze experiments with synchronous machines	EECE/ENRG 372

Revision History

Revision Date	**Revised By**	**Revision Description**
11/12/2013	Tom Grady	Initial specs for 2014 catalog
11/20/2013	Todd Morton	Minor modification for initial spec
10/13/2014	Morad Abdelaziz	Revised Course number, title, description, prerequisites, lab equipment, software, prerequisite outcome and outcomes
06/20/2016	John Lund	Modified to new format and added textbook
05/20/2021	Amr Radwan	Revised class prefix, lab equipment and software, lab size limit, ABET mapping, and prerequisite outcomes.
06/14/2022	Amr Radwan	Harmonized prerequisite outcome language to match changes to EECE 320 and 372 language.

Course Number and Title: EECE 378 – Smart and Renewable Power
Credit Hours: 4
Contact Hours: 3 hours lecture, 2 hours lab
Course Coordinator: Xichen Jiang
Textbook:

A. Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley, 2011.

D. Glover, M. Sarma, and T. Overbye, "Power System Analysis and Design", Cengage, 2016.

Supplemental Materials: Course notes, IEEE papers

Course (Catalog) Description:

A study of smart grid and renewable energy technologies. Topics covered include basics of power system operation, smart grid objectives and main features, alternative energy technologies and interface to utility grid, storage systems technology, Plug-in Hybrid Electric vehicle technology, demand response and demand side management and smart grid monitoring. Also offered as ENRG 378.

Prerequisites: EECE/ENRG 374
Program(s): Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Explain the basics of power system structure and operation	2, 4
2.	Explain the evolution and objectives of the smart grid	4, 7
3.	Explain the various techniques used in smart grid monitoring, communication, and control	1, 4
4.	Model photovoltaic systems with different equivalent circuits and use them to predict their power output under various operating conditions	1, 2
5.	Describe the construction of a wind turbine and compare their output power to the Betz limit	1, 2
6.	Describe generator, load, and transmission line models used in power system analysis	1
7.	Calculate and analyze the power flow in a network	1
8.	Apply optimization techniques to power system planning and operation	1, 2, 4

Topics:

Module 1: Power Systems Operation

- Load, transmission lines, and generators
- AC power flow analysis
- DC power flow analysis
- Economic dispatch and unit commitment

Module 2: Renewable and Distributed Generation

- Distributed generation concept and definition
- Wind power
- PV power
- Energy storage
- Renewable energy intermittency in power system operation

Module 3: Smart Grid

- History and evolution
- Objectives and challenges of the smart grid
- Demand response and smart grid monitoring

Lab Equipment: LabVolt (FESTO) System
Software: MatLab, Simulink, PowerWorld, PLECS
Lab Facility: ET 328
Lab Size Limit: 12
Lab Fee Type: Equipment replacement, Materials and supplies

Prerequisite Outcomes		**Course**
1.	Evaluate and analyze three-phase circuits and perform real and reactive power calculations.	EECE/ENGR 372
2.	Calculate power factor and apply power factor correction	EECE/ENGR 372

Revision History

Revision Date	**Revised By**	**Revision Description**
11/12/2013	Tom Grady	First Draft
11/20/2013	Todd Morton	Minor modifications for initial draft
10/13/2014	Morad Abdelaziz	Revised Course number, title, description, prerequisites, software, prerequisite outcome and outcomes
6/20/2016	Todd Morton	Modified to new format and added textbook
10/13/2021	Xichen Jiang	Course outcome mapping changed to new SO’s 1-7. Rubric changed from EE to EECE. Updated contact hours, course coordinator, textbook, supplemental materials, outcomes of instruction, topics, lab equipment, lab software, and prerequisite outcomes.

Course Number and Title: EECE 397A Wireless Networking and Applications

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Junaid Khan

Textbook: *Computer Networking: A Top-Down Approach Featuring the Internet, 8th edition, by James F. Kurose and Keith W. Ross*

Supplemental Materials:

Wireless Communication Networks and Systems, Cory Beard and William Stallings, Pearson, first edition, 2015.

Course (Catalog) Description:

This course introduces fundamental concepts of wireless networks. The course starts with the introduction of computer networking basics such as loss, delay, throughput at the network edge/core. Then it takes a top-down approach begining at the application layer of a network and working its way down to the wireless physical layer. It also covers a broad range of wireless networking standards, and reviews important wireless network application areas (e.g., Network Security, Internet of Things and Connected Vehicles)

Prerequisites: EECE 244

Program(s): Required – EECE-Electronics

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Interpret different network types and be able to use fundamental benchmarks (delay, loss, throughput) to evaluate wireless networks	6, 7
2.	Create a network application using a client-server communication model using socket programming	1, 7
3.	Apply congestion control mechanisms to analyze transport layer protocols such as TCP, UDP	6
4.	Distinguish between different routing protocols on the network layer	1, 7
5.	Apply wireless collision avoidance protocols such as CSMA/CA at the link/MAC layer	1, 2, 6
6.	Differentiate between different wireless communication technologies and standards	1, 6
7.	Create teams to design a wireless network and evaluate its performance using standard metrics	2
8.	Prepare well-written technical design reports and laboratory reports consisting of observations, analysis, and discussion.	3, 6

Topics:

Wireless networks basics, edge/core, delay loss, throughput, OSI layers
Application layer protocols (HTTP, FTP, DNS), P2P and Client/server model
Transport layer, UDP, TCP Congestion control (Tahoe/Reno)
Routing protocols (Link state, distance vector, RIP. OSPF, BGP), Subnetting
Wireless MAC concepts, Wireless 802.xx standards (e.g. Wifi, Bluetooth/Zigbee/LoRa), CRC, ALOHA, CSMA/CA
Intro to physical layer (coding, DMZ/Manchester etc), MIMO
Adv. topics:
IoT, Multimedia streaming, Vehicular Networks, 5G/mmWave technology
Network Security – Authentication, Symmetric and public key cryptography, privacy preservation, WEP for Wifi

Lab Equipment: Computer, Raspberry Pi

Software: Linux, NS3, Wireshark

Lab Facility: TBD

Lab Size Limit: 36

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Identify and formulate fundamental microcomputer system hardware architecture and components	EECE244

Revision History

Revision Date	**Revised By**	**Revision Description**
12/17/2020	Junaid Khan	Initial specs for 2021 catalog

Course Number and Title: EECE 397B Machine Learning for Engineers

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Junaid Khan

Textbook: Machine Learning: A Probabilistic Perspective, Kevin Murphy

Supplemental Materials:

- *Elements of Statistical Learning*, Trevor Hastie, Robert Tibshirani and Jerome Friedman.
- *Machine Learning*, Tom Mitchell.
- *A Course in Machine Learning*, Hal Daumé III.

Course (Catalog) Description:

Provides an introduction to machine learning with particular attention on real-world engineering applications. Theoretical foundation and application of supervised learning techniques such as regression and classification as well as unsupervised learning techniques such as clustering and dimensionality reduction. State-of-the-art deep learning algorithms as well as their implementation and use in solving engineering problems. Applications may include object detection and identification in images/videos, pattern recognition in speech/audio, and traffic predictions.

Prerequisites: EECE 244; MATH 204; MATH 341 or MATH 345

Program(s): EECE

Outcomes of Instruction		Student Outcomes Addressed by Course
1.	Formulate and apply linear and logistic regression models to predict dependent variables in real world engineering examples	2, 6
2.	Apply multiclass classification techniques on different datasets and differentiate one-vs-one, one-vs-all and multinomial regression	1, 2, 6
3.	Apply K-means and other clustering techniques and explain the comparative results to larger audience in class	3
4.	Explain the difference between linear and non-linear dimensionality reduction.	3, 7
5.	Implement decision trees to solve regression and classification problems	6
6.	Compare and evaluate deep learning algorithms in the context of real-world engineering applications	1, 2, 5

Topics:

- Linear, Logistic Regression
- Bias/Variance Trade-off
- Overfitting, cross-validation, model order selection
- Multi-class Classification, KNNs
- Support Vector Machine (SVM)
- Principal Component Analysis PCA (dimensionality reduction)
- Clustering
- Decision Trees
- Boosting and Random Forests
- Deep Neural Networks basics

Lab Equipment: Computer, Raspberry Pi

Software: Python (including common ML frameworks such as TensorFlow or PyTorch), Jetson software development kit

Lab Facility: TBD

Lab Size Limit: 36

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Identify and apply fundamental microcomputer system hardware architecture and components	EECE244
2.	Apply probability and linear algebra concepts to solve engineering problems.	MATH204, MATH341 or 345

Revision History

Revision Date	**Revised By**	**Revision Description**
10/05/2021	Junaid Khan	Initial specs

Course Number and Title: EECE 397C - Artificial Intelligence and Reinforcement Learning

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Bhaskar Ramasubramanian

Textbook: *Artificial Intelligence: A Modern Approach*, S. Russell and P. Norvig

Supplemental Materials:

- *Reinforcement Learning: An Introduction*, R. S. Sutton, and A. G. Barto
- *A Course in Machine Learning*, Hal Daumé III.

Course (Catalog) Description:

This course introduces the fundamental principles, techniques, and applications of artificial intelligence (AI) and reinforcement learning (RL). Topics include knowledge representation, heuristic and algorithmic search methods, reasoning and planning in uncertain environments, and algorithmic learning techniques in unknown environments. The course also includes a discussion of the ethical and societal implications of AI and RL. Students completing this course will have a working knowledge of the design and implementation of various algorithms that will allow an intelligent agent to accomplish tasks in complex environments. Applications of topics covered in this course may include robotics, autonomous driving, and computer games.

Prerequisites: EECE 244; MATH 204; MATH 341 or MATH 345

Program(s): EECE students

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Recognize history of AI and its scientific foundations	1
2.	Apply principles of AI to engineering problems that require planning, inference, and learning	2, 7
3.	Develop solutions in a widely used programming language. Implement algorithms in laboratory working in teams and visualize solutions and outcomes.	5, 6
4.	Identify the key components of a reinforcement learning (RL) problem	1
5.	Formulate and solve an RL problem using various algorithms. Implement algorithms in laboratory.	5, 6, 7
6.	Recognize limitations of AI and identify potential ethical and societal implications through group discussions	3, 4, 5

Topics:

- Introduction, Intelligent Agents
- Solving Problems by Searching, Search in Complex Environments
- Logical Agents, First-Order Logic, Knowledge Representation
- Automated Planning
- Quantifying Uncertainty, Probabilistic Reasoning
- Reinforcement Learning, Sequential Decision Making
- Markov Decision Processes, Dynamic Programming, Q-learning
- Applications, Comparison with other Machine Learning Techniques
- Ethics, Safety, and the Future of AI

Lab Equipment: Computer

Software: Python (including common ML frameworks such as TensorFlow or PyTorch)

Lab Facility: TBD

Lab Size Limit: 36

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Identify and apply fundamental microcomputer system hardware architecture and components	EECE 244
2.	Apply probability and linear algebra concepts to solve engineering problems.	MATH 204, MATH 341 or MATH 345

Revision History

Revision Date	**Revised By**	**Revision Description**
09/29/2021	Bhaskar Ramasubramanian	Initial specs for AY2021-22 catalog

Course Number and Title: EECE 433 – Digital Signal Processing

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Ying Lin

Textbook:
"Understanding Digital Signal Processing", 3rd edition, by Richard G. Lyons, ISBN: 0131089897

Supplemental Materials: Course Notes and Vender Documentation such as
Freescale TWR-K65F180M-SCH.pdf
Freescale K65P169M180SF5RMV2 K65 Sub-Family Reference Manual
Freescale K65P169M180SF5V2 Technical Data
Eclipse eGit User Guide: http://wiki.eclipse.org/EGit/User_Guide

Course (Catalog) Description:
Introduction to the fundamentals of digital signal processing (DSP) and digital filtering. Topics include design and analysis of FIR filters and IIR filters, and practical applications of DSP. Students will gain both software simulation and hardware hands-on experience in implementing DSP algorithms.

Prerequisites: EECE 311, EECE 444

Program(s): Required – EECE-Electronics

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Implement fast Fourier transform (FFT) to analyze the frequency spectrum of digital signals.	1
2.	Design and implement FIR filters and IIR filters and analyze filter performances including passband ripples/gain, passband roll-off (transition region width), and stop band attenuation.	1,6
3.	Obtain filter impulse response and frequency responses given FIR and IIR filter structures, difference equations, or transfer functions.	1
4.	Recognize the impact of quantization and fixed-point and floating-point hardware.	1
5.	Apply DSP techniques to design solutions for practical applications.	1
6.	Use software tools for software development and computer-aided simulation.	1,6

Topics:
FFT
FIR filters and IIR filters
Definitions and comparisons
Z-domain transfer function
Frequency response
Design methods (window method and optimal method)
Implementation structures
Software implementation
DSP applications
Advanced digital filtering

Lab Equipment: MCU, Oscilloscope, Function generator, Windows PC with Serial port
Software: C Program Development System, Debugging hardware and software, Matlab
Lab Facility: ET338
Lab Size Limit: 30
Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Apply sampling theorem to obtain the discrete-time signal for a given continuous-time signal and to specify the digital spectrum.	EECE311
2.	Given a discrete-time signal, obtain the discrete Fourier transform (DFT) and apply the DFT results to analyze the frequency spectrum.	EECE 311
3.	Apply Z-transform to obtain system transfer functions and to analyze discrete-time LTI system behaviors (such as stability).	EECE 311
4.	Utilize a prewritten preemptive kernel including services such as timers, semaphores, mutexes, queues, and dynamic memory to design and test a real-time embedded system.	EECE 444

Revision History

Revision Date	**Revised By**	**Revision Description**
10/29/2013	Ying Lin	Initial spec for 2014 catalog
04/04/2015	Ying Lin	Add ABET mappings
04/27/2015	Ying Lin	Revise ABET mappings
04/28/2015	Ying Lin	Add textbook information and list of topics covered
06/17/2015	Ying Lin	Revise course outcomes
10/26/2015	Ying Lin	Revise course outcomes by using appropriate verbs and follow the new course spec format
06/13/2019	Ying Lin	Revise course outcomes, revise prerequisite outcomes, and map course outcomes to new SOs 1-7.
05/20/2021	Ying Lin	Change course rubric from EE to EECE. Revise prerequisite outcomes to be consistent with EECE444 course outcomes.

Course Number and Title: EECE 444 – Embedded Systems

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Todd Morton

Textbook: None

Supplemental Materials: Vender Documentation, Course Notes

Course (Catalog) Description:

The advanced study of real-time embedded systems hardware and software analysis and design. Includes real-time kernels, kernel services, and networking in a variety of hardware and software applications.

Prerequisites: EECE 344

Program(s): Required – EECE

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Utilize a prewritten preemptive kernel including services such as timers, semaphores, mutexes, queues, and dynamic memory to design a real-time embedded system.	1
2.	Design and document programs that meet given requirements, best practices, and conventions.	2
3.	Employ a revision control system to manage code revisions and distribution in team-based projects.	1
4.	Design embedded systems software and hardware as part of a team.	5
5.	Use programming design models and analysis tools to help formulate and analyze design solutions.	1
6.	Develop and implement a verification plan to verify technical requirements.	6

Topics:

Design Models and Analysis Tools – Dataflow diagrams
Introduction to Preemptive Real-Time Kernels - MicroC/OS
Task Switching and Design
Time Management
Intertask Communications
Semaphores
Mutexs
Event Flags
Message Queues,
Memory Partitions
Team-based Agile Development
Requirements Verification

Lab Equipment: MCU Development Board, Windows PC, Mixed-Signal Oscilloscope, DMM

Software: C Program Development System, Debugging hardware and software, Version control System, Real-time Preemptive Kernel, and Static Code Analyzer.

Lab Facility: ET340

Lab Size Limit: 30

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		Course
1.	Develop C programs for resource constrained and safety critical embedded system.	EECE 344
2.	Develop real-time embedded firmware that utilizes interrupts and simple cooperative multitasking.	EECE 344
3.	Develop low-level driver programs and interface hardware for common peripherals.	EECE 344
4.	Employ a Git revision control system to manage code revisions and distribution for projects with a single developer.	EECE 344
5.	Employ debugging tools and appropriate instrumentation to verify function and timing in real-time embedded firmware and hardware.	EECE 344
6.	Design and document C programs that meet given requirements, best practices, and conventions.	EECE 344

Revision History

Revision Date	Revised By	Revision Description
06/28/2013	Todd Morton	Initial spec for 2014 catalog
04/04/2015	Todd Morton	Added Program Outcomes
04/14/2016	Todd Morton	New format and rewritten outcomes based on course evaluation.
05/20/2021	Todd Morton	Changed course outcome mapping to new SO's 1-7. Changed rubric from EE to EECE.
04/12/2022	Todd Morton	Spring 2022 course review

Course Number and Title: EECE 460 – Digital Communication Systems

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Andy Klein

Textbook: *Software Receiver Design,* by Johnson, Sethares, Klein, 2011, ISBN: 0521189446

Supplemental Materials:

Digital and Analog Communication Systems, by Leon W. Couch, Pearson/Prentice Hall, 2007.

Digital Communications, by John G. Proakis, Pearson/Prentice Hall, 1989.

Course (Catalog) Description:

This course focuses on advanced digital communication system design, analysis, and implementation. Random processes will be used to model communication systems and analyze their performance in noise. Advanced communication techniques will be studied, such as: multicarrier systems, spread spectrum, equalization, channel coding, and modern wireless protocols and standards.

Prerequisites: EECE 360, EECE 433 (co-req)

Program(s): Required – EECE-Electronics

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Use random processes to describe stochastic transmitted and received signals in digital communication systems.	1
2.	Derive the optimum receiver structure digital transmission through an AWGN channel.	1
3.	Compute symbol and bit error probabilities of common digital communication systems in AWGN, and compare them with simulated and experimental error rates.	1
4.	Describe and quantify the tradeoffs between digital modulation formats (bandwidth efficiency, energy efficiency, symbol/bit error probability, receiver complexity).	1
5.	Be familiar with emerging digital and wireless communication protocols and techniques.	4

Topics:
Review of modulation, sampling.
Correlation.
Practical impairments to reliable communication.
Probabilistic analysis of bit error rate.
Carrier recovery via PLL, Costas loop, decision direction.
Pulse shaping, matched filtering, Nyquist criterion.
Timing recovery algorithms.

Multipath and intersymbol interference, linear equalization via trained and blind methods.
End-to-end receiver design.
(Time-permitting) Advanced topics such as multicarrier and spread-spectrum.

Lab Equipment: Oscilloscope, function generator, RTL-SDR USB dongle.

Software: Simulation software such as Matlab

Lab Facility: ET338

Lab Size Limit: 36

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		Course
1.	Derive expressions for transmitted signals in time and frequency domains (e.g. DSB, DSB-SC, SSB, PAM, PSK).	EECE 360
2.	Describe and analyze the major practical impairments to reliable communication, such as fading channels, imperfect oscillators, and synchronization errors.	EECE 360
3.	Obtain filter impulse response and frequency responses given FIR and IIR filter structures, difference equations, or transfer functions.	EECE 433

Revision History

Revision Date	Revised By	Revision Description
10/29/2013	Ying Lin	Initial spec for 2014 catalog
10/23/2014	Andy Klein	Updated description, prerequisites (replaced EE 361 with EE 360), and course outcomes.
04/30/2015	Andy Klein	Added numbers to outcomes (indicating initial exposure, reinforcement, mastery). Added list of topics. Added textbook.
10/20/2015	Andy Klein	Put into new course spec format, updated equipment list.
5/19/2021	Andy Klein	EE to EECE change, new ABET outcomes mapping, updated pre-req outcomes to match outcomes in pre-req courses

Course Number and Title: EECE 471 – Energy Project Proposal

Credit Hours: 2

Contact Hours: 2hrs lecture

Course Coordinator: Amr Radwan

Textbook: None

Supplemental Materials: Course Notes

Course (Catalog) Description:

This is the first of three courses for the interdisciplinary culminating project in the electrical engineering – energy option. Students define objectives, perform research, and prepare project proposals for EECE 472 and EECE 473

Prerequisites: EECE 378, EECE 444, ENRG 320, EECE 480 with concurrency

Program(s): Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Development of a technical proposal report and demonstration of improvements via multiple revisions and feedback.	1, 3
2.	Apply product development cycles and project management skills to direct a project from conception to developing project requirements and verification plan.	1, 2, 6
3.	Demonstration of teamwork skills, effective communication, leadership, and collaboration.	4, 5
4.	Completion and delivery of a complete and quality work in a timely manner.	2, 4
5.	Research and apply new systems, hardware, or software that have not been covered in previous coursework.	1, 2, 6, 7
6.	Demonstration of active participation within the team and in the class, professional conduct, inclusion, and diversity.	4, 5
7.	Understand the health, environmental, and cost impacts of designs and process technologies.	2

Topics:

Ethics and codes of conduct
Research sources
Preparation of lab notebook
Project teams
Project constraints, specifications, and requirements
Development of verification/testing plan
Project Proposal

Lab Equipment: As needed
Software: As needed
Lab Facility: ET328
Lab Size Limit: 16
Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	This is a culminating project. Therefore, the student must have successfully completed the program option through the junior year as defined by the listed prerequisites.	EECE378, EECE480, EECE 444, ENRG 320

Revision History

Revision Date	**Revised By**	**Revision Description**
10/28/2013	Todd Morton	Initial specs for 2014 catalog
06/20/2016	Todd Morton	Change to new format
06/20/2016	Todd Morton	Update outcome contribution to SO's
05/20/2021	Amr Radwan	Change the course prefix to EECE, and the new outcomes mapping.
11/11/2021	Andy Klein	Fixed bug in prereqs
06/14/2022	Amr Radwan	Revisions to outcomes of instruction and topics

Course Number and Title: EECE 472 – Energy Project Research and Development

Credit Hours: 4

Contact Hours: 4hrs lecture

Course Coordinator: Xichen Jiang

Textbook: None

Supplemental Materials: Course Notes

Course (Catalog) Description:

This is the second of three courses for the interdisciplinary energy project. Students complete the research and develop design concepts based on the constraints defined in EECE 471.

Prerequisites: EECE 471

Program(s): Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Research and develop design concepts for an energy related project that meets the proposed project requirements and design constraints.	1, 2
2.	Demonstration of teamwork, active participation, effective communication, leadership, and professional conduct.	3, 4, 5
3.	Completion and delivery of a complete and quality work in a timely manner.	2, 4, 5
4.	Research and apply new systems, hardware, or software that have not been covered in previous coursework.	1, 2, 6, 7
5.	Documentation of an initial design, preliminary test results, and challenges in a technical report.	3, 6

Topics: Project Development

Lab Equipment: As needed
Software: As needed
Lab Facility: ET328
Lab Size Limit: 16
Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Has successfully developed a project proposal and description that includes project requirements and development plan	EECE 471

Revision History

Revision Date	**Revised By**	**Revision Description**
11/20/2013	Todd Morton	Initial specs for 2014 catalog
06/20/2016	Todd Morton	Change to new format
10/06/2021	Xichen Jiang	Course outcome mapping changed to new SO's 1-7. Rubric changed from EE to EECE.
06/14/2022	Xichen Jiang	Changed Outcomes of Instruction.

Course Number and Title: EECE 473 – Energy Project Implementation
Credit Hours: 4
Contact Hours: 4hrs lecture
Course Coordinator: Amr Radwan
Textbook: None
Supplemental Materials: Course Notes

Course (Catalog) Description:

This is the third of three courses for the interdisciplinary energy project. Students complete the implementation of an energy related project as defined in EECE 471 and EECE 472.

Prerequisites: EECE 471, EECE 472
Program(s): Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Demonstration of a final prototype that meets the proposed project requirements and design constraints.	1, 2, 6
2.	Demonstration of teamwork skills, effective communication, leadership, and collaboration.	4, 5
3.	Demonstration of active participation within the team and in the class, professional conduct, inclusion, and diversity.	4, 5
4.	Completion and delivery of a complete and quality work in a timely manner.	2, 4
5.	Research and apply new systems, hardware, or software that have not been covered in previous coursework.	1, 2, 6, 7
6.	Documentation of final design review, results, and challenges in a technical report.	1, 3

Topics:
Project development and implementation

Lab Equipment: As needed
Software: As needed
Lab Facility: ET328
Lab Size Limit: 16
Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Has adequately delivered research and development results for the project	EECE 472

Revision History

Revision Date	**Revised By**	**Revision Description**
11/20/2013	Todd Morton	Initial specs for 2014 catalog
06/20/2016	Todd Morton	Change to new format
05/20/2021	Amr Radwan	Change the course prefix to EECE, and the new outcomes mapping.
06/14/2022	Amr Radwan	Change of outcomes of instruction and topics

Course Number and Title: EECE 480 – Control Systems

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: Amr Radwan

Textbook: *Control Systems Engineering*, Nise, N.S., John Wiley and Sons.

Supplemental Materials:

none

Course (Catalog) Description:

A study of analog control systems and techniques using operational mathematics, Laplace transforms, transfer functions, second-order systems, stability criteria, frequency response analysis, PID compensation. Laboratory investigation of control systems and computer modeling.

Prerequisites: EECE 310

Program(s): Required – EECE-Electronics, Required – EECE-Energy

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1	Model control systems in block diagram form.	1
2	Find open loop and closed loop transfer functions of simple control systems.	1
3	Find the steady state error of unity feedback control systems.	1
4	Use Root Locus and frequency response techniques to identify system stability and response with changes to forward path gain.	1
5	Use PID compensation networks to modify plant response.	1
6	Test and evaluate control systems in the lab.	6
7	Simulate control system response with appropriate software tools.	1, 6

Topics:

1. Introduction to control systems
    a. Historical background
    b. Case study
2. Modeling in the frequency domain
    a. Review of Laplace
    b. Review of transfer functions
    c. Transfer functions for electrical systems (review)
    d. Transfer functions for translational mechanical systems
    e. Transfer functions for rotational mechanical systems
    f. Transfer functions with gears
    g. Applicability to other domains (magnetic, thermal, etc.)
    h. Linearizing non-linear systems
3. Time Response
    a. Poles and zeroes (review)
    b. First order systems
    c. Second order systems
    d. Second order systems described by Damping Ratio
    e. Higher order systems
    f. Zero response
    g. Non-linearity effect
4. Subsystem Reduction
    a. Block diagrams
    b. Analysis and design of feedback
    c. Reduction of block systems
5. Stability
    a. Routh-Hurwitz Criterion
6. Steady State Errors
7. Root Locus
    a. Sketching the Root Locus
    b. Refining the sketch with angle calculations
    c. Designing transient response with gain adjustment
    d. General and positive feedback Root Locus
8. Design with Root Locus
    a. Cascade compensation
    b. Feedback compensation
9. Frequency Response (review)
10. Design via Frequency Response
    b. Lag
    c. Lead
    d. Lag-Lead
    e. Lag-Lead-Proportional

Lab Equipment: Prototype board, DMM, DC Power Supply, Oscilloscope, Function generator.
Software: Circuit analysis software such as Multisim and Matlab

Lab Facility: ET338

Lab Size Limit: 24

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Compute the Laplace transform given a continuous time signal. Obtain the inverse Laplace transform using the partial fraction expansion method	EECE 310
2.	Solve and analyze and design first and second order circuits using the Laplace transform method	EECE 310
3.	Given an input signal, compute the output of a continuous time LTI system in both the time and frequency domain	EECE 310
4.	Interpret LTI system behavior from the system impulse and/or frequency response (magnitude and phase responses)	EECE 310

Revision History

Revision Date	**Revised By**	**Revision Description**
06/22/2012	Todd Morton	Modify the program outcome labels
10/16/2013	John Lund	Modified for new degree offering. Updated prefix and prerequisites.
03/20/2015	John Lund	ABET mappings
04/19/2015	John Lund	Outline and textbook
08/19/2016	John Lund	Change to new format
05/20/2021	Amr Radwan	Revised class prefix, lab size limit, topics, and ABET mapping.

Course Number and Title: EECE 491 – Project Proposal

Credit Hours: 2

Contact Hours: 2hrs lecture

Course Coordinator: Todd Morton

Textbook: None

Supplemental Materials: None

Course (Catalog) Description:

This is the first of three courses for the culminating project. Students define objectives, perform research, and prepare project proposals for EE 492 and EE 493.

Prerequisites: EECE 321, EECE 460 or concurrent, EECE 372 or concurrent, EECE 480 or concurrent

Program(s): Required – EECE-Electronics

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Create a written proposal and requirements document that effectively communicates the required content.	3
2.	By working with a 'customer', can determine the needs of a design with consideration for real factors such as public health and safety, global, cultural, social, environmental, and economic.	2
3.	Can derive a set of requirements to formulate the design based on the needs and constraints and, in turn, develop a system-level design based on the requirements.	1, 2
4.	Recognize ethical and professional responsibilities and make informed judgements.	4
5.	Choose the appropriate learning strategies to acquire and apply new knowledge.	7
6.	Can function effectively as a member of a team by creating a collaborative and inclusive environment.	5

Topics:

Engineering design process

Writing effective requirements

Deriving specifications that meet requirements

Selecting components that meet requirements

Lab Equipment: All EECE lab equipment as needed for project.

Software: All EECE software as needed for project

Lab Facility: ET340 and others as needed

Lab Size Limit: 24

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		Course
1.	This is a culminating project. Therefore, the student must have successfully completed the program option through the junior year as defined by the listed prerequisites.	EECE 321, EECE 460, EECE 372, EECE 480

Revision History

Revision Date	Revised By	Revision Description
04/01/2015	Todd Morton	Added Program Outcomes
06/12/2017	Todd Morton	Modified Program Outcomes for new EAC criteria
05/20/2021	Todd Morton	Change course outcome mapping to new SO’s 1-7

Course Number and Title: EECE 492 – Project Hardware Design

Credit Hours: 4

Contact Hours: 3hrs lecture, 2hrs lab

Course Coordinator: John Lund

Textbook: *Printed Circuit Boards: Design, Fabrication, Assembly and Testing,* Khandpur, R.S., McGraw-Hill Education, 2005. ISBN: 978-0071464208

Supplemental Materials:

none

Course (Catalog) Description:

Second of three project courses. Design and fabrication of PCB-based capstone project hardware with special attention to modern commercial manufacturing techniques.

Prerequisites: EECE 491

Program(s): Required – EECE-Electronics

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1	Be able to complete an embedded product hardware design to meet project requirements.	1, 2
2	Ability to produce a well written circuit description, a clear, complete and accurate schematic and parts list.	3
3	Understand the health, environmental, and cost impacts of designs and process technologies.	2
4	Identify and evaluate the suitability of new tools and design components.	7
5	Understand and demonstrate safe operation of equipment and materials.	2
6	Understand a typical product development cycle and apply project management skills to develop a project from requirements to hardware prototype.	2,6
7	Function on a team through a product design cycle providing meaningful feedback on peer designs.	5

Topics:

1) Overview of circuit development
2) Project planning and scheduling
    a. Gantt charts
3) Printed Circuits
    a. Board types
    b. Schematic and Layout Software
    c. Design rules
    d. Surface protection
        i. Tenting vias
        ii. Conformal coating
    e. Sourcing
4) Regulations
    a. RoHS
    b. WEEE
5) Design Considerations
    a. Grounding and thermal considerations
    b. Trace width
    c. Resistors
    d. Capacitors
    e. Crystals/Resonators
    f. Regulators
    g. Coin/button cell batteries
    h. IC packages (including BGA)
    i. High-density interconnects
    j. Geometry considerations and mounting
6) Assembly
    a. Schematic and layout labeling
    b. Bill-of-materials (BOM) and parts list generation
    c. Solder methods and masks
    d. Component placement
    e. Reflow
7) Testing and rework

Lab Equipment: Oscilloscope, function generator, power supply, digital multimeter, reflow oven, pick-and-place, microscope, soldering iron, hot air rework station

Software: Altium

Lab Facility: ET340

Lab Size Limit: 24

Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Can develop a well written requirements document and development plan for an electrical system, which includes both hardware and software components.	EECE 491
2.	Makes a commitment to the course project, project team, and project leader. Attends meetings and supports the needs and goals of the course.	EECE 491

Revision History

Revision Date	**Revised By**	**Revision Description**
10/29/2013	John Lund	Initial spec for 2013 catalog
3/20/2015	John Lund	ABET Mapping
4/28/2015	John Lund	Added outline, objectives, and text
5/7/2016	John Lund	Updated ABET format, added Lab Equipment
5/20/2021	John Lund	Updated document format, prefix, ABET mappings, consolidated and updated outcomes.
6/14/2022	John Lund	Mapped SO1 to course outcome #1

Course Number and Title: EECE 493 – Project Software and System Implementation

Credit Hours: 4

Contact Hours: 4hrs lecture

Course Coordinator: Todd Morton

Textbook: None

Supplemental Materials: None

Course (Catalog) Description:

This is the third of three courses for the culminating project. Students complete the design and verification of software and software/hardware integration for the final project implementation based on the constraints defined in EECE 491.

Prerequisites: EECE 491, EECE 492

Program(s): Required – EECE-Electronics

Outcomes of Instruction		**Student Outcomes Addressed by Course**
1.	Design and build a system that meets previously defined project requirements and constraints.	1, 2
2.	Design and conduct experiments to verify project requirements	6
3.	Can function effectively as a member of a team by creating a collaborative and inclusive environment	5
4.	Communicates effectively in the oral design reviews.	3
5.	Choose the appropriate learning strategies to acquire and apply new knowledge	7

Topics:

Project requirements changes (Iteration in design)

Requirements verification plans

Software system level design

Code reviews and code review teams

Project demonstration

Code repositories and releases

Project Asset Library (PAL)

Lab Equipment: All EECE lab equipment as needed for project.
Software: All EECE software as needed for project
Lab Facility: ET340 and others as needed
Lab Size Limit: 24
Lab Fee Type: Materials and Supplies

Prerequisite Outcomes		**Course**
1.	Has successfully developed a project proposal and description that includes project requirements and development plan	EECE 491
2.	Has successfully completed the hardware design for the project	EECE 492

Revision History

Revision Date	**Revised By**	**Revision Description**
10/29/2013	Todd Morton	Initial specs for 2014 catalog
04/01/2015	Todd Morton	Added Program Outcomes
06/20/2016	Todd Morton	Rewording of outcomes and new format.
06/12/2017	Todd Morton	Rewrite outcomes for new EAB criteria

1. Chemistry 161: General Chemistry
2. 5 Credits, basic science
3. Instructor: Elizabeth Raymond
4. Textbook: Chemistry: An Atoms-Focused Approach, 3rd edition, Gilbert, Kirss, Bretz, and Foster, 2020.
    a. Other supplemental materials: scientific calculator
5. Specific course information
    a. Catalog description: Matter, measurement, dimensional analysis, stoichiometry, atomic and molecular structure, periodic trends, and molecular interactions. Lab included.
    b. Prerequisites: MATH 114
    c. Required course
6. Specific goals for the course
    a. Specific outcomes:
    i. Develop an understanding of the structure of atoms and the development of modern atomic theory.
    ii. Use the concepts of bonding and the electronic structure of the atom to predict the three-dimensional shapes and electron distributions within molecules.
    iii. Use the periodic table to predict the chemical properties and electronic structure of elements.
    iv. Correctly use symbolism and vocabulary to communicate chemical ideas.
    v. Understand how the interactions between particles (atoms, ions, and molecules) dictate the physical properties of matter.
    vi. Correctly use mathematical models and methods to describe a chemical event quantitatively.
    b. Student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: SO1 and SO6

1. Computer Science 140: Programming Fundamentals in C++
2. 4 Credits, math
3. Instructor: See-Mong Tan
4. No textbook listed
    a. Other supplemental materials: none listed
5. Specific course information
    a. Catalog description: Basic concepts of computer programming using the C++ programming language. Topics covered: introduction to computer architecture, and elements of a language such as control structures, functions, basic I/O, one dimensional and parallel arrays, text file I/O.
    b. Prerequisites: MATH 112 or higher
    c. Required course
6. Specific goals for the course
    a. Specific outcomes:
    i. A good understanding of navigating the UNIX development environment (how to use development tools in C++, including Make files and GNU C++; and the use of a text editor in writing code).
    ii. A strong understanding of basic types in C++, including int, float, double, char, string.
    iii. A strong understanding of console I/O.
    iv. A strong understanding of compound types like arrays and vectors.
    v. A strong understanding of C++ functions and return types.
    vi. A strong understanding of loops in C++, including how to construct solutions to accumulator problems in C++.
    vii. A basic understanding of C++ classes and inheritance.
    viii. A basic understanding of pass by value, pass by reference and pointer types in C++.
    ix. A basic understanding of file I/O using the C++ standard library.
    x. A strong understanding of how to use code and the computer algorithms required to synthesize the solution to a reasonable sized problem (a simple console-based arcade game)

1. Economics 386: Electricity Economics

2. 4 Credits; Other Topic

3. Instructor: Reid Dorsey-Palmateer

4. Textbook: No required textbook.

    a. Course materials will be uploaded to the course Canvas page.

5. Specific course information

    a. Electricity markets have become more complex in recent years because of new energy production and usage technologies, regulatory changes, and increased environmental concerns. This course will look at demand and supply aspects of electricity markets, including the impact of government economic and environmental regulation. Emphasis will be on the U.S. electricity market.
    b. Prerequisites or co-requisites: ECON 206 or HNRS 254 or HNRS 202
    c. Required for majors

6. Specific goals for the course

    a. Students completing this course will gain an understanding of the factors that affect the demand for electricity, be able to discuss advantages and disadvantages of restructuring electricity markets, understand how wholesale electricity markets work, understand approaches to and implications of both retail electricity price regulation and long run electricity planning and understand implications of environmental regulation on electricity markets and consumption.

7. Brief list of topics to be covered

    a. Natural Monopoly and Traditional Electricity Regulation; Market Power in Restructured Electricity Markets; Evaluating Restructuring of Electricity Markets; Green Electricity; Demand and Electricity Pricing

1. Energy 320: Science of Energy Resources

2. 4 Credits; Other Topic

3. Instructor: Tim Kowalczyk

4. Textbook: Energy Science: Principles, Technologies, and Impacts, 3rd Edition, John Andrews and Nick Jelley, 2017.

5. Specific course information

    a. Course description: Overview of energy resources and processes within a unified physical framework. Addresses traditional and renewable resources including fossil fuels, nuclear, wind, solar, hydroelectric, geothermal, and biofuels. Systems-level issues such as efficiency, transmission, and reliability are also covered.
    b. Prerequisites: MATH 125; PHYS 115 or 162; CHEM 161
    c. Required for majors

6. Specific goals for the course

    a. i. Use systems-level thinking to compare costs and benefits of different energy resources.
    ii. Apply principles of thermodynamics to quantify the efficiency of energy processes.
    iii. Explain the science behind renewable resource generation, extraction, and conversion in the context of wind, hydroelectric, solar, and nuclear technologies.
    iv. Critically examine research and development of emerging energy conversion technologies.

7. Brief list of topics to be covered

    a. Wind, hydroelectric, solar, nuclear energy, thermal cycles, and thermal power plant efficiency.

1. Energy 380: Energy and the Environment

2. 4 Credits; Other Topic

3. Instructor: Imran Sheikh

4. Textbook: Sustainable Energy - Without the Hot Air, David JC MacKay, 2009.

   a. Recommended textbook: Energy: Its Use and the Environment, 5th edition, R.A. Hinrichs and M.H. Kleinbach, 2012.

5. Specific course information

   a. Saying that there is no such thing as a free lunch is a glib way of expressing the first law of thermodynamics and gets at the core of this class. How do our choices in energy use impact the global and local environment? What does the future hold in terms of human use of energy? This class emphasizes the physical principles behind energy and the effects of energy use on the environment. We will explore the interdependence of world economies and environment as well as look at individual opinions and choices on energy related issues. Also offered as ESCI 380.

   b. Prerequisites: CHEM 161 and MATH 114

   c. Required for majors

6. Specific goals for the course

   a. In this course, we will develop an understanding –and working knowledge –of energy resources and their technological systems. This course has four BIG IDEAS:
   i. Your personal energy needs are spread across all areas of your daily life.,
   ii. Energy is not consumed, it is converted from one form to one or more other forms of lower quality,
   iii. Energy conversions of all kinds impact the environment, and
   iv. Society has many future energy options and needs to make profound choices.

These idea swill provide a framework for your work in building an understanding of the physical principles behind societal energy use. We will perform analyses of the environmental impacts of energy systems at today's and future use levels over local, regional, and global spatial scales. Analysis of the range of current and future energy choices will be stressed. To build command of the big ideas, students will be expected to become well versed in underlying physical principles and formulae.

7. Brief list of topics to be covered

   a. Environmental harm tied to an energy resource and conversion technology; Scenarios involving energy use and environmental impacts

1. English 302: Technical Writing
2. 5 Credits, other (English)
3. Dr. Geri E. Forsberg
4. Textbook: No assigned textbook for this course
    a. Supplemental materials: (recommended textbook) Technical Communication: A Reader-Centered Approach (8^{th} edition), Paul V. Anderson, 2013.
5. Specific course information
    a. Catalog Description: Students engage with rhetorical and technical practices for creating artifacts that help people do things with technology, such as usability testing, screencasting, web authoring, document design, and information architecture. The course covers a variety of technical genres and focuses on the ethical and social implications of a technical writer's choices.
    b. Prerequisites: ENG 101; junior standing.
    c. Required course
6. Specific goals for the course
    a. Specific outcomes:
       i. Understand the differences between academic writing and technical writing.
       ii. Identify an audience for all communication.
       iii. Plan and manage short and long-term writing projects.
       iv. Research before writing professional documents.
       v. Write documents that are clear, organized, and coherent.
       vi. Apply technical writing principles to writing projects.
       vii. Collaborate with others to achieve a result.
       viii. Listen actively to critical feedback, respond gracefully to that feedback, and process that feedback in a productive manner.
       ix. Provide honest, tactful, and productive feedback to others.
       x. Use computer technology to develop technical documents.
       xi. Use Google Docs or other technology to edit drafts of written material.
       xii. Design documents that are visually attractive.
       xiii. Create and deliver an effective narrated visual presentation.
       xiv. Recognize ethical principles related to technical writing and communication.
       xv. Empathize with those with whom you are communicating.
       xvi. Understand design thinking and UX design as it relates to professional writing.
       xvii. Develop critical thinking abilities about written and visual information.
       xviii. Identify misinformation, disinformation, and false information.

b. Student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: SO3

7. Brief list of topics to be covered: Writing a Visual Research Report.; Creating a Reader-Centered Infographic.; Writing Self Presentation Documents.

1. Environmental Sciences 380: Energy and the Environment

2. 4 Credits; Other Topic

3. Instructor: Imran Sheikh

4. Textbook: Sustainable Energy - Without the Hot Air, David JC MacKay, 2009.

    a. Recommended textbook: Energy: Its Use and the Environment, 5th edition, R.A. Hinrichs and M.H. Kleinbach, 2012.

5. Specific course information

    a. Saying that there is no such thing as a free lunch is a glib way of expressing the first law of thermodynamics and gets at the core of this class. How do our choices in energy use impact the global and local environment? What does the future hold in terms of human use of energy? This class emphasizes the physical principles behind energy and the effects of energy use on the environment. We will explore the interdependence of world economies and environment as well as look at individual opinions and choices on energy related issues. (Also offered as ENGR 380)

    b. Prerequisites: CHEM 161 and MATH 114

    c. Required for majors

6. Specific goals for the course

    a. In this course, we will develop an understanding –and working knowledge –of energy resources and their technological systems. This course has four BIG IDEAS:
    i. Your personal energy needs are spread across all areas of your daily life.,
    ii. Energy is not consumed, it is converted from one form to one or more other forms of lower quality,
    iii. Energy conversions of all kinds impact the environment, and
    iv. Society has many future energy options and needs to make profound choices.

These ideas will provide a framework for your work in building an understanding of the physical principles behind societal energy use. We will perform analyses of the environmental impacts of energy systems at today's and future use levels over local, regional, and global spatial scales. V. Analysis of the range of current and future energy choices will be stressed. To build command of the big ideas, students will be expected to become well versed in underlying physical principles and formulae.

7. Brief list of topics to be covered

   a. Environmental harm tied to an energy resource and conversion technology; Scenarios involving energy use and environmental impacts

1. Mathematics 124: Calculus and Analytic Geometry I
2. 5 Credits; math
3. Instructor name: Greg Shwartz
4. Textbook: Calculus: Single and Multivariable, 7th edition, Hughes-Hallett, Gleason, McCallum, et al, 2017.
    a. Supplemental materials: graphic calculator
5. Specific course information
    a. Catalog description: Average and instantaneous rates of change, interpretation, computation, and application of derivatives to optimization, rates, graphing, and antiderivative problems. Graphing calculator required.
    b. Prerequisites: MATH 115 or 118
    c. Required course
6. Specific goals for the course
    a. Specific outcomes:
    i. Develop ability in problem solving.
    ii. Interpret and communicate mathematics.
    iii. Work comfortably with the following types of functions: trigonometric, polynomial, absolute value, exponential, logarithmic, rational, and hyperbolic, as well as functions defined parametrically, or by graph or table.
    iv. Apply the concepts of transformation, composition, symmetry and inverses to the functions listed above.
    v. Understand and apply the concept so limits and continuity.
    vi. Understand and apply the limit definition of a derivative numerically, algebraically, and graphically.
    vii. Understand the relationship between the graph of a function and its derivatives.
    viii. Use the derivative rules to determine the derivative of a function, whether given in equation form, graphic form, or via tables.
    ix. Strengthen algebraic simplification skills by simplifying derivatives.
    x. Understand and apply the concept of implicit differentiation.
    xi. Evaluate the first and second derivatives of a function and interpret the results.
    xii. Construct and interpret sign charts.
    xiii. Use the first and second derivative tests to determine the extrema of a function.

xiv. Create and interpret functions that model real world applications then use calculus to optimize those functions.
xv. Use differentiation to reveal and compare related rates.
xvi. Become familiar with L'Hopital's Rule and its application.
xvii. Become familiar with the hyperbolic functions and their derivatives.
xviii. Work with parametric equations and their derivatives.
xix. Become familiar with antiderivatives and differential equations.

1. Mathematics 125: Calculus and Analytic Geometry II
2. 5 Credits; math
3. Instructor's name: Andrew Richardson
4. Calculus, 7^{th} ed, by Hughes-Hallett, Gleason, McCallum, et al.
    a. Supplemental materials: graphic calculator
5. Specific course information
    a. Brief description – catalog description
       The definite integral, techniques of integration, applications including area and volume, growth and decay, introduction of differential equations.
    b. Prerequisites: MATH 124
    c. Required course
6. Specific goals for the course
    a. Specific outcomes:
       i. Understand the definite integral as a limit of Riemann sums.
       ii. Estimate definite integrals using Left Hand Sums, Right Hand Sums, Midpoint, Trapezoid, and Simpson Rules.
       iii. Understand under what conditions a technique for estimating an integral result in an overestimate or an underestimate.
       iv. Find antiderivatives graphically.
       v. Use the FTC to evaluate definite integrals and to represent a particular antiderivative.
       vi. Compute antiderivatives and definite integrals using substitution (including change of limits) and integration by parts.
       vii. Compute antiderivatives and definite integrals of rational functions which may require a technique of partial fractions or trigonometric substitution.
       viii. Determine whether an integral with an infinite limit of integration converges.
       ix. Compute improper integrals.
       x. Use integration to compute areas, volumes, quantities dependent on density, centers of mass, work, force of a fluid, and arc lengths.

1. Mathematics 204: Elementary Linear Algebra
2. Credits, contact hours, and categorization of credits

   4 credits; math
3. Instructor's name: Adam Nyman
4. Textbook: Linear Algebra and its Applications, 5th ed., by Lay, Lay, and McDonald
   a. Supplemental materials: none listed
5. Specific course information
   a. Brief description – catalog description
      Systems of linear equations; matrices; the vector space Rn; linear independence, bases, subspaces, and dimension in Rn; introduction to determinants and the eigenvalue problem applications.
   b. Prerequisites: MATH 125, MATH 224 is recommended
   c. Required course
6. Specific goals for the course
   a. Specific outcomes:
      i. Ability to translate between systems of linear equations, vector equations, and matrix equations, and perform elementary row operations to reduce the matrix to standard forms.
      ii. Understanding of linear combination and span.
      iii. Determination of the existence and uniqueness of a system of linear equations in terms of the columns and rows of its matrix.
      iv. Ability to represent the solution set of a system of linear equations in parametric vector form and understand the geometry of the solution set.
      v. Understanding of linear dependence and independence of sets of vectors.
      vi. Understanding of linear transformations defined algebraically and geometrically, and ability to find the standard matrix of a linear transformation.
      vii. Understanding and computation of the inverse and transpose of a matrix.
      viii. Understanding and computation of the determinant of a matrix and its connection with invertibility.
      ix. Understanding of the notions of a vector space and its subspaces and knowledge of their defining properties.
      x. Knowledge of the definitions of a basis for and the dimension of a vector space, and ability to compute coordinates in terms of a given basis.

xi. Ability to find bases for the row, column, and null spaces of a matrix, find their dimensions, and knowledge of the Rank Theorem.

xii. Ability to find eigenvalues and eigenvectors of a matrix.

xiii. Knowledge of all aspects of the Invertible Matrix Theorem.

xiv. Knowledge of the Diagonalization Theorem and ability to diagonalize a matrix

1. Mathematics 224: Multivariable Calculus and Geometry I
2. Credits, contact hours, and categorization of credits

   5 credits; math
3. Instructor's name: Edoh Amiran
4. Textbook: Multivariable Calculus, 7^{th} ed, by McCallum
   a. Supplemental materials: none listed
5. Specific course information
   a. Brief description – catalog description

      Coordinate systems, curves and vectors in the plane and in space, partial derivatives, applications including optimization and motion, multiple integrals.
   b. Prerequisites: MATH 125
   c. Required course
6. Specific goals for the course
   a. Specific outcomes:

      i. appropriate recollection and use of the definitions of vectors, linearization, and derivatives with respect to vectors

      ii. ability to describe settings geometrically, including graphs and level sets of functions, projections, and the angles between vectors

      iii. ability to describe and calculate the behavior of functions, including rates of change, critical points and optimal values

      iv. ability to describe geometric regions analytically for purposes of integration

      v. projections, decompositions, and calculations of rates using vectors

      vi. integrals in rectangular, polar, cylindrical, and spherical coordinates

1. Mathematics 331: Ordinary Differential Equations
2. Credits, contact hours, and categorization of credits

   4 credits; math
3. Instructor's name: Daphne Scott
4. Textbook: Differential Equations: From Calculus to Dynamical Systems, 2nd ed, by Noonburg, 2019.
   a. Supplemental materials: graphing calculator
5. Specific course information
   a. Brief description – catalog description

      First order equations, first order systems (primarily linear), applications and modeling, qualitative reasoning
   b. Prerequisites: MATH 204, MATH 224 recommended
   c. Required course
6. Specific goals for the course
   a. Specific outcomes:
      i. Understand and utilize the essential course content at an appropriate level.
      ii. Recognize that a problem can have different useful representations (graphical, numerical, or symbolic) and select the most appropriate format and methods.
      iii. Model real world problems mathematically and interpret the results appropriately.
      iv. Use appropriate software and technological tools, and judge when such use is helpful.
      v. Communicate mathematical results and arguments clearly, both orally and in writing.
      vi. Appreciate the central role of mathematics in the sciences and the real world.
      vii. Set up an initial value problem for a differential equation or system that models a given dynamical process and, when it is possible to solve the problem, to interpret the solution in the context of the problem.
      viii. Recognize separable differential equations, find their general solutions, and use the general solution to solve initial value problems.
      ix. Recognize linear first-order differential equations, solve them using the method of integrating factors, and solve related initial value problems.
      x. Sketch and read slope-fields of first-order equations, use slope-fields to qualitatively describe solutions, and understand the relationship between slope-fields and Euler's method.

xi. Construct the phase line for autonomous first-order equations, and find and classify equilibrium solutions, and use the phase line to qualitatively describe solutions.
xii. Understand the statement and implications of the existence and uniqueness theorems.
xiii. Find bifurcation values and construct and interpret bifurcation diagrams for autonomous first-order differential equations that depend on a parameter and understand how a small change in the parameter value can affect the qualitative behavior of solutions.
xiv. Convert a higher-order differential equation into a first-order system.
xv. Produce and interpret direction fields and phase portraits for systems of autonomous differential equations and use them to analyze the qualitative behavior of solutions to the system and understand the relationship between solution curves in the phase plane and solutions of the system and the solution's component curves. Find equilibrium solutions of such systems.
xvi. Find the general solution of any 2x2 linear system with constant coefficients, solve initial value problems for such systems, classify the equilibrium solutions of such a system, and describe the qualitative behavior of solutions by analyzing the phase portrait.
xvii. Understand the trace-determinant plane as a graphical summary of the possible qualitative behaviors for 2x2 linear systems with constant coefficients and use it to analyze such systems that depend on a parameter.
xviii. Find the general solution of second-order homogenous linear equations with constant coefficients, solve related initial value problems, describe the behavior of the solutions and understand the use of such equations to model oscillatory behavior.

1. Mathematics 345: Statistics for Engineers
2. Credits, contact hours, and categorization of credits

   4 credits; math
3. Instructor name: Amy Anderson
4. Textbook: Applied Statistics and Probability for Engineers, 5^{th} ed, by Montgomery and Runger.
   a. Supplemental materials: calculator
5. Specific course information
   a. Brief description – catalog description
      Basic probability, discrete and continuous probability distributions. Descriptive statistics and the use of computer statistical packages. Statistical inference, including 1- and 2-sample hypothesis tests and confidence intervals for means and proportions, paired t test and sample size calculations.
   b. Prerequisites: MATH 125
   c. Required course
6. Specific goals for the course
   a. Specific outcomes:
      i. Explain the concepts of a population, a sample, and variability.
      ii. Distinguish between retrospective studies, observational studies, and designed experiments as means of data collection.
      iii. Understand the concepts of sample space and events, and the interpretation of probability.
      iv. Use the addition rule, multiplication rule and total probability rule in probability computation.
      v. Understand the concepts of conditional probability and independence, and Bayes Theorem, and be able to solve problems involving these concepts.
      vi. Understand the concept of a random variable, both discrete and continuous.
      vii. Obtain the probability mass function of a discrete random variable for some random experiments or situations.
      viii. Understand the probability mass function(p.m.f.), probability density function (p.d.f.), cumulative distribution function (c.d.f.), the relationship between the p.m.f. /p.d.f. and the c.d.f., and be able to obtain one from the other.
      ix. Calculate the mean and variance of a random variable (both discrete and continuous) and evaluate probabilities involving the distribution of the random variable, using calculus if necessary.
      x. Understand the characteristics of the binomial, Poisson, continuous uniform and exponential distributions, and solve basic problems involving these distributions.

xi. Understand the importance of the normal distribution and solve elementary probability problems involving the normal distribution.
xii. Calculate the basic statistical measures of a data set, i.e., sample mean, sample standard deviation, sample median, range.
xiii. Construct and interpret frequency distributions, histograms, boxplots and probability plots.
xiv. Understand the concept of a sampling distribution and be able to use the central limit theorem.
xv. Understand the concept of a confidence interval and how it is used for estimation.
xvi. Construct a confidence interval for the population mean, the population proportion, the difference in two population means or the difference in two population proportions.
xvii. Compute the sample size needed to estimate population mean or population proportion.
xviii. Understand the idea behind hypothesis testing, and p-value.
xix. Conduct a hypothesis test for the population mean, population proportion, difference in two population means and difference in two population proportions and compute the p-value for the test.
xx. Know when to use and how to conduct a paired t test.
xxi. Use a statistical software package, such as Minitab and/or Excel, to plot graphs, to calculate basic statistical measures such as the mean and the median of a data set, and to compute the probabilities involving well-known distributions

1. Physics 161: Physics with Calculus I
2. Credits, contact hours, and categorization of credits

   5 credits, basic science
3. Instructor: Takele Seda
4. Physics for Scientists and Engineers, 4th ed, by RD Knight
   a. Other supplemental materials: none listed
5. Specific course information
   a. Brief description – catalog description

      Kinematics and dynamics of particles; work and energy; gravitation; collisions and conservation of momentum. Includes lab.
   b. Prerequisites: MATH 124 or concurrent
   c. Required course
6. Specific goals for the course
   a. Specific outcomes:

      i. Construct and utilize graphs, vector diagrams, and natural language to *qualitatively* describe how objects move and respond to forces.

      ii. Use math to *quantitatively* describe how objects move and respond to forces.

      iii. use the concepts of conservation of energy and momentum to qualitatively and quantitatively describe how objects move.

      iv. Implement a structured approach to solving physics problems, particularly those posed in natural language (i.e. the type of problem that students will face outside the classroom)
   b. Student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: SO1 and SO6

1. Physics 162: Physics with Calculus II
2. Credits, contact hours, and categorization of credits

   5 credits, basic science
3. Instructor: Svenja Fleischer
4. Physics for Scientists and Engineers, 4th ed, by RD Knight, 2017
   a. Other supplemental materials: none listed
5. Specific course information
   a. Brief description – catalog description

      Electrostatics, DC circuits, magnetic fields, and electromagnetic induction. Includes lab.
   b. Prerequisites: PHYS 161, MATH 124, and MATH 125 or concurrent
   c. Required course
6. Specific goals for the course
   a. Specific outcomes:

      i. Apply core concepts of electromagnetism to the motion and interactions of charged particles.

      ii. These concepts include electric and magnetic forces, electric and magnetic fields, electric potential and potential energy, and the principle of superposition.

      iii. Apply concepts of current, voltage, resistance, and capacitance to analyze DC circuits.

      iv. Apply mathematical models to make quantitative predictions in the context of electromagnetic interactions.

      v. Collect and analyze data and build mathematical models by inferring patterns in observations of natural phenomena.

      vi. Apply concepts and mathematical models to perform multi-step analysis of real-world phenomena.

      vii. Communicate scientific ideas, explanations, and arguments clearly and concisely.

      viii. Transfer the mathematical and conceptual foundation developed in this class to future science courses.
   b. Student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: SO1 and SO6

1. Physics 163: Physics with Calculus III
2. Credits, contact hours, and categorization of credits

   5 credits, basic science
3. Instructor: Takele Seda
4. Physics for Scientists and Engineers, 4^{th} ed, by RD Knight, 2017
   a. Other supplemental materials: none listed
5. Specific course information
   a. Brief description – catalog description
      Rigid body kinematics and dynamics; rotation and oscillation; waves in elastic media; light as a wave; interference and diffraction of light; geometric optics. Includes lab.
   b. Prerequisites: PHYS 162, MATH 124, and MATH 125 or concurrent
   c. Required course
6. Specific goals for the course
   a. Specific outcomes:
      i. Apply core concepts of classical mechanics to the motion of a rigid body in 2 dimensions. These concepts include force and Newton's laws, torque and Newton's 2nd law for rotations, the work-energy principle, and the conservation of linear and angular momentum.
      ii. Be able to solve equations of motion for oscillatory situations in analytical and graphical ways.
      iii. Understand wave properties of light and sound including interference, diffraction, and polarization.
      iv. Be familiar with concepts of geometric optics including reflection, refraction, lenses, and optical instruments.
      v. Apply concepts and mathematical models to perform multi-step analysis of real-world phenomena involving incompressible fluids.
      vi. Collect and analyze data to infer patterns in natural phenomena.
      vii. Communicate scientific ideas, explanations, and arguments clearly and concisely.
   b. Student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: SO1 and SO6

Appendix B

Faculty Vitae

1. Name: Xichen Jiang

2. Education:
    - Ph.D. in Electrical Engineering, University of Illinois, 2016.
    - M.S. in Electrical Engineering, University of Illinois, 2012.
    - B.S. in Electrical Engineering, University of Illinois, 2010.

3. Academic experience:
    - Associate Professor, Western Washington University, 2020-present.
    - Assistant Professor, Western Washington University, 2016-2020.

4. Non-academic experience:
    - Hardware Intern, ViaSat, 2013.
    - Instrumentation Intern, Exxon Mobil, 2009.
    - Controls Intern, Proctor and Gamble, 2008.
    - Circuit Design Intern, Coilcraft, 2007.

5. Certifications or professional registrations:

6. Current membership of professional organizations:
    IEEE PES Member

7. Honors and awards:

8. Service activities (within and outside of the institution):
    Inside WWU
    - Faculty Senate member, 2018-present.
    - Academic Honesty Board member, 2018-present.
    - Departmental Scholarship Committee member, 2017-2020.

    Outside WWU
    - Reviewer for *IEEE Transactions on Power Systems*, 2013-present.
    - Reviewer for *IEEE Transactions on Smart Grid*, 2013-present.
    - Reviewer for Power and Energy Conference Illinois, 2014-present.

9. Notable Recent Publications:
    A. Radwan, O. Massey, I. Khouri, D. Tamai, and X. Jiang, "Performance Evaluation of Grid-Connected Converters Using Robust, PI, and PR Current Control Schemes," in Proceedings of the Mediterranean Conference on Control and Automation, Bari, Italy, June 2021.

    A. Brar, R. Sanborn, A. Radwan, and X. Jiang, "A Mobile Photovoltaic Battery System for Off-Grid Applications," in Proceedings of the International Conference on Electrical Communication and Computer Engineering, Istanbul, Turkey, June 2020.

A. Radwan, I. Khouri, and X. Jiang, "Modeling and Control of Current-Source Converters-Based AC Microgrids," in Proceedings of the International Conference on Smart Energy Grid Engineering, Oshawa, Canada, Aug. 2020.

A. Radwan, Y. Mohamed, and X. Jiang, "A Hybrid Wind-Photovoltaic Generation System: Modeling and Performance Evaluation," in Proceedings of the International Conference on Smart Energy Grid Engineering, Oshawa, Canada, Aug. 2019.

D. Saunders, T. Thornton, X. Jiang, and J. Davishahl, "Photovoltaic System Performance Under Partial Shading Conditions: An Undergraduate Research Experience," in Proceedings of the American Society for Engineering Education Annual Conference and Exposition, Tampa, FL, June 2019.

T. Christman, N. Uhrich, P. Swisher, and X. Jiang, "A Statistical Approach for Line Outage Detection in Power Systems with Transient Dynamics," in Proceedings of the Probabilistic Methods Applied to Power Systems, Boise, ID, June 2018.

X. Jiang, G. Rovatsos, A. D. Dominguez-Garcia, and V. V. Veeravalli, "Comparison of Statistical Algorithms for Power System Line Outage Detection," in Proc. of the IEEE International Conference on Acoustics, Speech, and Signal Processing, Shanghai, China, May 2016.

10. Professional Development:
    - September 15, 2021. "Flexible Modality Preparedness Workshop". WWU Center for Instructional Innovation and Assessment.

1. Name: Junaid Khan

2. Education:
    - Ph.D., Computer Science, University Paris, 2017.
    - Master of Science, Electrical Engineering, National University of Sciences and Technology, 2013.
    - Bachelor of Science, Telecommunications Engineering, National University of Computer and Emerging Sciences, 2009.

3. Academic experience:
    - Western Washington University, full-time
        - Assistant Professor, 9/2020 – present
    - New York University, Postdoctoral Associate, 9/2019-9/2020
    - University of Memphis, Postdoctoral Research Fellow – Computer Science Department, 1/2018-8/2019
    - INSA, Lyon, France, Postdoctoral Researcher 10/2016-12/2017
    - University Of California, Visiting Research Fellow, 6/2016-12/2017

4. Non-academic experience:
    - National Telecommunication Corporation, Islamabad, Pakistan,
        - NIP Trainee – Network and System Engineering Department, 2/2010-3/2011

5. Certifications or professional registrations:

6. Current membership of professional organizations:
    - IEEE Senior Member

7. Honors and awards:
    - NSF Smart and Connected Communities (S&CC) Aspiring PI Travel Grant, 2018
    - IEEE Best paper Award at the ICNC Conference, 2018
    - University Paris-Est, Researcher Mobility Grant, 2016
    - IFIP Wireless Days Student Travel Grant, 2012

8. Service activities:
    - Regular peer reviewer for IEEE journals and conferences
    - Regular NSF panelist, reviewing grant proposals
    - Program Director of Electrical and Computer Engineering
    - Co-PI on NSF S-STEM project which works to improve outcomes for low-income engineering students in their first two years of study.
    - Member of numerous program, department, and university committees.

9. Most important publications and presentations from the past five years:

J.A. Khan, K. Bangalore, A Kurkcu, K. Oxbay. TREAD-Privacy Preserving Incentivized Connected Vehicles Mobility Data Storage on IPFS-Enabled Blockchain. NO. TRBAM-21-02593. 2021.

J.A. Khan, Y. Ghamri-Doudane. "ROVERS: Incentive-based Recruitment of Connected Vehicles for Urban Big Data Collection", IEEE Transactions on Vehicular Technology, 2019.

J. A. Khan, Y. Ghamri-Doudane, C. Westphal. "Information-Centric Fog Network for Incentivized Collaborative Content Caching and Retrieval in the Internet of Everything (IoE)", IEEE Communications Magazine, 2019.

J. A. Khan, Y. Ghamri-Doudane. "SAVING: Socially Aware Vehicular Information-centric Networking", IEEE Communications Magazine, 2016.

J. A. Khan, Y. Ghamri-Doudane, D. Botvich. "Autonomous Identification and Optimal Selection of Popular Smart Vehicles for Urban Sensing – An Information-centric Approach", IEEE Transactions on Vehicular Technology, 2016.

J. A. Khan, C. Westphal, J.J. Garcia-Luna-Aceves, Y. Ghamri-Doudane. "Reversing the Meaning of Node Connectivity for Content Placement in Networks of Caches", IEEE ICNC, 2020.

J. A. Khan, L. Wang, E. Jacobs, A. Talebian, S. Mishra, C.A. Santo, Mihalis Golias, C. Astorne-Figari. "Smart Cities Connected and Autonomous Vehicles Readiness Index", In Proceeding of the 2nd ACM/EIGSCC Symposium on Smart Cities and Communities, p. 8, ACM, 2019.

J. A. Khan, C. Wetphal, J.J. Garcia-Luna-Aceves, Y. Ghamri-Doudane. "NICE: Network-oriented Information-centric Centrality for Efficiency in Cache Management", ACM ICM, 2018.

J. A. Khan, R. Pujol, R. Stanica, F. Valois. "On the Energy Efficiency and Performance of Neighbor Discovery Schemes for Low Duty Cycle IoT Devices", 14th ACM PE-WASUN, 2017.

B. Brik, J. A. Khan, Y. Ghamri-Doudane, N. Lagraa. "PUB-LISH: A Distributed Service Advertising Scheme for Vehicular Cloud Networks", IEEE CCNC, 2019.

10. Most recent professional development activities:

- 2021 ABET Symposium

1. Name: Andrew G. Klein
2. Education:
    - Ph.D., Electrical and Computer Engineering, Cornell University, 2006.
    - Master of Science, Electrical Engineering and Computer Sciences, University of California – Berkeley, 2000.
    - Bachelor of Science, Electrical Engineering, Cornell University, 1998.

3. Academic experience:
    - Western Washington University, full-time
        - EECE Program Director, 2019-2020 (interim), 2021-present
        - Professor, 2019-present
        - Associate Professor, 2016-2019
        - Assistant Professor, 2014-2016
    - Worcester Polytechnic Institute, Assistant Professor, 2007-2014, full-time
    - Supélec (Paris, France), Postdoctoral researcher, 2006, full-time

4. Non-academic experience:
    - Intel Corporation, intern, computer chipset testing, 1996-1997, full-time.
    - ComSilica Inc., Member of Technical Staff, designed wireless chipsets, 2001-2002, full time.
    - Consultant, (expert witness, technical expert, expert opinion), 2008-present, part-time.

5. Certifications or professional registrations:
    - Licensed ham radio operator

6. Current membership of professional organizations:
    - IEEE Senior Member

7. Honors and awards:
    - WPI ECE Department Joseph Samuel Satin Distinguished Fellow in Electrical and Computer Engineering, 2010-11.

8. Service activities:
    - Regular peer reviewer for IEEE journals and conferences
    - Regular NSF panelist, reviewing grant proposals
    - Program Director of Electrical and Computer Engineering
    - Co-PI on NSF S-STEM project which works to improve outcomes for low-income engineering students in their first two years of study.
    - Member of numerous program, department, and university committees

9. Most important publications and presentations from the past five years:

A. Grootveld, K.P. Vedula, V. Bugayev, L. Lackey, D.R. Brown, and A.G. Klein, "Tracking of dynamical processes with model switching using temporal convolutional networks," in Proc. IEEE Aerospace Conf., Mar. 2021, doi: 10.1109/AERO50100.2021.9438450.

L. Lackey, A. Grootveld, and A.G. Klein, "Semi-supervised convolutional triplet neural networks for assessing paper texture similarity," in Proc. Asilomar Conf. on Signals, Systems, and Computers, Nov. 2020, doi: 10.1109/IEEECONF51394.2020.9443454.

S. Farazi, A.G. Klein, and D.R. Brown III, "Average age of information in update systems with active sources and packet delivery errors," in IEEE Wireless Comm. Letters, vol. 9, no. 8, pp. 1164-1168, Aug. 2020, doi: 10.1109/LWC.2020.2983397.

S. Farazi, A.G. Klein, and D.R. Brown III, "Fundamental bounds on the age of information in multi-hop global status update networks," in Journal of Communications and Networks (JCN) Special Issue on Age of Information, vol. 21, no. 3, Jun. 2019, doi: 10.1109/JCN.2019.000038.

S. Farazi, A.G. Klein, and D.R. Brown III, "Fundamental Bounds on the Age of Information in General Multi-Hop Interference Networks," in Proc. 2nd Age of Information Workshop (AoI'19) / IEEE Intl. Conf. on Computer Communications (INFOCOM), Apr. 2019, doi: 10.1109/INFCOMW.2019.8845150.

S. Farazi, A.G. Klein, and D.R. Brown, "Age of information in energy harvesting status update systems: When to preempt in service?," in Proc. IEEE Intl. Symp. on Inf. Theory (ISIT), Jun. 2018, doi: 10.1109/ISIT.2018.8437904.

S. Farazi, A.G. Klein, and D.R. Brown, "Average age of information for status update systems with an energy harvesting server," in 1st Age of Information Workshop (AoI'18) / Proc. IEEE Intl. Conf. on Computer Communications (INFOCOM), Apr. 2018, doi: 10.1109/INFCOMW.2018.8406846.

R.K. Martin and A.G. Klein, "Improved student independence through competitive tinkering," in Proc. IEEE Frontiers in Education Conf. (FIE), Oct. 2017, doi: 10.1109/FIE.2017.8190500.

A.G. Klein, S. Farazi, W. He, and D.R. Brown III, "Staleness bounds and efficient protocols for dissemination of global channel state information," in IEEE Trans. Wireless Comm., vol. 16, no. 9, pp. 5732-5746, Sep. 2017, doi: 10.1109/TWC.2017.2715020.

10. Most recent professional development activities:

- 2021 ABET Symposium

1. Name: Ying Lin

2. Education:
    - Ph.D., Electrical Engineering, Syracuse University, (2007)
    - M.S., Applied Statistics, Syracuse University, (2006)
    - M.S., B,S., Electrical Engineering, Harbin Institute of Technology, China, (1997, 1995)

3. Academic experience:
    - Associate Professor, Western Washington University, 2015-present
    - Assistant Professor, Western Washington University, 2010- 2015
    - Visiting Scholar, University of Washington, 2006- 2007, 2012-2013
    - Assistant Professor, State University of New York at New Paltz, 2008-2010

4. Non-academic experience:
    - System Engineer, software development for telecom applications, Centell Telecommunications Corporation, Ltd., Beijing, China, 1997-2000

6. Current membership of professional organizations:
    - Institute of Electrical and Electronics Engineers (IEEE)
    - American Society for Engineering Education (ASEE)

7. Honors and awards:
    - All University Doctoral Prize, Syracuse University, 2007
    - 2nd prize, Sci&Tech Advancement Award, National Posts and Telecommunications Industry Corporation, China, 1999

8. Service Activities:

    Western Washington University (WWU) Service
    - E&D first-year program director search committee, Chair (2019-2020)
    - E&D (ETEC) department scholarship committee, Chair (09/2013-12/2016)
    - Coordinating EE program women student focus group follow-up meeting and social event (Spring 2019, winter 2021)
    - EECE faculty search committee member (2021-2022)
    - EE/EET faculty search committee member (2011-2018)
    - New EE/EECE program curriculum development (9/2013-present)
    - EET/EE/EECE faculty advisor (2012-present)
    - EET/EE/EECE ABET accreditation process participant (2012 - present)
    - Scholastic standing committee member (2012-2016, 2019-present)
    - International studies curriculum committee, member (09/2018-06/2021)
    - Participant of Compass-to-Campus (2011-2013, 2019)
    - Academic honesty board member (2015-2017)
    - Judge for WWU annual Robotic competition (2014-2017)
    - Faculty advisor of WWU IEEE student branch (2010-present) and Marine Technology club (2012-present)

Outside of Institution

- Member of Whatcom Robotics Advisory Board (2010-present)
- Session monitor for IEEE GHTC Annual Conference, 2016, 2019
- Session monitor for ASEE Annual Conference, 2017
- Reviewer for various journals and conferences such as *IEEE Transactions on Signal Professing and ASEE Annual Conference* (2010-2021)
- FTC Robotics Team Coach (2017-2021)
- FTC Robotics Washington State Competition Judge (2014)

9. Briefly list the most important publications and presentations from the past five years:

Ying Lin and Steve Sandlin, "An Integrated Mixed-signal Circuit Design Course Project", Proc. American Society for Engineering Education Annual Conference, June, 2020.

Ying Lin and Todd Morton, "A Microcontroller-based DSP Laboratory Curriculum", Proc. American Society for Engineering Education Annual Conference, June, 2017.

Ying Lin, John Lund, and Todd Morton: "A Hands-on First-year Electrical Engineering Introduction Course", Proc. American Society for Engineering Education Annual Conference, June, 2017.

Todd Morton and Ying Lin, "An Integrated DSP and Embedded Microcontroller Laboratory Curriculum", Proc. ASEE annual conference, 2016.

Isaiah Ryan, Aaron Cramer, and Ying Lin, "Real-time Real-life oriented DSP Lab Modules", ASEE annual conference, 2015.

Ying Lin and Hao Chen, "Distributed Detection Performance Limit under Dependent Observations and Non-ideal Channels", IEEE Sensors Journal, Vol 15, Issue 2, Feb., 2015.

10. Briefly list the most recent professional development activities:

- Attending IEEE GHTC annual conference sessions related to DSP applications (2016, 2019)
- "STEM Equity & Inclusion Workshops 1~4", WWU (2017, 2019, 01/30/2020)
- "Engineering Inclusive Classrooms – Guiding Principles and Strategies", webinar by University of Michigan, Center for Research on Learning and Teaching in Engineering (04/10/2019)
- "Learning Tech Group: The New Face of Lecture Capture", organized by the CIIA, WWU (05/09/2018)
- "Incorporating 360-Degree Assessment into Your Classroom", webinar by Millersville University of Pennsylvania, through WWU's CIIA (02/28/2018)
- "2017 Interdivisional Town Hall Meeting: The Culture of Teaching", ASEE Annual Conference, 06/26/2017
- "Student Success Collaborative training", WWU (01/23/2017)
- "RSP workshop", WWU (05/02/2016)

1. Name: John Lund

2. Education:

- PhD, Electrical Engineering, University of Washington, Seattle, WA (2009)
- M.S., Electrical Engineering, University of Washington, Seattle, WA (2007)
- B.S., Computer Engineering, Washington State University, Pullman, WA (2004)

3. Academic Experience:

- Associate Professor of Electrical and Computer Engineering, Western Washington University. 2018-present
- Assistant Professor of Electronics Engineering Technology/Electrical Engineering, Western Washington University. 2013-2018
- Assistant Professor of Electrical Engineering, University of Alaska. 2009-2013

4. Non-Academic Experience:

- State of Alaska Department of Transportation and Public Utilities, Utility Relocation Division. Worked with utility companies and project contractors to develop relocation plans and relocation agreements. Part time. 2001-2004.

5. Certifications or Professional Registrations:

6. Membership in Professional Organizations:

IEEE

- General member
- Oceanic Engineering Society member
- SAE

7. Honors and Awards:

- Undergraduate Research Award 2013
- Outstanding Undergraduate Mentor 2012
- UAA Innovate Award 2011
- UAA Innovate Award 2012

8. Service Activities:

- Faculty Mentor IEEE OES Student Chapter WWU
- Faculty Mentor SAE Formula Student Club WWU
- WWU Faculty Senate Executive Committee 2015-2018
- Treasurer IEEE Alaska Section (2010-2013)
- Reviewer Journal of Intelligent Transportation Systems (IEEE)
- Reviewer Journal of Nanotechnology (IEEE)

- Reviewer Journal of Biomedicine (IEEE)
- Dean Search Committee (2013, University of Alaska)
- FE Examination Preparation Volunteer Lecturer

9. Notable Recent Publications:

Lund, John, Anthony Paris, and Jennifer Brock. “Mouthguard-Based Wireless High-Bandwidth Helmet-Mounted Inertial Measurement System.” HardwareX, v 6. Elsevier, e00041. 2018. https://doi.org/10.1016/J.OHX.2018.E00041.

John Lund “Consumer Electronics Design as Preparation for Capstone Design” 2018 IEEE Frontiers in Education Conference (FIE). San Jose, CA USA, October 3-6, 2018.

John Lund “Community Outreach Through K-12 Engineering Education: Water Conservation Implementation, Observations, and Survey” 2018 IEEE Global Humanitarian Technology Conference (GHTC). San Jose, CA USA, October 18-21, 2018.

Mitchell Overdick†, Joseph Canfield†, John Lund “A Small Energy-Harvesting Autonomous Surface Vehicle” 2018 IEEE Oceans Conference and Exposition. Charleston, SC USA, October 22-25, 2018.

Andrew Falabella†, John Lund, David Wallin “Application of a customizable sensor platform to detection of atmospheric gasses by UAS” 2018 International Conference on Unmanned Aircraft Systems (ICUAS). Dallas, TX USA, June 12-15, 2018. PP 883-890.

John Lund, Todd Petersen “Implementation of a Long-Lifespan Sensor Network for Infrastructure Monitoring in Remote Regions” Proceedings of the 2018 IEEE I2MTC Conference. Houston, TX USA, May 14-17, 2018. PP2151-2153.

10. Professional Development:

- ASEE 2016
- IEEE SPMB 2015
- ASME 2013
- ITSC 2012
- IEEE Sections Congress 2012

1. Name: Todd Morton

2. Education:
   - MSEE, University of Washington, 1988
   - BSEE, University of Washington, 1983

3. Academic experience:

   Western Washington University

   - Professor, Electrical and Computer Engineering, 2001- present
   - Associate Professor, Electronics Engineering Technology, 1994-2001
   - Assistant Professor, Electronics Engineering Technology, 1988-1994
   - Program Coordinator, Electronics Engineering Technology, 2005-2013
   - Program Director, Electrical and Computer Engineering, 2013-2021
   - Chair, Engineering Technology Department, 2008-2012
   - Affiliate Faculty, Institute for Energy Studies, Since 2012

4. Non-academic experience:

   Jet Propulsion Laboratory
   NASA/ASEE Summer Faculty Fellowship, Summers 1992, 1993, 1994, 1995, and 2000

   Physio-Control Corporation
   Design Engineer, 1983-88

5. Certifications or professional registrations:

6. Current membership in professional organizations:

   Institute of Electrical and Electronics Engineers, Since 1981, Senior Member
   American Society for Engineering Education, since 1989

7. Honors and awards:

8. Service activities (within and outside of the institution):

   - ABET-ETAC Program Evaluator Since 2009
   - Electronics and Computer Engineering Technology Department Heads Association, 4-Year Representative, 2010-2012
   - Engineering and Design Department, Curriculum Committee, Since 2005
   - Engineering and Design Department, Resource Committee, Since 2005
   - Electronics Engineering Technology/ Electrical Engineering Faculty and Staff Search Committees, Chair, 2007, 2008, 2009, 2011, 2012, 2013-14
   - College of Science and Engineering, Planning, Policy, and Budget Committee, since 2014

- College of Sciences and Technology Dean Search Committee, 2013-14
- Institute for Energy Studies, Curriculum Committee, since 2013
- Institute for Energy Studies, Personnel Committee, since 2013
- College of Sciences and Technology Dean's Advisory Committee (DAC), 2008-2012
- College of Science and Technology Personnel Committee, 2004 – 2008

9. Briefly list the most important publications and presentations from the past five years – title, co-authors if any, where published and/or presented, date of publication or presentation:

   Jeff Newcomer, Nikki Larson, Derek Yip-Hoi, Todd Morton, Transitioning to Engineering Without Losing Experiential Learning, ASEE National Conference, June 2019, Tampa, FL, Published in the Proceedings. (10%)

   Ying Lin, Todd Morton, A Microcontroller-based DSP Laboratory Curriculum, ASEE National Conference, June 2017, Columbus, OH, Published in the Proceedings. (50%)

   Ying Lin, John Lund, Todd Morton, A Hands-on First-year Electrical Engineering Introduction Course, ASEE National Conference, June 2017, Columbus, OH, Published in the Proceedings. (15%)

10. Briefly list the most recent professional development activities:
    - 2021 Embedded On-line Conference
    - Multiple webinars for developing video and on-line assignment submission and grading – Zoom, Camtasia, GradeScope
    - Multiple webinars and documentation for new embedded microcontrollers – NXP, Renesas, SEGGER
    - Multiple webinars and documentation on GitLab Issues and using GitLab for Agile development

1. Name: Amr Radwan

2. Education:
   - PhD, Electrical Engineering, University of Alberta, 2016
   - M.Sc, Electrical Engineering, University of Alberta, 2012
   - B.Sc., Electrical Engineering, Ain Shams, University, 2007

3. Academic Experience:
   - Western Washington University, Assistant Professor, full-time, 2018-present
   - University of Alberta, Teaching and Research Assistant, full-time, 2010-2016

4. Non-Academic Experience:
   - MPP Engineering Inc., Electrical Engineer Power System Studies, full-time, 2015-2018
   - Dar Al-handashah for Engineering Consultants, Electrical Engineer Distribution systems design, full-time, 2009-2010

5. Professional Registration:

   Professional Engineer, Association of Professional Engineers and Geoscientists of Saskatchewan

6. Current Memberships:

   Senior Member, IEEE

7. Honors and Awards:
   - One of the Best Conference Paper Presentation Award (2020, 2021)
     IEEE International Conference on Smart Energy Grid Engineering (SEGE), Oshawa, ON
   - The Honor Degree for Academic Distinction (2007), Ain Shams University

8. Service Activities:

   Western Washington University
   - Student Academic Grievance Board, Member (2021-2024)
   - Annual Engineering and Design Scholarship's Committee, Chair (2020-present)
   - Faculty Search Committee, Member (2019, 2020, 2021)
   - Undergraduate Student Advisor (2018-present)

   Journal Administration
   - Guest Editor for a Special Issue, "Power electronic converters in renewable energy and active distribution systems," MDPI Energies (2021-2021)
   - Guest Editor for a Special Issue, "Modeling and control of power electronic converters in renewable energy and smart grid systems," MDPI Electronics (2019-2021)

   Technical Reviewer
   - Reviewer for IEEE Transactions, IEEE Access, and IET

9. Recent Publications:

M. Magableh, Amr Radwan, and Y. Mohamed, “Assessment and mitigation of dynamic instabilities in single-stage grid-connected photovoltaic systems with reduced dc-link capacitance,” IEEE Access, vol. 9, pp. 55522 - 55536, 2021.

S. Rezaee, Amr Radwan, M. Moallem, and J. Wang, “Voltage source converters connected to very weak grids - accurate dynamic modeling, small-signal analysis, and stability improvement,” IEEE Access, vol. 8, pp. 201120-201133, 2020.

Amr Radwan and Y. Mohamed, “Grid-connected wind-solar cogeneration using back-to-back voltage source converters,” IEEE Transactions on Sustainable Energy, vol. 11, no. 1, pp. 315-325, 2020.

Amr Radwan, X. Jiang, D. Tamai, O. Massey, and I. Khouri, “Performance evaluation of grid-connected converters using the mixed sensitivity robust current control,” in Proceedings of the Mediterranean Conference on Control and Automation, pp. 398-402, 2021.

Amr Radwan, I. Khouri and X. Jiang, “Modeling and control of current-source converter-based AC microgrids,” in Proceedings of IEEE International Conference on Smart Energy Grid Engineering, pp. 97-101, 2020.

A. Brar, R. Sanborn, Amr Radwan and X. Jiang, “A Mobile photovoltaic-battery system for off-grid applications,” in Proceedings of International Conference on Electrical, Communication, and Computer Engineering, pp. 1-5, 2020.

10. Recent Professional Development Activities:

- Flexible Modality Preparedness
  Western Washington University, Bellingham, WA, Online Training (1 session, 2021)
- Rapid Instructional Design Strategies
  Western Washington University, Bellingham, WA, Online Training (1 session, 2021)
- Women and STEM: Opt-Out or Lean In?
  Mediterranean Conference on Control and Automation, Bari, Italy, Online Panel (1 session, 2021)
- Instructional Design for Blended and Online Courses Workshop
  Western Washington University, Bellingham, WA, Online Training (6 sessions, 2021)
- Inclusion and Social Mindfulness in STEM
  Western Washington University, Bellingham, WA (2 sessions, 2020)

1. Name: Bhaskar Ramasubramanian

2. Education:
    a. Ph.D., Electrical and Computer Engineering, University of Maryland, 2018
    b. M. S., Electrical and Computer Engineering, University of Maryland, 2016
    c. M. Tech., Systems and Control Engineering, Indian Institute of Technology Bombay, 2011
    d. B. Tech., Electrical and Electronics Engineering, Visvesvaraya National Institute of Technology, 2009

3. Academic experience:
    - Western Washington University, full-time, Assistant Professor, 2021-present
    - University of Washington, full-time, Postdoctoral Research Associate, 2018-2019
    - University of Maryland, Graduate Research & Teaching Assistant, 2011-2018

4. Non-academic experience:

5. Certifications or professional registrations:

6. Current membership of professional organizations:
    - IEEE Member

7. Honors and awards:
    - National Science Foundation (NSF) CISE Research Initiation Initiative (CRII): Project titled Cognizant Learning for Autonomous Cyber-Physical Systems; Funding amount (duration): $174, 921 (Feb 15, 2022 – Feb 14, 2024); Role: PI
    - Best Paper Finalist, ACM/ IEEE International Conference on Cyber-Physical Systems (ICCPS), CPS-IoT Week, 2020
    - Outstanding Teaching Assistant, University of Maryland, 2018
    - A. James Clark School of Engineering Distinguished Graduate Fellowship, University of Maryland, 2011

8. Service activities:
    - Postdoctoral Lead, Engineering Exploration portion of Univ. Washington Engineering Academy Summer Program. Introduced high school students to topics in machine learning, network security, and threat mitigation.
    - Program Committee Member: Conference on Autonomous Agents and Multiagent Systems, 2021, 2022; Conference on Decision and Game Theory for Security, 2018-2021.
    - Member, IEEE Control Systems Society Technical Committee on Security and Privacy, 2021.

- Reviewer, Multiple peer-reviewed journals and conference proceedings to help disseminate technical research to the scientific community, 2014-2021.

9. Notable Recent Publications:

   B. Xiao, B. Ramasubramanian, R. Poovendran, "Agent-Temporal Attention for Reward Redistribution in Episodic Multi-Agent Reinforcement Learning," In Proceedings of the International Conference on Autonomous Agents and Multi-Agent Systems, pp. 1391 – 1399, May 2022

   B. Ramasubramanian, M. A. Rajan, M. G. Chandra, R. Cleaveland, S. I. Marcus, "Resilience to Denial-of-Service and Integrity Attacks: A Structured Systems Approach," European Journal of Control, vol. 63, pp. 61 – 69, January 2022.

   B. Ramasubramanian, L. Niu, A. Clark, L. Bushnell, R. Poovendran, "Secure Control in Partially Observable Environments to Satisfy LTL Specifications," IEEE Transactions on Automatic Control, vol. 66, no. 12, pp. 5665 – 5679, December 2021.

   B. Ramasubramanian, L. Niu, A. Clark, R. Poovendran, "Reinforcement Learning Beyond Expectation," In 60th IEEE Conference on Decision and Control, pp. 1528 – 1535, December 2021.

   B. Ramasubramanian, B. Xiao, L. Bushnell, R. Poovendran, "Safety-Critical Online Control with Adversarial Disturbances," In 59th IEEE Conference on Decision and Control, pp. 3731 – 3738, December 2020.

   B. Xiao, Q. Lu, B. Ramasubramanian, A. Clark, L. Bushnell, R. Poovendran, "FRESH: Interactive Reward Shaping in High-Dimensional State Spaces using Human Feedback," In Proc. of the International Conference on Autonomous Agents and Multiagent Systems, 2020, pp. 1512-1520.

   L. Niu, B. Ramasubramanian, A. Clark, L. Bushnell, R. Poovendran, "Control Synthesis for Cyber-Physical Systems to Satisfy Metric Interval Temporal Logic Objectives under Timing and Actuator Attacks," In Proc. 11th ACM/ IEEE International Conference on Cyber-Physical Systems, 2020, pp. 162-173.

10. Most recent professional development activities:
    - Spring 2022: Designed and developed a new undergraduate elective class on Artificial Intelligence and Reinforcement Learning. Topics included knowledge representation, algorithmic search methods, reasoning and planning in uncertain environments, algorithmic learning in unknown environments, and a discussion of ethical and societal implications of AI and RL.
    - Panelist, US National Science Foundation, for reviewing proposals submitted for possible funding.
    - Summer 2021: Attended workshop for new faculty on Effective Teaching and Learning Strategies conducted by SMATE, WWU.

1. Name: Stephen D. Sandelin
2. Education:
    - Bachelor of Science, Electrical Engineering, Washington State University, 1995.
3. Academic experience:
    - Instructor, Engineering & Design Department, Western Washington University, 2012-present.
4. Non-academic experience:
    - Product Definer, Maxim Integrated Products, Microcontroller Group, 2005-2012
    - Design Manager, Maxim Integrated Products, Microcontroller Group, 2003-2005
    - Engineer, Dallas Semiconductor, 1999-2000
    - Design Engineer, Dallas Semiconductor, 1997-2000
    - Design Engineer, Advanced Microelectronics, 1996-1997
    - Rifleman, Squad Leader, United States Army, 101st Airborne Division, 1987-1991
5. Certifications or professional registrations:
6. Current membership in professional organizations:
7. Honors and awards:
8. Service activities:
9. Most important publications and presentations from the past five years:
10. Most recent professional development activities:

1. Name: Tina Smilkstein

2. Education:
    - Ph.D., Electrical Engineering, University of California Berkeley, 2007.
    - M.A., Electrical Engineering University of California – Berkeley, 2003.
    - B.S., Business Administration, Nanzan University, 1989.

3. Academic experience:
    - Western Washington University, part-time
        - Instructor, 1/2022-present
    - California Polytechnic State University
        - Associate Professor, 2015-2021
        - Assistant Professor, 2009-2015
    - University of Missouri,
        - Assistant Professor, 2006-2009
    - University of California Berkeley
        - Teaching Assistant, part-time, 1998-2006

4. Non-academic experience:
    - Fujitsu Artificial Intelligence Research Center, C-cube Software, 1992-1996
    - Hitachi Chubu Software – Programmer/SE/Translator, 1989-1992
    - Hitachi Chubu Software, Programmer, 1988-1989

5. Certifications or professional registrations:

6. Current membership in professional organizations:
    - IEEE Engineering in Medicine and Biology Society, current member
    - Society of Women Engineers, current member
    - Institute of Electrical and Electronics Engineers, current member
    - IEEE Solid State Circuits Society, current member
    - Women in Computer Science and Engineering, current member
    - IEEE Technology and Society, current member

7. Honors and awards:

8. Service activities:

9. Most important publications and presentations from the past five years:

T. Smilkstein, *Jitter Reduction on High-Speed Clock Signals*, Ph.D. Thesis, University of California at Berkeley, 2007 (Advisor: Robert W. Brodersen). (100% contribution).

T. Smilkstein, *Clocktree Generation for an Automated IC Design Flow*, Master's Thesis, University of California at Berkeley, May 2003 (Advisor: Robert W. Brodersen). (100% contribution).

T. Smilkstein, "The Power of Visibility", 2020 American Society for Engineering Education Pacific Southwest (ASEE PSW) Conference, Conference rescheduled to 2021.

T. Smilkstein, "Diversity, Equity, and Inclusion Project", 2020 American Society for Engineering Education Pacific Southwest (ASEE PSW) Conference, Conference rescheduled to 2021.

T. Smilkstein. "A Fully Feedforward Jitter Removal Circuit for Low GHz Applications", in IEEE Dallas Circuits and Systems Conference, Dallas, Texas, October 12-13, 2014. Accepted but not presented.

10. Most recent professional development activities:
    - Intro to Equitable and Inclusive Teaching, 2021 (CalPoly)
    - TIDE (Teaching inclusivity, diversity, and equity), 2020 (CalPoly)

Appendix C
Equipment

Electrical and Computer Engineering Equipment

Room	Category	Equipment Name
ET 331	Electronics Laboratory	19 Total Workstations 15 workstations that each include:
		Dell Optiplex 7460 All in one PC
		Fluke 8808A Bench Multimeters
		Agilent DSO-X 3012A Digital Storage Oscilloscope w/built in Function Generator
		Tektronix AFG 1022 Function generator
		Keithley 2231A Triple Channel DC Power Supply
		3 workstations that each include:
		Dell Optiplex 7460 All in one PC
		Fluke 8808A Bench Multimeters
		Keysight DSO-X 3012T Digital Storage Oscilloscope w/built in Function Generator
		Keithley 2231A Triple Channel DC Power Supply
		Tektronix AFG 1022 Function generator
		1 workstation that includes:
		Dell Optiplex 7460 All in one PC
		Keysight DSOX1102G Oscilloscope
		Keysight E3630A Triple Output Power Supply
		853D Soldering/Reflow station
		Additional Equipment:
		12 x Fluke 87 IV Handheld Multimeters
		6 x Fluke 87V Handheld Multimeters
ET 328	Energy Laboratory	
		10 LabVolt Workstations
		Power Supplies: 3 x 8821-10, 7 x 8821-20
		AC Ammeters: 3 x 8425, 1 x 8425-00
		AC Voltmeters: 2 x 8426, 1 x 8426-00
		DC Volt-Ammeters: 3 x 8412, 1 x 8412-00
		Single Phase Wattmeter: 3 x 8431
		Wattmeter: 2 x 8441
		Three-Phase Wattmeter: 1 x 8441-10, 1 x 8441-20
		Resistive Load: 6 x 8311, 6 x 8311-00
		Smoothing Inductors: 6 x 8325-10
		SVC Reactors/Thyristor-Switched Capacitors: 3 x 8334-00
		Power Thyristors: 6 x 8841-20
		Tandem Rheostats: 2 x 8737-00

		Filtering Inductors/Capacitors: 3 x 8325-A0
		Rectifier and Filtering Caps: 3 x 8842-A0
		Capacitive Load: 10 x 8331-00,
		Line Inductors: 3x 8326-A0
		Inductive Load: 3 x 8321, 8 x 8321-00
		Insulated DC-DC Converter: 3 x 8835-00
		Power Diodes: 3 x 8842-10
		Transformer: 9 x 8341, 3 x 8341-20, 8 x 8353-00
		Four Quadrant Dynamometer/Power Supply: 8960-20
		Electro Dynamometer: 3 x 8911, 1 x 8911-00
		SCR Speed Control: 1 x 9011
		Lead Acid Batteries: 3 x 8801-00, 8 x 8802-10
		Solar Panel Test Bench: 2 x 8805-00
		AC Power Network Interface: 3 x 8622-00
		Three-Phase Transmission Line: 6 x 8329-00
		Three-Phase Transformer Bank: 8 x 8348-40
		IGBT Chopper/Inverter: 6 x 8837-B0
		Synchronizing Module/Three-Phase Contactor: 8 x 8621-A0
		Three-Phase Regulating Autotransformer: 6 x 8349-00
		Three Phase Filter: 3 x 8326-00
		Three-Phase Transformer: 8354-00
		P.I.D. Controller: 3 x 9034-00
		Wind Turbine Demonstrator: 1 x 8216-D0
		Wind Turbine Generator/Controller: 3 x 8216-00
		Data Acquisition and Control Interface: 8 x 9063-00
		18 x Fluke T5-1000 Electrical Tester
		Thyristor Firing Unit: 6 x 9030-30
		Chopper/Inverter/Controller Unit: 3 x 9029-00
		Function Generator: 3 x 9033-00
		Current/Voltage Isolator: 3 x 9056-10
		Enclosure/Power Supply: 3 x 8840
		Real Time Digital Simulator: 1 x OP5600
		High Voltage and Current Probe: 1 x OP8662
		Permanent Magnet Synchronous Machine: 1x 8245-00
		(3) dSpace Advanced Control Kits 1104 (includes DS1104 R&D Controller Board)
		(3) dSpace 3-Inverter Assemblies

		Motors: Squirrel Cage Induction: 3 x 8221 Four Pole Squirrel Cage Induction: 1 x 8221-00, 4 x 8221-20 Synchronous Machine: 3 x 8241 Synchronous Motor/Generator: 1 x 8241-00, 4 x 8241-20 Capacitor Start Motor: 2 x 8251, 5 x 8251-00 Capacitor-Run Motor: 1 x 8253 Direct Current Machine: 3 x 8211 DC Motor/Generator: 5 x 8211-00 Universal Motor: 2 x 8254 Wound Rotor Machine: 3 x 8231 Synchronous Reluctance Motor: 1 x 8246 Three-Phase Rheostat: 3 x 8731 Synchronizing Module: 1 x 8621 Repulsion-Induction Motor: 1 x 8255 Permanent Magnet DC Motor: 8x 8213-00 Three-Phase Wound-Rotor Induction Machine: 5 x 8231-00
ET 340	Embedded Systems Laboratory	
		Fluke PM6306 RCL Meter
		16 work stations, each with the following:
		Dell Optiplex 7460 All in one PC
		Tektronix MDO3024 Mixed Signal Oscilloscope
		Fluke 8808A Bench Multimeters
		Keithley 2231A Triple Channel DC Power Supply
		2 work stations, each with the following:
		Dell Optiplex 7460 All in one PC
		Keithley 2231A Triple Channel DC Power Supply
		Fluke 8808A Bench Multimeters
ET 338	Communicat-ions Laboratory	
		12 workstations, each with the following:

		Dell Optiplex 7460 All in one PC
		Tektronix MSO2024 Mixed Signal Oscilloscope
		Fluke 8808A Digital Multimeter
		Agilent 33210A Function Generator
		Keysight E3630A Triple Output Power Supply
		Additional Equipment:
		9 x Fluke 177 Multimeter
		Stanford Research Systems SR715 LCR Meter
		2 x Giga-Tronics 6061A Synthesized RF Signal Generator
		Zeny 852D+ Hot air rework & soldering station
		Metcal PS2E-01 Soldering Station
All Labs	Software Tools	Each computer in the EE Labs has the following software tools installed: Altium Designer, Eagle, Atmel Studio, Code Composer, Code Warrior, Cygwin, Xilinx ISE Design Suite, Freescale Kinetis Design Studio, LT Spice, MatLab, Multisim 13.0, Cypress PSoC Create & Designer, TeraTerm, National Instruments LabView, Microsoft Office
ET 332	Research and Development Laboratory	Agilent MSO-X 3014A Mixed Signal Oscilloscope
		Tektronix DPO-3012 Digital Phosphor Oscilloscope
		3 x Topward TPS-4000 Power Supply, Dual Tracking
		Wavetek Model 166 Function Generator
		Hewlett Packard 3468A Digital Multimeter
		Hewlett Packard 4262A LCR Meter
		2 x Philips PM2813 Programmable Power Supply
		Kenwood TS-440S Transceiver
		Kenwood Power Supply PS-50
		Kenwood TL-922A
		Tektronix DPO3012 Two Channel Oscilloscope
		Hewlett Packard 35660A Dynamic Signal Analyzer
		Metcal MFR220 Dual Soldering Iron
		Metcal BVX100 Fume Extractor
		2 x Zeny 852D+ Hot air rework & soldering station
		AmScope Microscope w/ USB Camera
		Sigma System Temperature Chamber
		T-962 Infrared IC heater
		MPP-11 Pick and Place System
		Silhouette Cameo Stencil Cutter
		Various hand tools - cutters, strippers, tweezers, pliers, etc.
		Flashforge Creator Pro Dual Extruder 3D Printer

		Sentry Air Systems SS-200-SKY Fume extractor
		Metcal PS2E-01 Soldering Station
		Ultra-Dry 1490V Desiccant Dry Cabinet
		65x Analog Discovery 2 Pro
		5x Ettus USRP software-defined radios
		12x Jetson Nano 2GB developer kits

Appendix D
Institutional Summary

1. The Institution

a. Western Washington University
516 High Street
Bellingham, WA 98225

b. Dr. Sabah Randhawa, President

c. Dr. Andrew G. Klein, Program Director Electrical & Computer Engineering

d. Western Washington University is accredited by the Northwest Commission on Colleges and Universities (NWCCU), one of the eight agencies recognized by the U.S. Department of Education as a national accrediting body. The initial NWCCU accreditation was granted in 1921, and the accreditation status was last confirmed in 2017; the university is scheduled for its next evaluation by NWCCU during the 2024-2025 academic year.

Further information about the institution's national accreditation and other specialized program accreditation can be found at the following website: https://www.wwu.edu/accreditation/.

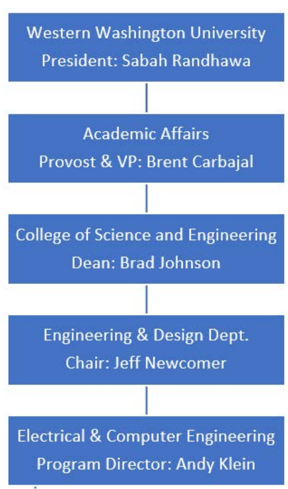
2. Type of Control

Western Washington University is a state, 4-year, comprehensive University.

3. Educational Unit

The Electrical & Computer Engineering program is one of four programs in the Engineering & Design Department. The other three programs are Manufacturing Engineering, Plastics and Composites Engineering, and Industrial Design.

The following chart shows the administrative chain of responsibility:



4. **Academic Support Units**

Chemistry
Chair, Dr. P. Clint Spiegel

Computer Science
Chair, Dr. Filip Jagodzinski

English
Chair, Dr. Kathryn Vulic

Mathematics
Chair, Dr. David Hartenstine

Physics & Astronomy
Chair: Dr. Janelle Leger

5. **Non-academic Support Units**

Western Libraries
Dean of Libraries: Mark Greenberg

University Information Technology
Vice Provost for Information Technology and Chief Information Officer: Chuck Lanham

College Information Technology
Director of Network Computer Services: Todd Epps

Career Services Center
Director: Effie Eisses

University Accreditation, Assessment, Faculty Development, Teaching and Learning Resources
Vice Provost for Undergraduate Education: Dr. Jack Herring

Office of Research and Sponsored Programs
Vice Provost for Research: Dr. David Patrick

Admissions Office
Dir. of Admissions: Cezar Mesquita

Registrar's Office
Interim Registrar: Shelli Soto

Disability Access Center
Dir. DAC and Dep. ADA Coordinator: Josef Mogharreban

Civil Rights and Title IX Compliance
Dir. of Civil Rights and Title IX Compliance: Daniel Records-Galbraith

6. Credit Unit

Western Washington University is on the quarter system. Each quarter is ten weeks excluding Finals week. All Engineering programs require courses in Fall, Winter, and Spring quarters. Summer quarter attendance is not required to meet program requirements.

In the Engineering and Design Department one quarter credit represents one class hour or two laboratory hours per week.

Table D-1. Program Enrollment and Degree Data

Electrical and Computer Engineering

	Academic Year		Enrollment Year					Total Undergrad	Total Grad	Degrees Awarded			
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
Current 2021-22		FT	51	43	42	32		168			32		
		PT											
1 year prior to current 2020-21		FT	71	49	34	33		151			35		
		PT											
2 years prior to current 2019-20		FT	88	36	36	26		186			23		
		PT											
3 years prior to current 2018-19		FT	72	32	32	23		159			26		
		PT											
4 years prior to current 2017-18		FT	86	34	35	21		176			23		
		PT											

Table D-2. Personnel

Electrical and Computer Engineering 2021-2022

	HEAD COUNT		FTE[2]
	FT	PT	
Administrative[2]	0	2	.334
Faculty (tenure-track)[3]	8	0	7.833
Other Faculty (excluding student Assistants)	2	0	.611
Student Teaching Assistants[4]	0	0	
Technicians/Specialists	3	0	1.50
Office/Clerical Employees	3	0	.75
Others[5]			

Appendix E

Assessment Supporting Documentation

Note: The printed Excel sheets in this Appendix are much easier to view as navigable spreadsheet documents; they appear in the display materials.

Student Outcome Assessment Evaluation

Student Outcome: SO1: "an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics"

Evaluation Date: 06/17/2021

Supporting Documents: *EECE233_AssessmentEvaluationSO1.docx, EECE233_F20_SO1_Data.xlsx, EECE444_AssessmentEvaluationSO1.docx, EECE444_W21_SO1_Data.xlsx, EECE310_AssessmentEvaluationSO1.docx, EECE310_Sp21_SO1_Data.xlsx, EECE220_ AssessmentEvaluationSO1.docx, EECE220_W21_SO1_Data.xlsx, EECE360_AssessmentEvaluationSO1.pdf, EECE360_W19_SO1_Data.xlsx*

Prior Recommendations and attainment: None.

Assessment Methodologies	
1.	EECE 233 Boolean Algebra and K-maps, Midterm and Final
2.	EECE 444 Fixed-point math programming lab
3.	EECE 220 Small signal transistor exam problem
4.	EECE 310 Transfer function and stability, Final exam
5.	EECE 360 Receiver carrier phase and SNR

Assessment Targets	
1.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
2.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
3.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
4.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
5.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level

Attainment of Outcome	
1.	100% attained outcome at satisfactory level or better, 0% unsatisfactory
2.	83% attained outcome at satisfactory level or better, 0% unsatisfactory
3.	92% attained outcome at satisfactory level or better, 4% unsatisfactory
4.	98% attained outcome at satisfactory level or better, 0% unsatisfactory
5.	96% attained outcome at satisfactory level or better, 0% unsatisfactory

Recommended Changes	
1.	Rescale
2.	Move assignment to individual lab if it fits in the overall lab structure
3.	Rescale
4.	Rescale
5.	None

Recommended Re-assessment Plan

1.	Reassess with proctored exam
2.	Assess in individual lab
3.	Reassess with proctored exam
4.	Reassess with proctored exam
5.	No reassessment needed

Other Possible Changes	

Assessment of Student Outcome 1 in EECE220

Instructor: Amr Radwan

Assessor: Amr Radwan

Assessment Quarter and Year: Winter 2021

This report assesses Student Outcome 1 "*an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics*". The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 220 – Electronics I. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 220 is the first course in the electronics sequence. In this class students learn the operating principles of semiconductor devices and use those principles to develop models for device operation. These models are then applied to the design and analysis of circuits that use semiconductor devices. As such students must use the mathematical descriptions of diodes and transistors to predict the behavior of these devices in the lab and are evaluated for those abilities in the lab reports, homework, and exams. To evaluate this, one question was used from the final exam. Students are required to represent a transistor using the small signal model and then use circuit analysis techniques to calculate the input, the output resistance, and the voltage gain. This assessment was made for the EECE 220 class of Winter quarter, 2021.

For this assessment, the EECE program at Western looks at the percentage of students who achieved a satisfactory or exemplary on the average scores. Where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of SO1 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data

Unsatisfactory	0	2	4.17%	
Developing	1	2	4.17%	
Satisfactory	2	10	20.83%	Result:
Exemplary	3	34	70.83%	3

Discussion:

In EECE 220, 91% of the students demonstrated satisfactory or exemplary performance and 4.17% of students demonstrated an unsatisfactory performance. The results imply a very good performance of the class. There are some factors that should be noted about this class and this quarter when evaluating the performance presented here with year over year data going forward.

- This class was taught for the first time in an online modality during the global pandemic. Final exam was offered in an open book model where students were given a specific time window to work on the problems and submit their solution remotely. The assessment data might change once we are back to normal face-to-face mode with closed book exams.
- A re-assessment without Covid restrictions is suggested.

EECE 220 Student Outcome 1 Measure
W21 Final Exam - Problem 5: Small signal modeling and analysis of MOSFETs

Total Number of Students:	48
Number Qualified:	48

Max Points	10		
Students	**Points**	%	Scale 0-3
Student1	2	20	0
Student2	2	20	0
Student3	6	60	1
Student4	6	60	1
Student5	7	70	2
Student6	8	80	2
Student7	8	80	2
Student8	8	80	2
Student9	8	80	2
Student10	8	80	2
Student11	8	80	2
Student12	8	80	2
Student13	8	80	2
Student14	8	80	2
Student15	9	90	3
Student16	9	90	3
Student17	9	90	3
Student18	9.5	95	3
Student19	10	100	3
Student20	10	100	3
Student21	10	100	3
Student22	10	100	3
Student23	10	100	3
Student24	10	100	3
Student25	10	100	3
Student26	10	100	3
Student27	10	100	3
Student28	10	100	3
Student29	10	100	3
Student30	10	100	3
Student31	10	100	3
Student32	10	100	3
Student33	10	100	3
Student34	10	100	3
Student35	10	100	3
Student36	10	100	3

Student37	10	100	3
Student38	10	100	3
Student39	10	100	3
Student40	10	100	3
Student41	10	100	3
Student42	10	100	3
Student43	10	100	3
Student44	10	100	3
Student45	10	100	3
Student46	10	100	3
Student47	10	100	3
Student48	10	100	3

0-40%	Unsatisfactory	0	2	4.17%
41%-60%	Developing	1	2	4.17%
61%-80%	Satisfactory	2	10	20.83%
81%-100%	Exemplary	3	34	70.83%
			34	

Assessment of Student Outcome 1 in EECE233

Instructor: Steve Sandelin

Assessor: Steve Sandelin

Assessment Quarter and Year: Fall 2020

This report assesses Student Outcome 1 "*an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics*". The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 233. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

Background:

EECE 233 is the first course in the digital electronics sequence and serves as a pre-requisite for the embedded microcontrollers sequence. In this class students learn the electrical basis for digital representation of numbers and signals, basic principles of digital logic operation and design and analysis techniques for creating primitive logic gate level circuits. As such students must use discrete mathematics, in the form of Boolean algebra and its graphical equivalent Karnaugh Maps, to optimize logic circuits for minimal implementation. To evaluate this use of discrete mathematics, two questions were used, one from the midterm exam and one from the final exam. The first requires the student to use Karnaugh Maps to reduce a canonical representation of a logic design to the minimum standard form representation. The second problem, presented in two parts, repeats the use of Karnaugh Maps for logic minimization and then requires the use of algebraic manipulation of a standard form equation to further modify it. This allows us to evaluate the students use of both techniques as well as increased competency with Karnaugh Maps as the quarter progressed. This assessment was made for the EECE 233 class of Fall quarter, 2020.

For this assessment, the EECE Program at Western looks at the percentage of students who achieved a satisfactory or exemplary on the average scores. Where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of Student Outcome 1 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data:

Unsatisfactory	0	0	0.0%	
Developing	1	0	0.0%	
Satisfactory	2	17	35.42%	Result:
Exemplary	3	31	64.58%	3

Discussion:

In EECE 233, 17 of 48 students demonstrated satisfactory performance and 31 of 48 students demonstrated exemplary performance. This represents a very good outcome for the class as a whole and, at least in this category, there were no students who failed to demonstrate knowledge of the assessed topic by the end of the quarter.

There are some factors that should be noted about this class and this quarter when evaluating the performance presented here with year over year data going forward.

- This is a very strong class. A disproportionally high number of students accepted into the program this year are very strong students.
- This class was taught for the first time in an online modality during a global pandemic. Certain course policies with respect to partial credit and late submission grading were relaxed.
- This data includes mid-term and end-term demonstration of Karnaugh Maps. At mid-term 10 students had scores of developing, while at end-term the student understanding of the topic was very much improved.

EE 220-2 Student Outcome 1) Measures

Total Number of students: 48
Number Qualified: 48

Student	KMap1	KMap1 Scaled	KMap2	KMap2 Scaled
max	20	3.00	10.00	3.00
S1	10	1.50	10	3.00
S2	10	1.50	10	3.00
S3	10	1.50	10	3.00
S4	10	1.50	10	3.00
S5	10	1.50	10	3.00
S6	10	1.50	10	3.00
S7	15	2.25	10	3.00
S8	18	2.70	10	3.00
S9	17	2.55	10	3.00
S10	10	1.50	10	3.00
S11	18	2.70	10	3.00
S12	20	3.00	10	3.00
S13	10	1.50	10	3.00
S14	18	2.70	10	3.00
S15	20	3.00	10	3.00
S16	17	2.55	7	2.10
S17	17	2.55	10	3.00
S18	12	1.80	10	3.00
S19	13	1.95	7	2.10
S20	10	1.50	10	3.00
S21	17	2.55	10	3.00
S22	12	1.80	9	2.70
S23	12	1.80	10	3.00
S24	17	2.55	10	3.00
S25	13	1.95	10	3.00
S26	15	2.25	10	3.00
S27	16	2.40	10	3.00
S28	10	1.50	10	3.00
S29	12	1.80	10	3.00
S30	12	1.80	10	3.00
S31	12	1.80	10	3.00
S32	17	2.55	10	3.00
S33	12	1.80	10	3.00
S34	12	1.80	8	2.40
S35	12	1.80	10	3.00
S36	20	3.00	10	3.00
S37	20	3.00	10	3.00
S38	12	1.80	10	3.00
S39	17	2.55	10	3.00

S40	12	1.80	10	3.00
S41	12	1.80	10	3.00
S42	17	2.55	10	3.00
S43	20	3.00	10	3.00
S44	17	2.55	10	3.00
S45	20	3.00	10	3.00
S46	12	1.80	10	3.00
S47	17	2.55	10	3.00
S48	12	1.80	10	3.00

Unsatisfactory	0	0	0.00%
Developing	1	0	0.00%
Satisfactory	2	17	35.42%
Exemplary	3	31	64.58%

Bool Alg	Bool Alg Scaled	Ave Score	Rnd Score
10.00	3.00	3.00	3.00
7	2.10	2.20	2.00
7	2.10	2.20	2.00
10	3.00	2.50	3.00
10	3.00	2.50	3.00
10	3.00	2.50	3.00
7	2.10	2.20	2.00
7	2.10	2.45	2.00
10	3.00	2.90	3.00
10	3.00	2.85	3.00
8	2.40	2.30	2.00
10	3.00	2.90	3.00
10	3.00	3.00	3.00
10	3.00	2.50	3.00
6	1.80	2.50	3.00
10	3.00	3.00	3.00
7	2.10	2.25	2.00
8	2.40	2.65	3.00
8	2.40	2.40	2.00
7	2.10	2.05	2.00
10	3.00	2.50	3.00
10	3.00	2.85	3.00
10	3.00	2.50	3.00
9	2.70	2.50	3.00
10	3.00	2.85	3.00
10	3.00	2.65	3.00
7	2.10	2.45	2.00
8	2.40	2.60	3.00
7	2.10	2.20	2.00
7	2.10	2.30	2.00
7	2.10	2.30	2.00
7	2.10	2.30	2.00
10	3.00	2.85	3.00
10	3.00	2.60	3.00
7	2.10	2.10	2.00
10	3.00	2.60	3.00
10	3.00	3.00	3.00
10	3.00	3.00	3.00
7	2.10	2.30	2.00
10	3.00	2.85	3.00

10	3.00	2.60	3.00
10	3.00	2.60	3.00
10	3.00	2.85	3.00
10	3.00	3.00	3.00
10	3.00	2.85	3.00
7	2.10	2.70	3.00
6	1.80	2.20	2.00
10	3.00	2.85	3.00
6	1.80	2.20	2.00

Result:

3

Assessment of Student Outcome 1 in EECE310

Instructor: Ying Lin

Assessor: Ying Lin

Assessment Quarter and Year: Spring 2021

This report assesses Student Outcome 1 *"an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics"*. The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 310. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available the file "EECE310_Sp21_SO1_Data.xlsx" in the Student Outcome assessment folder.

Background:

EECE 310 is a sophomore-level core course that all EECE students need to take and is a pre-requisite for several other courses including EECE 311, EECE320, EECE360, and EECE480. In this class students learn the fundamentals of continuous-time signals and linear time-invariant (LTI) systems. Students also learn important transform tools to solve and analyze analog LTI systems. These tools include time-domain linear convolution, Laplace transform, and Fourier transform.

The evaluation data was taken from a problem of the final exam. Students were given the transfer function of a second-order system and asked to analyze the system stability by obtaining and evaluating the poles of the transfer function. The second part of the problem asked students to obtain the system impulse response by conducting inverse Laplace transform. This allows us to evaluate the students use of mathematical transforms – Laplace transform and inverse Laplace transform in LTI sytems. This assessment was conducted based on data from ECEE 310 class of Spring quarter, 2021.

For this assessment, the EECE Program at Western looks at the percentage of students who achieved a satisfactory or exemplary on the average scores, where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of Student Outcome 1 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data:

Unsatisfactory	0	0	0.0%	
Developing	1	1	2.44%	
Satisfactory	2	24	58.54%	Result:
Exemplary	3	16	39.02%	3

Discussion:

In EECE 310, 40 out of 41 students demonstrated either satisfactory or exemplary performance toward this assessment. This represents a very good outcome for the class as a whole in this category. A few factors might contribute to the high performance for this particular assessment.

- As noted from the assessment of other sophomore courses (such as EECE233) with the same cohort class, we have noticed that this group of students is a very strong class. A disproportionally high number of students accepted into the program this year are very strong students that are well prepared in math. EECE310 is a math-heavy course and students with strong math background would excel in the topics evaluated in the assessment data.
- This class was taught in an online modality during a global pandemic. Some course policies such as take-home exams and allowing open notes and open book during the exams might contribute to higher scores in certain problems.

EECE 310 ABET Student Outcome 1 Measure
Spring 2021 Final Exam question 4
Data mapping rules:

Total Number of Students	
Number Qualified:	
Student	
	max
T1	
T2	
T3	
T4	
T5	
T6	
T7	
T8	
T9	
T10	
T11	
T12	
T13	
T14	
T15	
T16	
T17	
T18	
T19	
T20	
T21	
T22	
T23	
T24	
T25	
T26	
T27	
T28	
T29	
T30	
T31	
T32	
T33	
T34	
T35	
T36	
T37	
T38	

T39
T40
T41

Unsatisfactory
Developing
Satisfactory
Exemplary

	42		
	41		
Laplace transform,Stability, & Impulse response		Scaled to 0-3	Rounded score
	5	3.00	3.00
	4	2.40	2.00
	5	3.00	3.00
	5	3.00	3.00
	5	3.00	3.00
	4	2.40	2.00
	4	2.40	2.00
	3	1.80	2.00
	4	2.40	2.00
	5	3.00	3.00
	5	3.00	3.00
	3	1.80	2.00
	3	1.80	2.00
	4	2.40	2.00
	5	3.00	3.00
	5	3.00	3.00
	5	3.00	3.00
	4	2.40	2.00
	4	2.40	2.00
	3	1.80	2.00
	4	2.40	2.00
	5	3.00	3.00
	5	3.00	3.00
	3	1.80	2.00
	3	1.80	2.00
	4	2.40	2.00
	4	2.40	2.00
	4	2.40	2.00
	5	3.00	3.00
	3	1.80	2.00
	5	3.00	3.00
	5	3.00	3.00
	3	1.80	2.00
	2	1.20	1.00
	4	2.40	2.00
	4	2.40	2.00
	3	1.80	2.00
	5	3.00	3.00
	5	3.00	3.00

Assessment of Student Outcome 1 in EECE 360

Instructor: A.G. Klein
Assessor: A.G. Klein

Assessment Quarter: Winter 2019
Date of Assessment: June 2021

This report assesses Student Outcome 1 *"an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics"*. The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 360 – Communication Systems. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

Background

EECE 360 is an introductory communication systems course, taken by all students in the EECE program, typically during the third year of study. The course relies heavily on pre-requisite material including LTI signal and system theory and application, and provides students with a system-level introduction to wired and wireless communication systems.

To partially evaluate this outcome, one exam question is used which includes many component parts and sub-problems, including the ability to apply LTI system theory, sampling, signal theory, and communication system theory. In this multi-part final exam question, students are given a block diagram of a quadrature transmitter and receiver and are asked to select the receiver carrier phase to maximize signal-to-noise ratio in the presence of various impairments such as: oscillator drift, variable propagation delay, channel-induced phase offsets, etc (impairments vary from year to year). In addition, students are asked to write the expressions for various intermediate signals in the block diagram, in both the time- and frequency-domains. This assessment was made for the EECE 360 class of Winter quarter 2019 since the final exam was optional in Winter 2020 due to COVID. This was question #2 on the final exam exam, and only sub-parts (a) through (d) were used.

For this assessment, the EECE Program at WWU looks at the percentage of students who achieved a satisfactory or exemplary on the average scores. Here, 3 defines an "exemplary" score, 2 is "satisfactory," 1 is "developing," and 0 is "unsatisfactory." Attainment of Student Outcome 1 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% in the unsatisfactory threshold.

Assessment Data

$N = 28$

Meaning	Score	# of students	Proportion of students
Unsatisfactory	0	0	0.0%
Developing	1	1	3.6%
Satisfactory	2	10	35.7%
Exemplary	3	17	60.7%

Result: 3

Discussion

In EECE 360, 10 of 28 students demonstrated satisfactory performance and 17 of 28 students demonstrated exemplary performance. This represents a very good outcome for the class as a whole and, at least in this category, there were no students who failed to demonstrate knowledge of the assessed topic on the final exam.

EECE 360, Winter 2019, Final Exam Problem 2 scores

Highest possible score: 20

	Exam Score on Question 2 (parts a through d, out of 20 points)	Score as percentage	Scaled to 0→3 (y=5*x-1.5)	Quantized
Student 1	18	90%	3	3
Student 2	18	90%	3	3
Student 3	16	80%	2.5	3
Student 4	14	70%	2	2
Student 5	16	80%	2.5	3
Student 6	14	70%	2	2
Student 7	17	85%	2.75	3
Student 8	16	80%	2.5	3
Student 9	17	85%	2.75	3
Student 10	18	90%	3	3
Student 11	15	75%	2.25	2
Student 12	15	75%	2.25	2
Student 13	17	85%	2.75	3
Student 14	16	80%	2.5	3
Student 15	8	40%	0.5	1
Student 16	15	75%	2.25	2
Student 17	16	80%	2.5	3
Student 18	15	75%	2.25	2
Student 19	17	85%	2.75	3
Student 20	18	90%	3	3
Student 21	18	90%	3	3
Student 22	16	80%	2.5	3
Student 23	14	70%	2	2
Student 24	14	70%	2	2
Student 25	17	85%	2.75	3
Student 26	14	70%	2	2
Student 27	20	100%	3.5	3
Student 28	12	60%	1.5	2

Quantized Score	Frequency	Proportion
0	0	0.0%
1	1	3.6%
2	10	35.7%
3	17	60.7%
Number of students	28	

Assessment of Student Outcome 1 in EECE444

Instructor: Todd Morton

Assessor: Todd Morton

Assessment Quarter and Year: Winter 2021

This report assesses Student Outcome 1 "*an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics*". The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 444 – Embedded Systems. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 444 is the third course in the embedded microcontrollers sequence and serves as a pre-requisite for digital signal processing and the senior project sequence. In this class students learn to program microcontrollers in C using real-time operating system and the CMSIS DSP math library. In order to minimize response and task times, the use of fixed-point math is required. To evaluate this use of discrete mathematics, a portion of Lab 3 is used. This part of lab requires the students to generate a sinewave with an amplitude controlled by a ADC result and the frequency controlled by the user input and a fixed sample rate. These inputs have different data types. The output is scaled and passed on to a DAC. The design must meet amplitude, frequency, and distortion requirements. This assessment was made for the EECE 444 class of Winter quarter, 2021.

For this assessment, the EECE program at Western looks at the percentage of students who achieved a satisfactory or exemplary on the average scores. Where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of SO1 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data

Unsatisfactory	0	0	0.00%	
Developing	1	2	16.67%	
Satisfactory	2	6	50.00%	Result:
Exemplary	3	4	33.33%	3

Discussion:

In EECE 444, 83% of the teams demonstrated satisfactory or exemplary performance and no teams demonstrated an unsatisfactory performance. The solution was formulated by small teams of 2 or 3 students. This is not ideal for a student outcome measure.

- Proposed change – move this portion of the lab to an individual assignment so this measure includes every student.

There are some factors that should be noted about this class and this quarter when evaluating the performance presented here with year over year data going forward.

- This class was taught for the first time in an online modality during a global pandemic. Students had access to a USB logic analyzer and scope to verify results.

EECE 444 Student Outcome 1 Measure
W21 Lab3 Sinewave frequency and amplitude using fixed-point numbers, Teams of 2 or 3.

Total Number of teams:	12
Number Qualified:	12

Student	Sine Math
max	3
T1	2
T2	2
T3	3
T4	1
T5	1
T6	2
T7	3
T8	3
T9	2
T10	3
T11	2
T12	2

Unsatisfactory	0	0	0.00%
Developing	1	2	16.67%
Satisfactory	2	6	50.00%
Exemplary	3	4	33.33%

Student Outcome Assessment Evaluation

Student Outcome: (SO2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

Evaluation Date: 06/18/2020, 06/17/2021

Supporting Documents: *AssessmentEvaluationSO2-EECE49x.docx*, *EECE49xSO2Unified.xlsx*, *AssessmentEvaluationSO2-EECE47x.docx*, *EECE47x_F20-S21_SO2_Data.xlsx*

Prior Recommendations and attainment: Assessed 06/15/2016 as student outcome (c). No changes were recommended.

Assessment Methodologies	
1.	EECE 491 Project Proposal and Description
2.	EECE 492 Hardware Design and Fabrication Specifications
3.	EECE 493 Code Review
4.	EECE 471 Project Proposal and Description
5.	EECE 472 Final Presentation / Proof-of-Concept: hardware R&D, test and measurement design and planning, design alternatives
6.	EECE 473 Final Presentation: technical soundness, test results, functionality, ethical and professional considerations

Assessment Targets	
1.	70% of the student attain the outcome at a satisfactory or exemplary level
2.	70% of the student attain the outcome at a satisfactory or exemplary level
3.	70% of the student attain the outcome at a satisfactory or exemplary level
4.	70% of the student attain the outcome at a satisfactory or exemplary level
5.	70% of the student attain the outcome at a satisfactory or exemplary level
6.	70% of the student attain the outcome at a satisfactory or exemplary level

Attainment of Outcome	
1.	88% attained outcome at satisfactory level or better.
2.	82% attained outcome at satisfactory level or better
3.	50% attained outcome at satisfactory level or better
4.	100% attained outcome at satisfactory level or better
5.	100% attained outcome at satisfactory level or better
6.	100% attained outcome at satisfactory level or better

Recommended Changes	
1.	No changes recommended. Assess again in 2023-24
2.	No changes recommended. Assess again in 2023-24
3.	No changes recommended. Assess again in 2023-24
4.	No changes recommended. Assess again in 2023-24
5.	No changes recommended. Assess again in 2023-24
6.	No changes recommended. Assess again in 2023-24

Recommended Re-assessment Plan	
1.	Reassess without COVID restrictions

2.	Reassess without COVID restrictions
3.	Reassess without COVID restrictions
4.	Reassess without COVID restrictions
5.	Reassess without COVID restrictions
6.	Reassess without COVID restrictions

Other Possible Changes	

Assessment of Student Outcome 2 in EECE 491-3

Instructor: John Lund

Assessor: John Lund

Assessment Quarter and Year: Fall 2019 – Spring 2020

This report assesses Student Outcome 2 "*an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors*" The EECE program at Western Washington University assess this outcome in part using student performance in EECE 491, EECE 492, and EECE 493. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis.

Background:

EECE 49x is the electronics capstone sequence for the EECE program at WWU. This sequence is partitioned into three classes that cover project requirements and planning (EECE 491), project hardware (EECE 492) and project software (EECE 493). As each of these courses include an element of applying design to produce a solution as specified in Outcome 2, mastery of each course is part of the evaluation process, with scoring in each course based on the following design and planning elements:

EECE 491:

- Features
- Constraints
- User Requirements
- Technical Requirements
- System Design

EECE 492:

- Gantt Chart
- Schematic Design
- PCB Layout
- 3D Component Design
- Stencil/Paste Design
- Test and Measurement Design and Planning
- Bill of Materials
- Change Forms

EECE 493:

- Design Constraint Compliance

- Code Quality
- Code Review Deadline

For this assessment, the EECE Program at Western looks at the percentage of students who achieved a satisfactory or exemplary on the average scores on all of the above criteria for each of the three courses. Where 2.5/3 defines an “exemplary” score, 1.5/3 “satisfactory,” 1/3 “developing,” and <1/3 “unsatisfactory.” Attainment of Student Outcome 2 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data (EECE 491):

Unsatisfactory	0 - 0.5	0	0.00%	
Developing	0.5 - 1.5	1	4.55%	
Satisfactory	1.5 - 2.5	13	59.09%	Result:
Exemplary	2.5 - 3.0	8	36.36%	3

Assessment Data (EECE 492):

Unsatisfactory	0 - 0.5	0	0.00%	
Developing	0.5 - 1.5	4	18.18%	
Satisfactory	1.5 - 2.5	9	40.91%	Result:
Exemplary	2.5 - 3.0	9	40.91%	3

Assessment Data (EECE 493):

Unsatisfactory	0 - 0.5	3	13.64%	
Developing	0.5 - 1.5	8	36.36%	
Satisfactory	1.5 - 2.5	11	50.00%	Result:
Exemplary	2.5 - 3.0	0	0.00%	1

Discussion:

In EECE 491 students overwhelmingly met course objectives, with only 1 of 22 students falling below the satisfactory or exemplary threshold. EECE 492 saw similar performance with 4 of 22 students in the developing region of outcome attainment. EECE 493 saw widespread failure of students to meet outcomes, mostly due to failures of design constraint compliance. No student had an exemplary outcome. The failures noted in EECE 493 were undoubtedly due to the impact of COVID-19 starting in February 2020 with an inability of students to receive their PCB designs due to southeast Asia supply issues. This was compounded by students losing access to test and measurement equipment by the time their hardware designs were available. Most student projects required substantial compromises to design requirements, and each student’s expectations were individually reorganized based on their project’s ability to be completed outside of the laboratory environment. The result of this was a near complete lack of design outcome attainment. Although the disruption led to widespread failure, this was largely failure of students to demonstrate their abilities, and it is highly unlikely students failed to meet outcomes en masse.

Because of the disruption in quality assessment and student potential to demonstrate mastery, major changes based on these observations are not recommended at this time.

EE 491-493Outcome 2 Measures

Total Number of students:	22
Number Qualified:	22

Student	Proposal Features	Proposal Constraints	Ethics	Description Ext. Specs
Bock, Nath	2	2	2	3
Bugayev, Vl	3	2	2	3
Christenser	3	2	3	3
Cowgill, Br	2	3	2	2
Crawford, I	1.5	2	2	3
Ehlers, Cam	3	3	2	3
Gould, Bry	2	1	2	2
Guilder, Da	2	2	2	3
Heppner, D	3	2	0	2
Hernandez,	2	2	2	2
Hollen, Mic	3	3	3	3
Jones, Abra	3	3	3	3
Morimoto,	3	3	3	2
Peel, Kenne	3	3	3	3
Perez, Jose	3	3	3	3
Rowe, Eme	3	3	3	3
Smith, Trist	3	3	3	3
Takehara, D	3	2	3	2
Tolsma, Da	3	3	2	2
Watters, M	3	3	3	2
Weitkamp,	3	3	2	2
Williamsor	2	1	2	1

Unsatisfactory	0 - 0.5	0	0.00%
Developing	0.5 - 1.5	1	4.55%
Satisfactory	1.5 - 2.5	13	59.09%
Exemplary	2.5 - 3.0	8	36.36%

Description Int. Specs	Description UI	Ave Score	Ave SO2	Gantt	Schematic
3	2	2.33	2.4	3	3
2	2	2.33	2.4	3	3
3	3	2.83	2.8	3	3
2	2	2.08	2.2	3	2
2	2	2.08	2.1	3	3
2	2	2.50	2.6	2	3
2	1	1.67	1.6	2	2
2	2	2.17	2.2	2	2
2	1	1.67	2	1	1
1	2	1.83	1.8	2	2
3	3	3.00	3	3	3
3	2	2.83	2.8	3	3
2	2	2.50	2.4	3	3
3	3	3.00	3	3	3
2	2	2.67	2.6	3	3
2	3	2.83	2.8	3	3
2	3	2.83	2.8	3	3
2	2	2.33	2.2	3	2
2	2	2.33	2.4	3	2
2	2	2.50	2.4	3	3
1	2	2.17	2.2	2	1
0	0	1.00	0.8	2	1

Unsatisfactory
Developing
Satisfactory
Exemplary

Result:
3

Layout	3D	Stencil	Test	BOM	Change Forms	Ave
3	2	3	3	3	3	2.875
3	2	2	3	2	2	2.5
2	2	2	3	2	2	2.375
2	2	3	2	2	2	2.25
2	2	3	2	2	2	2.375
2	2	3	2	2	2	2.25
1	1	2	1	1	1	1.375
2	2	2	2	2	1	1.875
1	0	2	2	2	1	1.25
2	0	2	2	3	2	1.875
3	2	2	2	3	3	2.625
3	2	2	2	3	3	2.625
3	2	2	2	3	3	2.625
3	3	2	3	3	3	2.875
2	2	3	2	3	3	2.625
2	2	2	2	2	3	2.375
3	2	2	3	2	3	2.625
2	2	1	2	3	3	2.25
2	1	2	2	2	3	2.125
3	2	2	3	2	2	2.5
2	1	1	2	1	1	1.375
0	0	0	0	0	2	0.625

0 - 0.5	0	0.00%	
0.5 - 1.5	4	18.18%	
1.5 - 2.5	9	40.91%	Result:
2.5 - 3.0	9	40.91%	3

Design Meets Constraints	Code Quality	Code Review Timeliness	Ave
2	2	2	2
2	2	2	2
1	2	2	1.666667
1	2	1	1.333333
1	1	2	1.333333
1	1	2	1.333333
1	0	0	0.333333
1	2	2	1.666667
0	1	1	0.666667
1	1	2	1.333333
2	2	2	2
0	1	0	0.333333
2	1	2	1.666667
2	2	2	2
1	1	2	1.333333
2	2	2	2
2	2	2	2
1	2	2	1.666667
1	2	2	1.666667
1	2	1	1.333333
0	1	1	0.666667
0	1	0	0.333333

Unsatisfactory	0 - 0.5	3	13.64%	
Developing	0.5 - 1.5	8	36.36%	
Satisfactory	1.5 - 2.5	11	50.00%	Result:
Exemplary	2.5 - 3.0	0	0.00%	1

Assessment of Student Outcome 2 in EECE 471-3

Instructor: Amr Radwan and Xichen Jiang

Assessor: Amr Radwan and Xichen Jiang

Assessment Quarter and Year: Fall 2020 – Spring 2021

This report assesses Student Outcome 2 "*an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors*" The EECE program at Western Washington University assess this outcome in part using student performance in EECE 471, EECE 472, and EECE 473. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis.

Background:

EECE 47x is the energy capstone sequence for the EECE program at WWU. This sequence is partitioned into three classes that cover project requirements and planning (EECE 471), initial design and hardware requirements (EECE 472) and project implementation (EECE 473). As each of these courses include an element of applying design to produce a solution as specified in Outcome 2, mastery of each course is part of the evaluation process, with scoring in each course based on the following design and planning elements:

EECE 471: the following elements are evaluated based on the final proposal score.

- Technical Requirements
- Features and Constraints
- Initial Design and Hardware Planning
- Project Budget and Cost Considerations
- Ethical and Professional Considerations
- Gantt Chart

EECE 472: the following elements are evaluated based on the final presentation and the proof-of-concept scores.

- Hardware Research and Development
- Test and Measurement Design and Planning
- Design Alternatives
- Gantt Chart

EECE 473: the following element are evaluated based on the final project demonstration score.

- Technical Soundness and Testing Results
- Final Product Functionality

- Ethical and Professional Considerations
- Future Work

For this assessment, the EECE program at Western looks at the percentage of students who achieved a satisfactory or exemplary on the average scores. Where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of SO2 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data (EECE 471)

Unsatisfactory	0	0	0.00%	
Developing	1	0	0.00%	
Satisfactory	2	1	33.33%	Result:
Exemplary	3	2	66.67%	3

Assessment Data (EECE 472)

Unsatisfactory	0	0	0.00%	
Developing	1	0	0.00%	
Satisfactory	2	0	0.00%	Result:
Exemplary	3	3	100.00%	3

Assessment Data (EECE 473)

Unsatisfactory	0	0	0.00%	
Developing	1	0	0.00%	
Satisfactory	2	0	0.00%	Result:
Exemplary	3	3	100.00%	3

Discussion:

Students overwhelmingly met the course objectives, with no students falling below the satisfactory or exemplary threshold. However, the following should be considered. Students did not have access to the lab space during the fall of 2020 (EECE 471). The lab space was provided for EECE 472 and 473 with a limited schedule. As the projects are of energy and high-power nature, lab access is typically necessary to provide adequate tools and components to build the circuits and verify the results. To adapt these limitations, the rubric and expectations of the project sequence have been relaxed during this year. Students were allowed to build part of the circuit experimentally and verify the rest of the results using simulation software such as Matlab/Simulink. Further, partners within each team were not able to meet frequently to work together on the project. Professors were available remotely with limited face-to-face meetings. Students have recorded the final project demonstrations and shared the recordings with the rest of the class to receive the feedback and evaluation. While the outcomes have met these relaxed rubric and expectations during this pandemic, a re-assessment of this outcome without COVID restrictions is necessary to consider the regular expectations of final physical products in fully functional conditions.

EECE 47x Student Outcome 2 Measure

EECE471: Final Proposal Score

Total Number of Teams:	3
Number Qualified:	3

Max Points	100	
Students / **Points**		0-40%
Team1	88	41%-60%
Team2	82	61%-80%
Team3	79	81%-100%

nsatisfactory	0	0	0.00%		
Developing	1	0	0.00%		
Satisfactory	2	1	33.33%	Result:	
Exemplary	3	2	66.67%		3

EECE 47x Student Outcome 2 Measure

EECE472: design presentation and proof of concept

Total Number of Teams:	3
Number Qualified:	3

Max Points		25			
Students	**M1 Points**		M1 Scaled to 3	%	0-40%
Team1		22	2.64	88	41%-60%
Team2		21	2.52	84	61%-80%
Team3		25	3	100	81%-100%

Max Points		60		
Students	**M2 Points**		M2 Scaled to 3	
Team1		55	2.75	91.66666667
Team2		54	2.7	90
Team3		57	2.85	95
				average
				89.83333333
				87
				97.5

nsatisfactory	0	0	0.00%	
Developing	1	0	0.00%	
Satisfactory	2	0	0.00%	Result:
Exemplary	3	3	100.00%	3

EECE 47x Student Outcome 2 Measure

EECE473: final project demonstration score

Total Number of Teams:	3
Number Qualified:	3

Max Points		100			
Students	**Points**		Scaled to 3	round score	0-40%
Team1		84	2.52	3	41%-60%
Team2		85	2.55	3	61%-80%
Team3		85	2.55	3	81%-100%

nsatisfactory	0	0	0.00%		
Developing	1	0	0.00%		
Satisfactory	2	0	0.00%	Result:	
Exemplary	3	3	100.00%		3

Student Outcome Assessment Evaluation

Student Outcome: SO3 an ability to communicate effectively with a range of audiences

Evaluation Date: 10/30/2019

Supporting Documents: *AssessmentEvaluationSO3-EE491-3.docx, EE471_3.pdf, EE473_3.pdf, EE491-493-SO3.xlsx, ENG302_2018-19.xlsx, ProjectProposalRubricF18, Score Distribution Plot_471_3.xlsx, Score Distribution Plot_473_3.xlsx*

Prior Recommendations and attainment: Watch the ENG302 scores to determine if they are a good measure

Assessment Methodologies	
1.	Grade distribution in ENG302 Technical Writing
2.	EE491-493 Proposal, system software presentation, EE493 code review presentation
3.	EE471 Midterm and final presentation scores
4.	EE473 Design review and final presentation scores

Assessment Targets	
1.	70% of the students attain a satisfactory or exemplary level.
2.	70% of the students attain a satisfactory or exemplary level.
3.	Normalized final presentation scores of 70 or higher
4.	Normalized final presentation scores of 70 or higher

Attainment of Outcome	
1.	91.3% students received a satisfactory grade. The target is met.
2.	89% attained outcome at satisfactory level or higher.
3.	100% of the students received a satisfactory score
4.	100% of the students received a satisfactory score

Recommended Changes	
1.	Reassess Fall 2020 to see if final grades are consistent enough to be considered a good measure.
2.	None
3.	None
4.	None

Recommended Re-assessment Plan	
1.	Reassess Fall 2020
2.	No, next scheduled assessment
3.	No, next scheduled assessment
4.	No, next scheduled assessment

Other Possible Changes	
	The University ACC is proposed new writing requirements for all students. If passed, the assessment plan for SO3 will need to be reevaluated.

Assessment of Student Outcome 3 in ENG 302

Instructor: Todd Morton

Assessor: Todd Morton

Assessment Quarter and Year: Fall 2019

This report assesses Student Outcome 3 "*an ability to communicate effectively with a range of audiences*" This is the new student outcome, which mapped from the old student outcome (g). The EE program at Western Washington University assessed this outcome in part using student performance in ENG 302 – Introduction to Technical & Professional Writing. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

Background:

The ENG 302 course description is:

ENG 302 – Introduction to Technical & Professional Writing

Introduction to major contemporary strategies and conventions used in written and oral communication for multiple audiences in professional settings. Covers a variety of written forms used in the preparation and design of technical and business documents, critical analyses of these forms and practices, and the ethical and social implications of a technical writer's choices.

This course maps well to Student Outcome 3 as it covers both written and oral communications with a range of audiences. While the overall grade does only measure communication, it has been problematic finding the assessment targets appropriate for the Unsatisfactory, Developing, Satisfactory, and Exemplary levels of attainment.

The first couple attempts at assessing this measure resulted in every student but two reaching Exemplary level so there was a concern that this was not a good measure.

For this assessment, the targets were modified so a grade of A defines "exemplary" attainment, B+ and A- "satisfactory", and C+ and B, "developing". Attainment of Student Outcome 3 with this measure is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data (ENG 302):

Unsatisfactory	< 1.7	0	0.000	
Developing	1.7 - 3.0	2	0.087	
Satisfactory	3.3 - 3.7	6	0.261	Result:
Exemplary	4.0	15	0.652	3

Discussion:

The results show SO3 was attained using this measure and target. However, there remains concern regarding the consistency of the final grades. This will be reassessed in Fall 2020 to see if there is enough consistency in the grades to consider this an effective measure.

Another complicating factor is the proposed new University writing requirements. If passed, ENG302 may not be the best, or even possible, course to require. In which case, a new measure will need to be identified.

ENG302 Grade Distribution

Total Number of students:	25
Number Qualified:	25

Student	Grade
AK	3.00
AM	4.00
AN	3.30
AO	3.70
AR	3.70
BW	3.70
CH	4.00
CO	3.30
DD	3.30
DG	3.70
DS	4.00
JCO	4.00
JM	4.00
ML	3.70
MM	3.70
MS	3.30
NG	3.30
RM	4.00
SD	4.00
SJ	4.00
SM	4.00
SS	4.00
SW	4.00
TR	4.00
TT	3.30

Unsatisfactory	< C-	0	0.000
Developing	C, C+, B	1	0.040
Satisfactory	B+, A-	12	0.480
Exemplary	A	12	0.480

Assessment of Student Outcome 3 in EE 491 and 493

Instructor: Todd Morton

Assessor: Todd Morton

Assessment Quarter and Year: Fall 2018 and Spring 2019

This report assesses Student Outcome 3 "*an ability to communicate effectively with a range of audiences*" This is the new student outcome, which mapped from the old student outcome (g). The EE program at Western Washington University assessed this outcome in part using student performance in EE EE491 and EE493. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. The assessment from EE 491 in Fall 2019 and EE493 in Spring 2019 showed no need for changes. Raw results are available in the Student Outcome assessment folder.

Background:

EE 491, Project Proposal, is the first course in a three-quarter senior project sequence. In this course students create a project proposal along with requirements and a first iteration of a system-level design. The *proposal is* scored based on a rubric, *ProjectProposalRubricF18.pdf*. Part of this score is based on writing, which is used in this assessment. For the final evaluation the three scores are evaluated individually and as an overall average.

EE 493, Project Software and System Implementation is the third course in a three-quarter senior project sequence. In this course students function as a course-wide team and smaller teams for the software code reviews. The *course participation* score is a measure of the course wide teamwork and the *code review* score is a measure for the code review teamwork. The *project completion* score measures the team's ability of meeting objectives. The *code review* score reflects only the teamwork score in the code review rubric. For the final evaluation the three scores are evaluated individually and as an overall average.

For this assessment, the EE Program at Western looks at the percentage of students who achieved a *satisfactory* or *exemplary* on the scores in each code review team and as an overall course team. Where 2.5/3 and above defines an "exemplary" score, 1.5 to 2.5 "satisfactory," 0.5 to 1.5 "developing," and 0 to 0.5 "unsatisfactory." Attainment of Student Outcome 5 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data (EE 493):

EE491 - Proposal Writing				Result:
Unsatisfactory	0 - 0.5	0	0.000	2
Developing	0.5 - 1.5	4	0.235	
Satisfactory	1.5 - 2.5	7	0.412	
Exemplary	>2.5	6	0.353	

EE493 - System Software Presentation				Result:
Unsatisfactory	0 - 0.5	0	0.000	2

Developing	0.5 - 1.5	4	0.235	
Satisfactory	1.5 - 2.5	8	0.471	
Exemplary	>2.5	5	0.294	

EE493 - Code Review Reader Presentation				Result:
Unsatisfactory	0 - 0.5	0	0.000	2
Developing	0.5 - 1.5	5	0.294	
Satisfactory	1.5 - 2.5	8	0.471	
Exemplary	>2.5	4	0.235	

Overall				Result:
Unsatisfactory	0 - 0.5	0	0.000	3
Developing	0.5 - 1.5	2	0.118	
Satisfactory	1.5 - 2.5	12	0.706	
Exemplary	>2.5	3	0.176	

Discussion:

The results show SO5 was attained in the Code Review, Course Participation, and overall measure. Project completion shows the outcome was marginally attained, however this was the first time Project Completion was measured through verified requirements. This will be watched in the future as it is suspected that this score will improve as the process for requirements writing and verification is improved.

No changes are recommended at this time. A teamwork questionnaire may be considered as an added measure.

EE Senior Project Proposal Grading Tool

Name(s) ____

Project Title____

Description	Student Outcome	Points Possible	Points Given
Project Title		0-1	
Summary		0-1	
Project Users, Problem Definition, Goals, and Features	1	0-3	
Project Constraints	2	0-3	
Project Ethics and Responsibilities	4	0-3	
Bibliography.	7	0-3	
Writing	3	0-3	
Totals: (9 required to pass course)		17	

0-1:
- 0 – Does NOT meet requirement
- 1 – Does meet requirement

0-3:
- 0 – Unsatisfactory
- 1 – Developing
- 2 – Satisfactory
- 3 – Exemplary

EE 493 and EE493 Outcome 3 Measures
EE493 - System Software Presentation. The presentation portion of the System Software review
EE493 - Code Review Reader Presentation. The reader's presentation score for the code review

Total Number of students:	17
Number Qualified:	17

Student		Proposal Writing	System Software Presentation	Code Review Reader Presentation
	max	3	3	3
S1		2.00	2.00	2.00
S2		2.00	1.00	1.00
S3		1.00	2.00	1.00
S4		1.00	1.00	3.00
S5		3.00	2.00	2.00
S6		3.00	3.00	2.00
S7		3.00	2.00	2.00
S8		2.00	2.00	2.00
S9		3.00	3.00	3.00
S10		1.00	2.00	3.00
S11		2.00	3.00	1.00
S12		2.00	2.00	2.00
S13		2.00	1.00	2.00
S14		1.00	3.00	1.00
S15		2.00	1.00	2.00
S16		3.00	3.00	3.00
S17		3.00	2.00	1.00

EE491 - Proposal Writing

Unsatisfactory	0 - 0.5	0	0.000
Developing	0.5 - 1.5	4	0.235
Satisfactory	1.5 - 2.5	7	0.412
Exemplary	>2.5	6	0.353

EE493 - System Software Presentation

Unsatisfactory	0 - 0.5	0	0.000
Developing	0.5 - 1.5	4	0.235
Satisfactory	1.5 - 2.5	8	0.471
Exemplary	>2.5	5	0.294

EE493 - Code Review Reader Presentation

Unsatisfactory	0 - 0.5	0	0.000
Developing	0.5 - 1.5	5	0.294
Satisfactory	1.5 - 2.5	8	0.471
Exemplary	>2.5	4	0.235

Assessment of Student Outcome (3) in EE 471

Instructor: Xichen Jiang

Assessor: Xichen Jiang

Assessment Quarter and Year: Fall 2018

This report assesses Student Outcome (3), "an ability to communicate effectively with a range of audiences." The EE program at Western Washington University assessed this outcome in part using student performance in EE 471. This document describes the background, details, and rubric for this outcome assessment and also provides the actual data and data analysis.

Background

EE 471 is the first course in a three course sequence in which students research, design, and implement an energy related project. In this course, the students focus on the research and development of the project. The measure selected for the assessment is from the midterm and final presentation scores the students received (see attached rubrics). The student groups were required to give 25-minute presentations on their project idea and proposal at the midpoint and the end of the quarter.

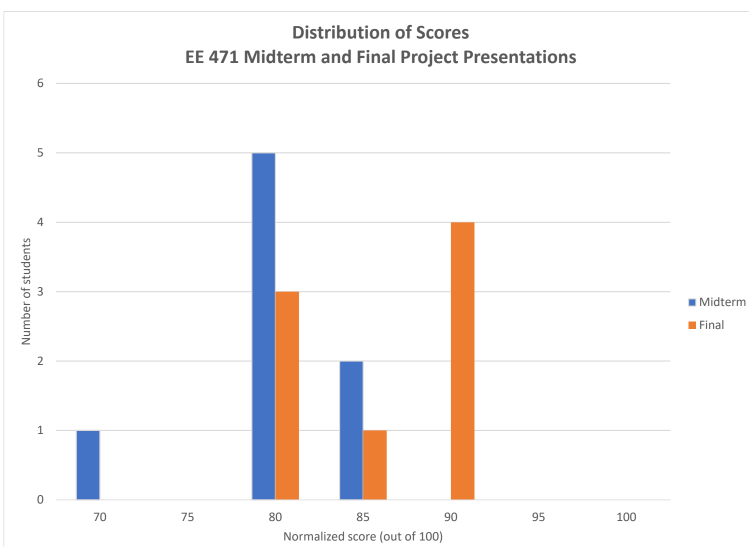


Figure 1: Score distribution.

Assessment Data

A histogram of the student scores for both the midterm and final presentations (normalized to 100) is shown in Figure 1 for comparison. The statistics of the final presentation scores are summarized in Table 1. It is worth noting that all students within the same group received the same scores.

Table 1: Statistics.

Total number of students	8
Mean Presentation Score (normalized)	88
Standard Deviation	3.5
Mean Percent Change	6.3

Discussion

For this assessment, the EE Program looked at the number of students who received normalized final presentation scores of 70 or higher, which is considered *satisfactory*. All of the midterm and final presentation scores were above the threshold. Therefore, this outcome was attained. In addition, the average presentation scores increased by 6.3% from the midterm to the final presentation, indicating improvement by the students.

Presenters' Names ____________________ **Title _________________**
Evaluator's Name (write on back of this page) **Date _________________**

EE 471 Midterm Proposal Presentation Evaluation Sheet

Presentation

Professionalism	_____ / 5
Clarity in Delivery	_____ / 5
Technical Soundness / Complexity of Project	_____ / 5
Organization of Slides / Content	_____ / 15
Comprehensiveness	_____ / 10
Explanation for Challenges / Testing Plan /Alternative Designs	_____ / 10
Constraints: Cost, Power Budget, Ethics, etc.	_____ / 5
Ability to Answer Questions	_____ / 5
Other Factors:	_____ / ±5*

Comments (please write on the back of this page if you want to remain anonymous):

Total **_____ / 60**

* Usually this will be 0 unless there is an exceptional case

Presenters' Names ____________________ **Title _________________**
Evaluator's Name (write on back of this page) **Date _________________**

EE 471 Final Proposal Presentation Evaluation Sheet

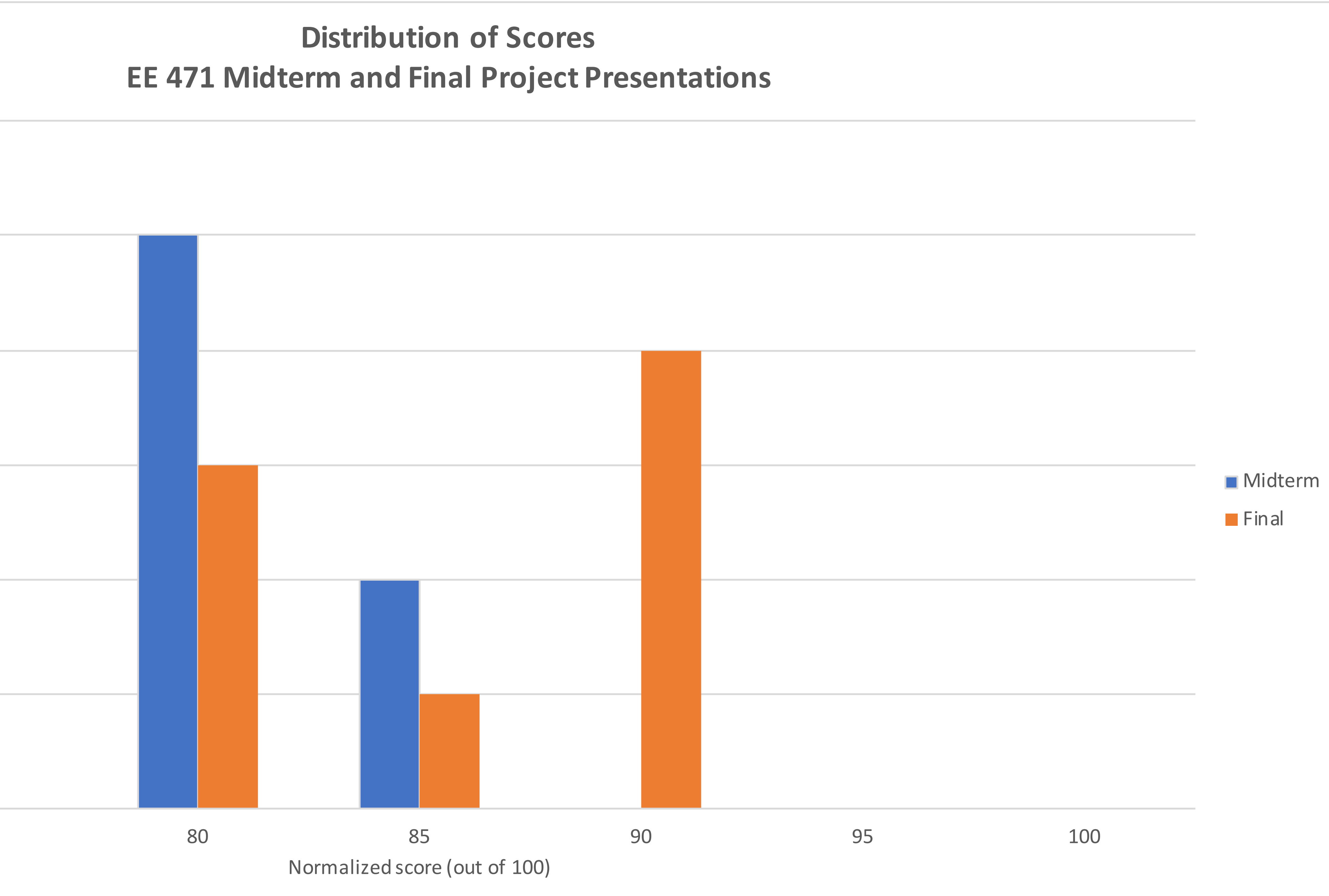
Presentation

Professionalism	_____ / 5
Clarity in Delivery	_____ / 5
Technical Soundness / Complexity of Project	_____ / 5
Organization of Slides / Content	_____ / 15
Comprehensiveness	_____ / 10
Explanation for Challenges / Testing Plan /Alternative Designs	_____ / 10
Constraints: Cost, Power Budget, Ethics, etc.	_____ / 5
Ability to Answer Questions	_____ / 5
Other Factors:	_____ / ±5*

Comments (please write on the back of this page if you want to remain anonymous):

Total **_____ / 60**

* Usually this will be 0 unless there is an exceptional case


Distribution of Scores
EE 471 Midterm and Final Project Presentations
80
85
90
95
100
Normalized score (out of 100)
Midterm
Final

	Midterm	Final	Normalized Midterm	Normalized Final
	44	52.5	73.33333333	87.5
	48	54.5	80	90.83333333
	48	54.5	80	90.83333333
	50	50.5	83.33333333	84.16666667
	50	50.5	83.33333333	84.16666667
	50	50.5	83.33333333	84.16666667
	53	55	88.33333333	91.66666667
	53	55	88.33333333	91.66666667
Averages	49.5	52.875	82.5	88.125
Percent Change	6.382978723		Standard Deviation	3.528511985

x-axis	y-axis Midterm	y-axis Final		Points
70	1	0		60
75	0	0		
80	5	3		
85	2	1		
90	0	4		
95	0	0		
100	0	0		

count	8

Assessment of Student Outcome (3) in EE 473

Instructors: Xichen Jiang, Amr Radwan

Assessors: Xichen Jiang, Amr Radwan

Assessment Quarter and Year: Spring 2019

This report assesses Student Outcome (3), "an ability to communicate effectively with a range of audiences." The EE program at Western Washington University assessed this outcome in part using student performance in EE 473. This document describes the background, details, and rubric for this outcome assessment and also provides the actual data and data analysis.

Background

EE 473 is the final course in a three course sequence in which students research, design, and implement an energy related project. In this course, the students focus on the implementation of the project. The measure selected for the assessment is from the design review and final presentation scores the students received (see attached rubrics). The student groups were required to give 40-minute presentations and demonstrations of their project at the midpoint and the end of the quarter.

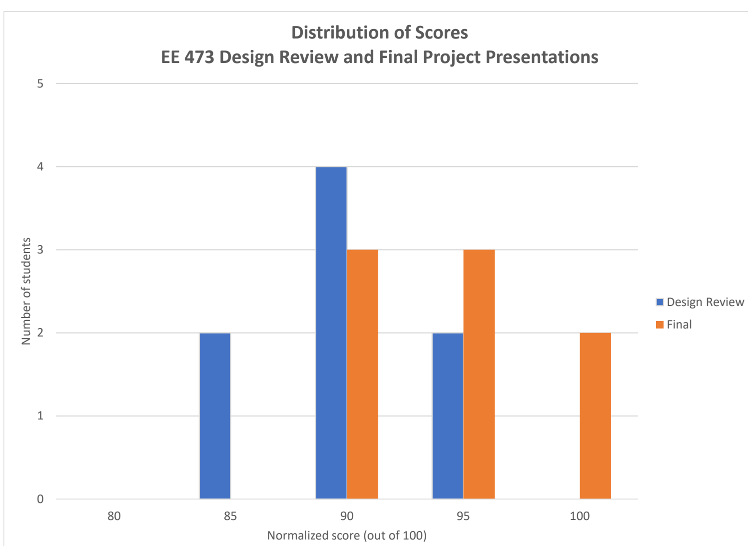


Figure 1: Score distribution.

Assessment Data

A histogram of the student scores for both the design review and final presentations (normalized to 100) is shown in Figure 1 for comparison. The statistics of the normalized final presentation scores are summarized in Table 1. Note that the scores used for this assessment are from the presentation scores only (i.e., demonstration scores are not included). It is also worth mentioning that all students within the same group received the same scores.

Table 1: Statistics.

Total number of students	8
Mean Presentation Score (normalized)	96
Standard Deviation	3.6
Mean Percent Change	−1.0

Discussion

For this assessment, the EE Program looked at the number of students who received normalized final presentation scores of 70 or higher, which is considered *satisfactory*. All of the design review and final presentation scores were above the threshold. The average presentation scores decreased by 1% from the design review to the final presentation. However, this decrease is not significant and could be due to variance in grading and small sample size.

Presenters' Names ____________________ **Title _________________**
Evaluator's Name (write on back of this page) **Date _________________**

EE 473 Design Review Presentation and Demo Evaluation Sheet

Presentation and Demo

Professionalism	_____ / 3
Clarity in Delivery	_____ / 5
Technical Soundness	_____ / 5
Organization of Slides	_____ / 10
Equations / Simulations	_____ / 3
Schematics / Flowcharts / Figures / Tables	_____ / 5
Progress Toward Final Project Completion	_____ / 9
Demo	_____ / 20

Other Factors: _____ / ±5*

Comments (please write on the back of this page if you wish to remain anonymous):

Total **_____ / 60**

* Usually this will be 0 unless there is an exceptional case.

Presenters' Names ____________________ **Title _________________**
Evaluator's Name (write on back of this page) **Date _________________**

EE 473 Final Presentation / Demonstration Evaluation Sheet

Presentation

Professionalism	_____ / 3
Clarity in Delivery	_____ / 6
Technical Soundness	_____ / 3
Organization of Slides	_____ / 6
Equations / Simulations / Testing Results	_____ / 6
Figures / Tables	_____ / 3
Schematics / Diagrams / Flowcharts	_____ / 5
Ability to Answer Questions	_____ / 6

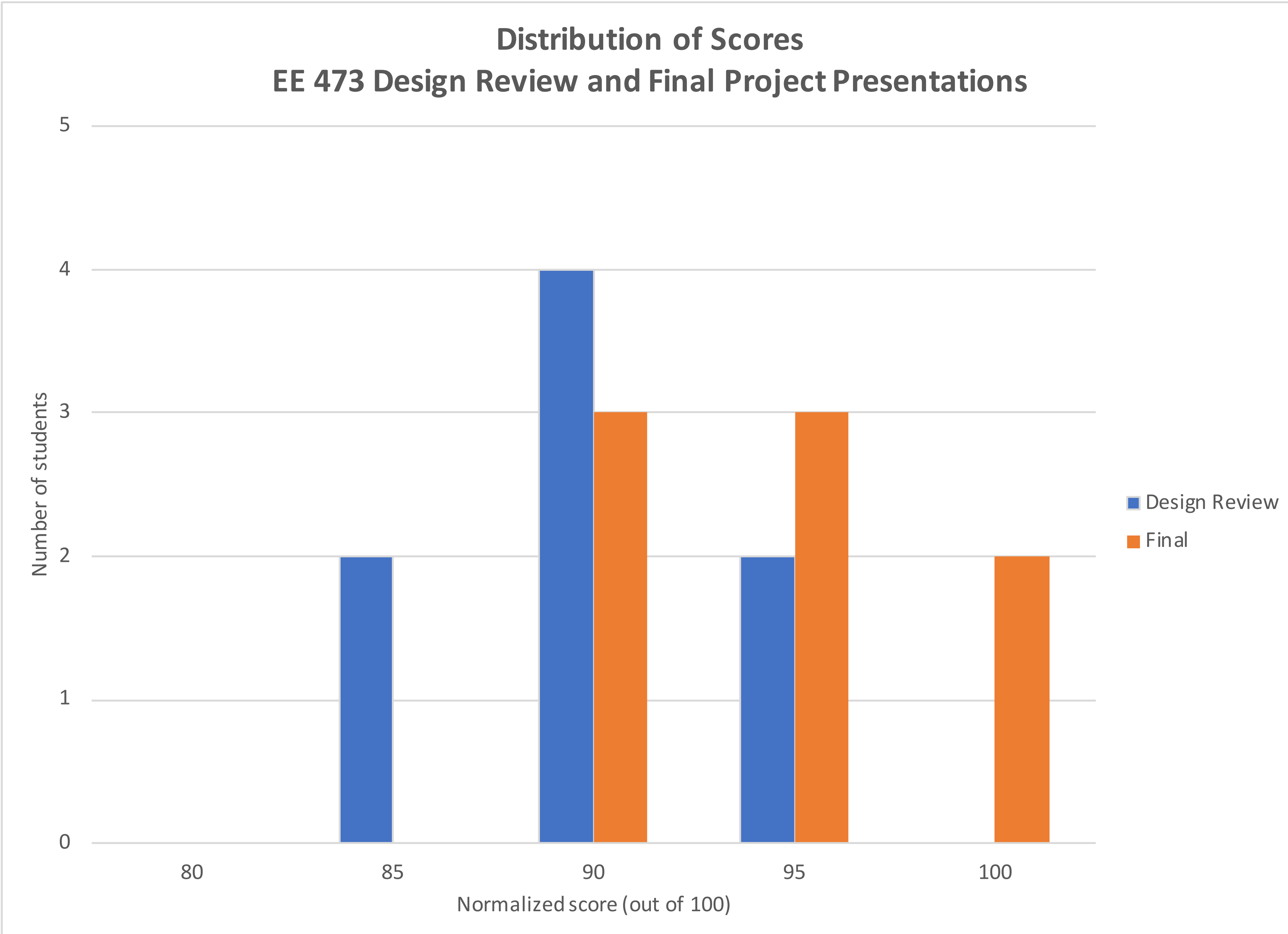
Demonstration

System Functionality / Completion of Project	_____ / 30
Explanation for Problems / Issues / Challenges	_____ / 12
Complexity of Project	_____ / 10
Other Factors:	_____ / ±5*

Comments (please write on the back of this page if you want to remain anonymous):

Total **_____ / 90**

* Usually this will be 0 unless there is an exceptional case.


Distribution of Scores
EE 473 Design Review and Final Project Presentations
Number of students
0
1
2
3
4
5
80
85
90
95
100
Normalized score (out of 100)
Design Review
Final

	Design Review	Final	Normalized Design Revi	Normalized Final
	36.5	36	91.25	94.73684211
	34	34.5	85	90.78947368
	34	34.5	85	90.78947368
	37.5	37	93.75	97.36842105
	37.5	37	93.75	97.36842105
	37.5	37	93.75	97.36842105
	39	38	97.5	100
	39	38	97.5	100
Averages	36.875	36.5	92.1875	96.05263158
Percent Change	-1.02739726		Standard Deviation	3.654553025

x-axis	y-axis Design R	y-axis Final	Points	Points Final
80	0	0	40	38
85	2	0		
90	4	3		
95	2	3		
100	0	2		

count	8

Student Outcome Assessment Evaluation

Student Outcome: SO4: "requires that students have an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts."

Evaluation Date: 06/14/2022, 06/18/2020, 06/17/2021

Supporting Documents: *Assessment of Student Outcome 4 - EE111 - 2019.docx, Assessment of Student Outcome 4 - EECE491.docx, Assessment of Student Outcome 4b - EE111 – 2019.docx, Ethics Quiz Survey Student Analysis Report.xlsx, Outcome 4b Evaluation Data EE111 - 2019.xlsx, Student Outcome 4 Evaluation Data EE111 - 2019.xlsx, EECE111_AssessmentEvaluationSO4.docx, EECE372_AssessmentEvaluationSO4.docx, EECE492_AssessmentEvaluationSO4.docx, EECE471_AssessmentEvaluationSO4.docx*

Prior Recommendations and attainment: Assessed as student outcomes (f, h, j). (f) See 2016-17 Evaluation. For (h,i) see 2015-16 Evaluation. Did partial eval in 2019-20 under (1)-(7).

Assessment Methodologies	
1.	EECE 491 Ethics Quiz
2.	EECE 471 Ethics Quiz
3.	EECE 111 Contemporary Issues Report
4.	EECE 111 Contemporary Issues Report Plagiarism
5.	EECE 378 Contemporary Issues Paper
6.	EECE 492 Contemporary Issues Paper

Assessment Targets	
1.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at a unsatisfactory level
2.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at a unsatisfactory level
3.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at a unsatisfactory level
4.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at a unsatisfactory level
5.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at a unsatisfactory level
6.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at a unsatisfactory level

Attainment of Outcome	
1.	82% attained outcome at satisfactory level or better.
2.	100% attained outcome at satisfactory level or better.
3.	90% attained outcome at satisfactory level or better.
4.	100% attained outcome at satisfactory level or better
5.	100% attained outcome at satisfactory level or better
6.	80% attained outcome at satisfactory level or better.

Recommended Changes

1.	None
2.	None
3.	None
4.	None
5.	None
6.	None

Recommended Re-assessment Plan	
1.	No re-assessment needed. Assess again in 3 years as usual.
2.	No re-assessment needed. Assess again in 3 years as usual.
3.	No re-assessment needed. Assess again in 3 years as usual.
4.	No re-assessment needed. Assess again in 3 years as usual.
5.	No re-assessment needed. Assess again in 3 years as usual.
6.	No re-assessment needed. Assess again in 3 years as usual.

Other Possible Changes	

Assessment of Student Outcome 4 in EECE 491

Instructor: John Lund

Assessor: John Lund

Assessment Quarter and Year: Fall 2019

This report assesses Student Outcome 4 "*an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*." The EECE program at Western Washington University assessed this outcome in part using student performance in EECE 491. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis.

Background:

EECE 491 is the first course in a three-quarter capstone. Part of preparing students for their future careers is instilling an understanding of the ethical obligations as responsible engineers. Ethics instruction in EECE 491 consists of students watching a 10-part video series by Michael Loui from University of Illinois. Each video is approximately 10 minutes long, covering a different topic of engineering ethics. Evaluation of student understanding of ethics topics is assessed by a quiz on ethics topics graded on completion.

For this assessment, the EECE Program at Western looks at the percentage of students who achieved a satisfactory or exemplary quiz score where 8/8 questions answered correctly defines an "exemplary" score, 7/8 "satisfactory," 6/8 "developing," and <6/8 "unsatisfactory." Attainment of Outcome 4 is defined as 70% of students meeting the satisfactory or exemplary threshold.

Assessment Data:

Number of Students:	22
Number of student attempts:	22

Unsatisfactory	<6	0	0.000	
Developing	6	4	0.182	
Satisfactory	7	8	0.364	Result:
Exemplary	8	10	0.4545	3

Discussion:

18 of 22 students completed the ethics quiz with a score of 7 or higher. The outcome is met. However, 4 students scored 6 out of 8 and that is an increase from prior years and should be watched, or the video

lecture series should be augmented by one or more live lectures to highlight non-intuitive elements of ethics and key concepts of professional ethics.

Assessment of Student Outcome 4 in EECE 471

Instructor: Amr Radwan

Assessor: Amr Radwan

Assessment Quarter and Year: Fall 2021

This report assesses Student Outcome 4 "*an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*". The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 471 – Energy Project Proposal. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 471 is the first course in a three-quarter capstone project course for students in the Energy concentration. Part of preparing students for their future careers is instilling an understanding of the ethical obligations as responsible engineers. Ethics instruction in EECE 471 consists of a 10-part video series by Michael Loui from University of Illinois. Each video is approximately 10 minutes long, covering a different topics of engineering ethics. Evaluation of student understanding is assessed by a quiz on ethics topics graded on completion of the video series.

For this assessment, the EECE program at Western Washington University looked at the percentage of students who achieved a satisfactory or exemplary on the scaled scores, where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of SO4 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold. The actual reports were graded out of 50 points, and these scores were scaled to 0-3 for the purpose of this assessment.

Assessment Data

Unsatisfactory	0	0	0.00%	
Developing	1	0	0.00%	
Satisfactory	2	3	33.33%	Result:
Exemplary	3	6	66.67%	3

Discussion:

For Fall 2021 offering of EECE 471 with 9 students, 100% of the students demonstrated satisfactory or exemplary performance and no students demonstrated developing or unsatisfactory performance. The results show that the class achieved a very good outcome for this assessment.

Assessment of Student Outcome 4 in EECE 111

Instructor: John Lund

Assessor: John Lund

Assessment Quarter and Year: Spring 2022

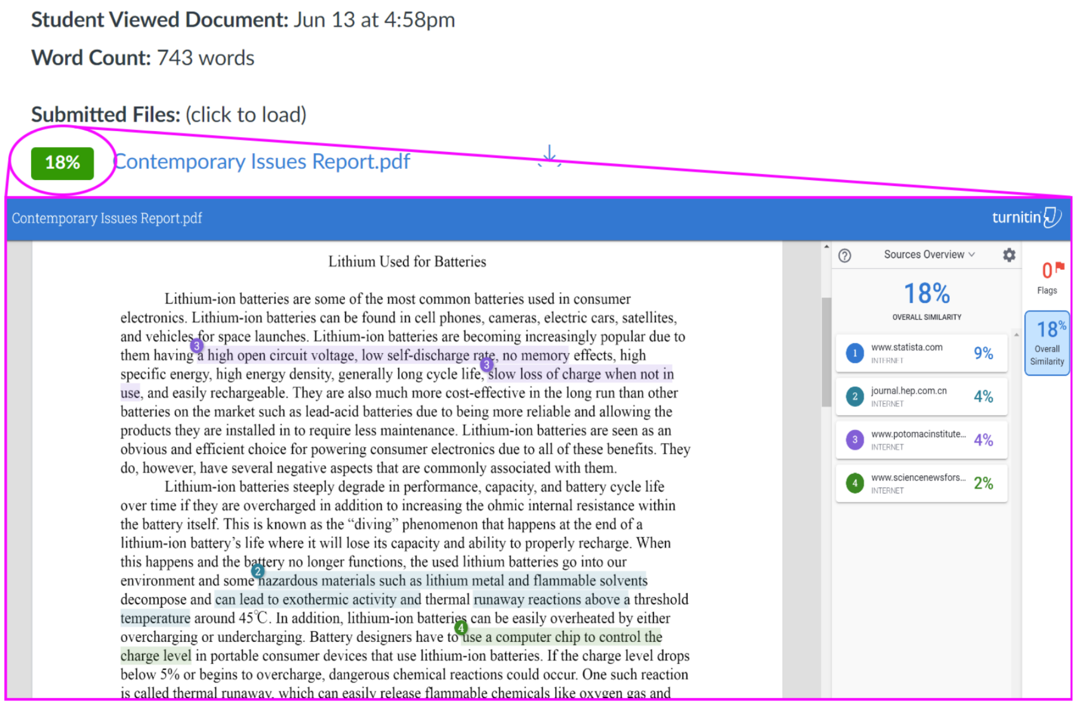
This report assesses Student Outcome 4 "*an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*". The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 111 – Circuit Analysis 1. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 111 is the first circuit analysis class students take in the EECE program at Western. As part of the course requirements, students are required to complete an assignment to examine one electrical engineering and computer science topic issue. This assignment encourages students to think more broadly about the field of engineering, and prompts them to examine considerations beyond circuit functionality. As shown in supporting document "Contemporary Issues Report 2022" students had the following prompt:

> *The goal of this report is to, early in your education, examine modern issues that extend beyond what you will encounter in your ordinary coursework. Work engineers do have impacts that extend well beyond their design, company, and even nation. In this report you will examine one issue in particular and identify problems, stakeholders, related issues, impacts, and unknowns relating to the issue at hand. You must work alone on this report, cite any sources you use, and make it clear with quotation marks whenever text in your report comes from a source other than yourself.*
> *You may choose a contemporary issue from the topic below, or you may request approval to us a different topic of your own choosing.*
> *Report Contents:*
>
> > *Your report should include the following components, and answer the following questions:*
> >
> > - *What are the primary problems raised by the issue?*
> > - *What are issues related to the issue at hand?*
> > - *Who are the major stakeholders related to this issue, and what are their perspectives? Try to honestly reflect the perspectives of different stakeholders even if you don't personally agree with them.*
> > - *What is the context of the issue, particularly the economic, environmental, cultural/social, and political contexts?*
> > - *What are important unknowns related to the issue which need to be found to properly address the issue?*
> > - *Include a bibliography with at least 5 citations taken from IEEE Xplore (available electronically through the library website)*

Evaluation

Students were evaluated based on two primary metrics. One was the ability of the student to recognize impacts thoroughly and with the proper context. Since this course was primarily analysis and students do not have sufficient design experience at this point in their education, analysis of application of ethical principles was analyzed not from ethical design choices, but ethical assignment performance. To do so, students were scored based on the originality of their work, and their avoidance of plagiarism as explicitly required in the assignment details. Reports were submitted via the software tool Canvas and analyzed with an add-on module to Canvas called “Turnitin” which examines the submitted text for segments of text with similar content to content in a large data repository, including online-searchable sources. An example of a Turnitin report is shown below:



Example Turnitin report for a student submission

For the two scoring sections (broader impact and considerations and ethics) students were graded on an identical competency scale of 0-3.

In the case of broader impact analysis, a score of 3 was given to submissions that effectively summarized the primary issue, secondary issues, primary stakeholders, and had an effective evaluation of stakeholder positions and considerations. A score of 2 was given to submissions that had a moderate amount of oversights in the above categories showing a developing ability. A score of 1 was given to submissions with substantial oversights in one of more of the above areas, and a score of 0 was given to subissions with insufficient consideration of the above factors.

For the analysis of applied ethics, student Turnitin scores were mapped to the same 0-3 scale as follows:

Turnitin Score	Outcome Evaluation Score
0-10	3 (exemplary)
11-20	2 (satisfactory)
21-30	1 (developing)
31+	0 (unsatisfactory)

Attainment of SO4 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data

Broader considerations score:

Unsatisfactory	0	0	0.00%	
Developing	1	3	10.00%	
Satisfactory	2	12	40.00%	Result:
Exemplary	3	15	50.00%	3

Ethical conduct score:

Unsatisfactory	0	0	0.00%	
Developing	1	0	0.00%	
Satisfactory	2	1	3.33%	Result:
Exemplary	3	29	96.67%	3

Discussion

Of the two separate measures for S04 used in EECE 111 to assess broader consideration and application of ethical decision-making, students scored at least 90% "satisfactory" or "exemplary" for both categories. This is a marked improvement from prior analysis at this stage of the program. The plagiarism review software has changed since the previous evaluation, and instructions have improved over time upon observation of students misunderstanding expectations. These changes and clarification may have resulted in improved student performance, but based on the assessment metrics, students in Spring 2022 EECE 111 clearly met SO4 outcome expectations.

Assessment of Student Outcome 4 in EECE 378

Instructor: Xichen Jiang

Assessor: Xichen Jiang

Assessment Quarter and Year: Spring 2022

This report assesses Student Outcome 4 "*an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*". The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 378 – Smart and Renewable Power. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 378 is the third course in a three course sequence in energy systems. The course introduces students to power system analysis and renewable energy. The measure selected for the assessment is the term project report that the students turn in at the end of the quarter. The students were tasked to research and write a summary paper on a topic related to the electric power grid (e.g., emerging technologies, historical development, energy economics, etc.). Their report must address the impact their selected topic in global, economic, environmental, and societal contexts.

For this assessment, the EECE program at Western Washington University looked at the percentage of students who achieved a satisfactory or exemplary on the scaled scores, where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of SO4 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold. The actual reports were graded out of 50 points, and these scores were scaled to 0-3 for the purpose of this assessment.

Assessment Data

Unsatisfactory	0	0	0.00%	
Developing	1	0	0.00%	
Satisfactory	2	6	60.00%	Result:
Exemplary	3	4	40.00%	3

Discussion:

For Spring 2022 offering of EECE 378 with 10 students, 100% of the students demonstrated satisfactory or exemplary performance and no students demonstrated developing or unsatisfactory performance. The results show that the class achieved a very good outcome for this assessment.

Assessment of Student Outcome 4 in EECE 492

Instructor: John Lund

Assessor: John Lund

Assessment Quarter and Year: Winter 2022

This report assesses Student Outcome 4 "*an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*". The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 492 – Project Hardware Design. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 492 is the second of three capstone project classes which focuses primarily on hardware design. As part of the course requirements, students are required to choose at least one component of their design and do a though search for an alternatve replacement part. As shown in the supporting document "Final Design Submission Guide" the requirement for this report includes:

> *. . .The essay should examine the pros and cons of this alternative part compared to your chosen component. The conclusion should be whether you evaluate the alternative part is a preferred replacement. The examination should consider public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (more details in class discussion).*

Students were given a maximum of 10 points on this portion of their final submitted portfolio. This 10 point score, based on grading expectations, was then mapped to a 4 point score where a score of 10 mapped to a 3, indicating the student was able to recognize nearly all relevant decision factors, assess their impact in the context of a variety of factors, and make an informed judgement on the suitability of the existing or replacement part. A score of 7 to 9 mapped to a 2, indicating a small lack of consideration for relevant impacts. A score of 4 to 6 mapped to a 1, indicating a demonstrated ability to recognize some relevant impacts and make appropriate and ethical design judgements, but the demonstrated attainment was lacking. A score of 3 or less mapped to a 0, indicating insufficient demonstration of the aforementioned abilities. For this assessment, the EECE program at Western Washington University looked at the percentage of students who achieved a satisfactory or exemplary on the scaled scores, where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of SO4 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data

Unsatisfactory	0	1	6.67%	
Developing	1	2	13.33%	
Satisfactory	2	8	53.33%	Result:
Exemplary	3	4	26.67%	3

Discussion

80% of student groups had satisfactory or exemplary performance on the essay used to evaluate Student Outcome 4. Of the students who demonstrated unsatisfactory or developing performance, issued related primarily to an inadequate understanding of expectations, reducing concern with outcome attainment even further.

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

Evaluation Date: 10/23/2019

Supporting Documents: *AssessmentEvaluationSO5-EE110, AssessmentEvaluationSO5-EE444, AssessmentEvaluationSO5-EE493*

Prior Recommendations and attainment: Prior assessment was made based on the student outcome (d) in the previous EAC criteria. Assessments were made in EE444, EE493, and EE110. Recommended changes included making small changes to EE444 and to add a specific teamwork question in the EE110 report. These changes were made. In addition, the teamwork survey and measures in EE444 and EE493 were modified to align with the new criteria.

Assessment Methodologies	
1.	EE444 Team project(s) Survey
2.	EE110 Teamwork Survey
3.	(ELEC) EE493 Course Participation, Project Completion, and Code Review Teamwork
4.	(ENRG) EE473 Student Teamwork Survey

Assessment Targets	
1.	All team members' answers on all teamwork survey questions average at or above 70% satisfactory or exemplary.
2.	70% of the students that were accepted into the program attain the outcome at the exemplary or satisfactory level.
3.	70% of the students attain the outcome at the exemplary or satisfactory level in all three measures.
4.	65% of the students attain the outcome at a satisfactory level

Attainment of Outcome	
1.	When all students in the course are analyzed as one group the data show no need for changes. The best scores were achieved in *Level of cooperation/conflict at meetings* and the lowest scores were achieved in *Team's ability to provide leadership*. When student teams in the course are analyzed individually, there is one team that showed the outcome was not attained in 3 of the five areas - *Member contributions to the project*, *Team productivity*, and *Team's ability to provide leadership*.
2.	100% of the students indicated satisfactory or exemplary levels of attainment.
3.	100% of the students attained the Code Review, Course Participation, and Overall targets. 76% of the students attained the Project Completion target.
4.	The average of all survey questions resulted in 65% of the student attained the outcome at a satisfactory level. Individually, question #2 resulted in 57%.

Recommended Changes	
1.	The team that scored below expectations was also the smallest team, with only 3 students. This may have contributed to the results. A modification that may improve this result is to make sure each team has at least four members.

	While the teamwork questionnaire appears to be an accurate measure, the questions are indicators of the team rather than the individuals. The new rubric for MfgE rewords the measures to reflect the individual's effectiveness. This would require a new questionnaire. Faculty will investigate using an on-line questionnaire, such as Teammates, or develop a new questionnaire to see if it can provide more insight into the student's effectiveness in functioning as a team member. Perhaps implementing this in multiple courses that use teamwork will benefit the student achievement
2.	The instructor will discuss with EE program faculty members about tools that could help promote teams to foster a collaborative and inclusive team environment. In future sections, it may help to have second year students selected for mentor/leadership role on teams and have a discussion on roles. Teamwork surveys, such MfgE's teamwork survey, should be the same for all courses and given through a program like Teammates.
3.	No changes are recommended at this time. A teamwork questionnaire may be considered as an added measure.
4.	The new rubric for MfgE rewords the measures to reflect the individual's effectiveness. This would require a new questionnaire. The EE faculty will investigate using an on-line questionnaire, such as Teammates, or develop a new questionnaire to see if it can provide more insight into the student's effectiveness in functioning as a team member.

Recommended Re-assessment Plan	
1.	No
2.	No
3.	No
4.	No

Other Possible Changes	

Assessment of Student Outcome 5 in EE 110

Instructor: Ying Lin

Assessor: Ying

Assessment Quarter and Year: Winter 2019

This report assesses Student Outcome 5 "*an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives*" This is the new student outcome, which mapped from the old student outcome (d). The EE program at Western Washington University assessed this outcome in part using student performance in EE 110. This document provides the background, details, and rubric for this outcome assessment as well as the actual data and data analysis. The assessment from Winter 2019 based on teamwork survey questionnaire shows no concern. However, the data indicates that some students felt that their team environment could be further improved. Raw results are available in the Student Outcome assessment folder.

Background:

EE 110, Intro to Electrical Engineering, is the first EE course that EE pre-majors take in winter quarter of their Freshman year. Through the course, students work as groups to complete a series of hands-on labs and a final course project. For the final course project, each team needs to design and built either an Arduino-based autonomous robot car or an Arduino-based solar tracker under given constraints and time line. Each team is responsible for establishing goals, planning tasks, executing the plans, and meeting milestones.

For the assessment of Student Outcome 5, the effectiveness of the EE110 project teams is assessed by a teamwork questionnaire submitted by the students who took EE110 in winter 2019 and were accepted and enrolled in the EE program in fall 2019. The assessment results from this group of students serve as a baseline for evaluating the teamwork effectiveness. For consistency, the survey questionnaire is the same as used in EE444 winter 2019. There are five survey questions, each one has four answers that correspond to *unsatisfactory* through *exemplary*. See ***"EE444TeamworkQuestionaireRubricF19.docx"*** for the survey rubrics.

For this assessment, the percentage of students' responses indicating a *satisfactory* or *exemplary* on the scores as an overall course was evaluated. Specifically, 3/3 defines an "exemplary" score, 2/3 "satisfactory," 1/3 "developing," and 0/3 "unsatisfactory." Attainment of Student Outcome 5 is defined as 70% of students' responses meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Result (EE110): The following table summarizes the survey results based on survey responses from twenty students.

	3	2	1	0	Assessment Result
Member contributions to the project	55%	45%	0%	0%	3

Level of cooperation/conflict at meetings	60%	40%	0%	0%	3
Team productivity	75%	25%	0%	0%	3
Team’s ability to provide leadership	70%	25%	0%	5%	3
Team’s ability to provide a collaborative and inclusive environment	75%	15%	10%	0%	3

Assessment conclusion: No concerns

Summary of Assessment Data (EE 110): See “***EE110projectTeamworkSurvey2019winter.xlsx”***

Raw Assessment Data (EE110): See “***RawDataSO5-EE110_teamworkQuestionaire.pdf***”

Discussion:

Although the assessment results show no concerns, two of the twenty students’ responses toward “Team’s ability to provide a collaborative and inclusive environment” indicate that the team environment for some teams needs improvement so no one would feel left out.

The instructor will discuss with EE program faculty members about tools that could help promote teams to foster a collaborative and inclusive team environment.

In future sections, it may help to have second year students selected for mentor/leadership role on teams and have a discussion on roles.

Teamwork surveys, such MfgE’s teamwork survey, should be the same for all courses and given through a program like Teammates.

EE-ABET SO #5	**Teamwork Assessment data**	
EE110, winter 2019		
Teamwork Survey received		20
Enrollment (pre-majors who are now enrolled in EE)		23
(Survey was taken in fall 2019 after admitted to EE)		
Student\Category	**Member contributions to the project** (0-3)	
S1	3	
S2	3	
S3	3	
S4	2	
S5	2	
S6	2	
S7	2	
S8	3	
S9	3	
S10	2	
S11	3	
S12	3	
S13	3	
S14	3	
S15	2	
S16	2	
S17	2	
S18	3	
S19	2	
S20	3	
Average	**2.55**	

Category	**3-count&percentage**
Member contributions to the project	11 55%
Level of cooperation/conflict at meetings	12 60%
Team productivity	15 75.00%
Team's ability to provide leadership	14 70%
Team's ability to provide a collaborative and inclusive enviro	15 75%

Note: the survey questions and rubrics are the same as used in EE444 winter 2019 for SO #5.

Level of cooperation/conflict at meetings	**Team productivity**
(0-3)	(0-3)
3	3
3	3
3	3
3	3
3	3
2	2
2	3
3	2
3	3
3	3
3	2
2	3
3	3
2	3
2	2
2	2
3	3
2	3
2	3
3	3
2.6	**2.75**
2-count&percentage	**1-count&percentage**
9	0
45%	0%
8	0
40%	0%
5	0
25.00%	0.00%
5	0
25%	0%
3	2
15%	10%

Team's ability to provide leadership
(0-3)
3
3
3
2
2
3
3
3
3
2
3
3
3
3
2
2
3
3
0
3

2.6

0-count&percentage
0
0%
0
0%
0
0.00%
1
5%
0
0%

Team’s ability to provide a collaborative and inclusive environment
(0-3)
3
3
3
3
2
3
3
3
3
3
3
2
3
1
3
2
3
3
1
3

2.65

Final Assessment Result

3

3

3

3

3

Assessment of Student Outcome 5 in EE 444

Instructor: Todd Morton

Assessor: Todd Morton

Assessment Quarter and Year: Winter 2019

This report assesses Student Outcome 5 "*an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives*" This is the new student outcome, which mapped from the old student outcome (d). The EE program at Western Washington University assessed this outcome in part using student performance in EE 444. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. The assessment from Winter 2019 is mixed – assessment of the course, as a whole, showed no that no changes were required, while the assessment of individual project teams show that one of the project teams indicated that changes be made. Raw results are available in the Student Outcome assessment folder.

Background:

EE 444, Embedded Systems, is the third course in a three-quarter embedded microcontroller sequence. For the final lab in the course, students are divided into teams. Each team is responsible for developing hardware, software, and requirement modifications for a designated project. The project is organized as an Agile project where students may make weekly changes to requirements and individual responsibilities. The effectiveness of the project teams is assessed by a teamwork questionnaire submitted after the project due date by each individual student. There are five questions, each one has four answers that correspond to *unsatisfactory* through *exemplary*.

For this assessment, the EE Program at Western looks at the percentage of students who achieved a *satisfactory* or *exemplary* on the scores in each team and as an overall course. Where 3/3 defines an "exemplary" score, 2/3 "satisfactory," 1/3 "developing," and 0/3 "unsatisfactory." Attainment of Student Outcome 5 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data (EE 444): See ***EE444Lab4TeamworkSurvey2019.xslx***

Discussion:

When all students in the course are analyzed as one group the data show no changes are needed. The best scores were achieved in *Level of cooperation/conflict at meetings* and the lowest scores were achieved in *Team's ability to provide leadership*.

When student teams in the course are analyzed, there is one team that showed that 3 of the five areas - *Member contributions to the project*, *Team productivity*, and *Team's ability to provide leadership* were not attained.

These results where consistent with faculty observations, so the measures appear to be accurately measuring the effectiveness of teamwork for SO5. The team that did not attain all outcomes was also the smallest team, with only 3 students. This may have contributed to the results. One comment made by a student is that they divided the tasks and just worked on their own.

A modification that may improve this result is to make sure each team has at least four members.

While the teamwork questionnaire appears to be an accurate measure, the questions are indicators of the team rather than the individuals. The new rubric for MfgE rewords the measures to reflect the individual's effectiveness. This would require a new questionnaire. Faculty will investigate using an on-line questionnaire, such as Teammates, or develop a new questionnaire to see if it can provide more insight into the student's effectiveness in functioning as a team member. Perhaps implementing this in multiple courses that use teamwork will benefit the student achievement.

No other modifications are suggested at this time as the students, overall, show that they can be effective working in teams.

Rubric for Student Outcome 5 Teamwork Questionnaire

Student Outcome 5 "*an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives*"				
Performance Indicator (Student has the ability to …..)	**Unsatisfactory (0)**	**Developing (1)**	**Satisfactory (2)**	**Exemplary (3)**
Member contributions to the project	Some members did no work at all	A few members did most of the work	The work was generally shared by all members	Everyone did an equal share of the work
Level of cooperation/conflict at meetings	Open warfare – still unresolved	Disagreements were resolved with considerable difficulty	Some disagreements, but they were easily resolved	No conflict, everyone seemed to agree on what to do
Team productivity	The team was not able to even establish goals	The team successfully established goals but did not plan tasks well and did not met objectives	The team successfully established goals and planed tasks but did not met some objectives	The team successfully established goals, planed tasks, and met objectives
Team's ability to provide leadership	No effective team leadership or misguided dictator-type leadership	Leadership only provided one or two 'superheroes'	All team members, at times, provided some level of leadership	All team members effectively provided leadership throughout the project
Team's ability to provide a collaborative and inclusive environment	Team members lacked respect, there were instances of demeaning comments towards others, and/or failed to collaborate	The team worked together well though some did not make contributions and felt left out	All team members were professional and respected each other's contributions and included everyone in discussions	All team members encouraged and motivated each other in a way that brought out exceptional contributions and collaboration

Vehicle Network Team	3-count
Member contributions to the project	25.00%
Level of cooperation/conflict at meetings	100.00%
Team productivity	25.00%
Team’s ability to provide leadership	25.00%
Team’s ability to provide a collaborative and inclusive environment	25.00%

Power Monitor	
Member contributions to the project	62.50%
Level of cooperation/conflict at meetings	75.00%
Team productivity	12.50%
Team’s ability to provide leadership	25.00%
Team’s ability to provide a collaborative and inclusive environment	50.00%

Audio System	
Member contributions to the project	20.00%
Level of cooperation/conflict at meetings	20.00%
Team productivity	60.00%
Team’s ability to provide leadership	20.00%
Team’s ability to provide a collaborative and inclusive environment	20.00%

MCU Power Monitor	
Member contributions to the project	33.33%
Level of cooperation/conflict at meetings	66.67%
Team productivity	0.00%
Team’s ability to provide leadership	0.00%
Team’s ability to provide a collaborative and inclusive environment	0.00%

USB BasicIO	
Member contributions to the project	0.00%
Level of cooperation/conflict at meetings	50.00%
Team productivity	25.00%
Team’s ability to provide leadership	25.00%
Team’s ability to provide a collaborative and inclusive environment	50.00%

Buletooth Wearable	
Member contributions to the project	0.00%
Level of cooperation/conflict at meetings	50.00%
Team productivity	0.00%
Team’s ability to provide leadership	25.00%
Team’s ability to provide a collaborative and inclusive environment	25.00%

All

Member contributions to the project	28.57%
Level of cooperation/conflict at meetings	60.71%
Team productivity	20.69%
Team's ability to provide leadership	21.43%
Team's ability to provide a collaborative and inclusive environment	32.14%

2-count	1-count	0-count	
75.00%	0.00%	0.00%	3
0.00%	0.00%	0.00%	3
75.00%	0.00%	0.00%	3
75.00%	0.00%	0.00%	3
75.00%	0.00%	0.00%	3

37.50%	0.00%	0.00%	3
25.00%	0.00%	0.00%	3
87.50%	0.00%	0.00%	3
75.00%	0.00%	0.00%	3
50.00%	0.00%	0.00%	3

80.00%	0.00%	0.00%	3
80.00%	0.00%	0.00%	3
40.00%	0.00%	0.00%	3
80.00%	0.00%	0.00%	3
60.00%	20.00%	0.00%	3

33.33%	33.33%	0.00%	1
33.33%	0.00%	0.00%	3
50.00%	50.00%	0.00%	1
66.67%	0.00%	33.33%	1
100.00%	0.00%	0.00%	3

100.00%	0.00%	0.00%	3
50.00%	0.00%	0.00%	3
75.00%	0.00%	0.00%	3
50.00%	25.00%	0.00%	2
50.00%	0.00%	0.00%	3

100.00%	0.00%	0.00%	3
50.00%	0.00%	0.00%	3
100.00%	0.00%	0.00%	3
50.00%	25.00%	0.00%	2
75.00%	0.00%	0.00%	3

67.86%	3.57%	0.00%	3
39.29%	0.00%	0.00%	3
72.41%	6.90%	0.00%	3
67.86%	7.14%	3.57%	3
64.29%	3.57%	0.00%	3

Vehicle Network Team

Question	JC	CE	RH	Dto
Member contributions to the project	3	2	2	2
Level of cooperation/conflict at meetings	3	3	3	3
Team productivity	2	3	2	2
Team’s ability to provide leadership	3	2	2	2
Team’s ability to provide a collaborative and inclusive environment	3	2	2	2

Power Monitor

Question	AB	RE	TH	DH
Member contributions to the project	3	2	2	3
Level of cooperation/conflict at meetings	3	2	2	3
Team productivity	2	2	2	2
Team’s ability to provide leadership	3	2	2	2
Team’s ability to provide a collaborative and inclusive environment	3	2	2	2

Audio System

Question	VB	JP	ER	TS
Member contributions to the project	2	2	3	2
Level of cooperation/conflict at meetings	3	2	2	2
Team productivity	3	2	2	3
Team’s ability to provide leadership	2	2	3	2
Team’s ability to provide a collaborative and inclusive environment	2	2	3	2

MCU Power Monitor

Question	NC	NC2	BG	SW
Member contributions to the project	1		3	2
Level of cooperation/conflict at meetings	3		2	3
Team productivity	1	1	2	2
Team’s ability to provide leadership	0		2	2
Team’s ability to provide a collaborative and inclusive environment	2		2	2

USB BasicIO

Question	BC	AG	DG	AJ
Member contributions to the project	2	2	2	2
Level of cooperation/conflict at meetings	2	2	3	3
Team productivity	2	3	2	2
Team’s ability to provide leadership	1	2	3	2
Team’s ability to provide a collaborative and inclusive environment	2	2	3	3

Buletooth Wearable

Question	NB	MH	Dta	CW
Member contributions to the project	2	2	2	2

Level of cooperation/conflict at meetings	3	2	2	3
Team productivity	2	2	2	2
Team’s ability to provide leadership	2	1	2	3
Team’s ability to provide a collaborative and inclusive environment	2	2	3	2

All

Question
Member contributions to the project
Level of cooperation/conflict at meetings
Team productivity
Team’s ability to provide leadership
Team’s ability to provide a collaborative and inclusive environment

4.00	1	3	0	0
4.00	4	0	0	0
4.00	1	3	0	0
4.00	1	3	0	0
4.00	1	3	0	0

SM	KP	RS	MS					
2	3	3	3	8.00	5	3	0	0
3	3	3	3	8.00	6	2	0	0
2	2	2	3	8.00	1	7	0	0
2	2	2	3	8.00	2	6	0	0
2	3	3	3	8.00	4	4	0	0

AT					
2	5.00	1	4	0	0
2	5.00	1	4	0	0
3	5.00	3	2	0	0
2	5.00	1	4	0	0
1	5.00	1	3	1	0

3.00	1	1	1	0
3.00	2	1	0	0
4.00	0	2	2	0
3.00	0	2	0	1
3.00	0	3	0	0

4.00	0	4	0	0
4.00	2	2	0	0
4.00	1	3	0	0
4.00	1	2	1	0
4.00	2	2	0	0

4.00	0	4	0	0

4.00	2	2	0	0
4.00	0	4	0	0
4.00	1	2	1	0
4.00	1	3	0	0

28.00	8	19	1	0
28.00	17	11	0	0
29.00	6	21	2	0
28.00	6	19	2	1
28.00	9	18	1	0

EE 493 Outcome 5 Measures
Code Review - Effective teamwirk for code review author and reader roles.
Course Participation grade.

Total Number of students:	17
Number Qualified:	17

Student		CodeReview	CoursePart	ProjComplete	Ave Score
	max	3	3	3	3
S1		2.00	2.31	2.25	2.19
S2		2.00	1.88	2.21	2.03
S3		2.50	2.54	0.75	1.93
S4		2.00	2.54	1.50	2.01
S5		2.50	2.58	2.11	2.40
S6		3.00	2.69	2.87	2.85
S7		3.00	2.31	2.87	2.73
S8		2.00	2.04	1.17	1.74
S9		3.00	3.31	2.05	2.79
S10		2.50	2.42	2.25	2.39
S11		2.00	2.35	2.03	2.13
S12		2.00	2.42	2.25	2.22
S13		2.00	1.96	1.40	1.79
S14		2.00	2.58	1.76	2.11
S15		2.00	1.88	1.00	1.63
S16		3.00	2.92	2.05	2.66
S17		2.00	2.69	2.05	2.25

Code Review Team				
	Unsatisfactory	0 - 0.5	0	0.000
	Developing	0.5 - 1.5	0	0.000
	Satisfactory	1.5 - 2.5	10	0.588
	Exemplary	>2.5	4	0.235
Course Participation				
	Unsatisfactory	0 - 0.5	0	0.000
	Developing	0.5 - 1.5	0	0.000
	Satisfactory	1.5 - 2.5	9	0.529
	Exemplary	>2.5	8	0.471
Project Completion				
	Unsatisfactory	0 - 0.5	0	0.000
	Developing	0.5 - 1.5	4	0.235
	Satisfactory	1.5 - 2.5	11	0.647
	Exemplary	>2.5	2	0.118

Overall

Name	Total		
	78	%	3
S1	60	76.92	2.31
S2	49	62.82	1.88
S3	66	84.62	2.54
S4	66	84.62	2.54
S5	67	85.90	2.58
S6	70	89.74	2.69
S7	60	76.92	2.31
S8	53	67.95	2.04
S9	86	110.26	3.31
S10	63	80.77	2.42
S11	61	78.21	2.35
S12	63	80.77	2.42
S13	51	65.38	1.96
S14	67	85.90	2.58
S15	49	62.82	1.88
S16	76	97.44	2.92
S17	70	89.74	2.69

Student Name	Teamwork(5)	Reader Teamwork (5)	Ave
	3	3	3
S1	2.0	2.0	2.0
S2	2.0	2.0	2.0
S3	3.0	2.0	2.5
S4	1.0	3.0	2.0
S5	3.0	2.0	2.5
S6	3.0	3.0	3.0
S7	3.0	3.0	3.0
S8	2.0	2.0	2.0
S9	3.0	3.0	3.0
S10	2.0	3.0	2.5
S11	2.0	2.0	2.0
S12	2.0	2.0	2.0
S13	2.0	2.0	2.0
S14	2.0	2.0	2.0
S15	2.0	2.0	2.0
S16	3.0	3.0	3.0
S17	2.0	2.0	2.0

Name	Project Complete	
	100	3.00
S1	75.0	2.25
S2	73.7	2.21
S3	25.0	0.75
S4	50.0	1.50
S5	70.5	2.11
S6	95.7	2.87
S7	95.7	2.87
S8	39.1	1.17
S9	68.4	2.05
S10	75.0	2.25
S11	67.7	2.03
S12	75.0	2.25
S13	46.7	1.40
S14	58.8	1.76
S15	33.3	1.00
S16	68.4	2.05
S17	68.2	2.05
Totals	63.892	1.92

Assessment of Student Outcome 5 in EE 493

Instructor: Todd Morton

Assessor: Todd Morton

Assessment Quarter and Year: Spring 2019

This report assesses Student Outcome 5 "*an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives*" This is the new student outcome, which mapped from the old student outcome (d). The EE program at Western Washington University assessed this outcome in part using student performance in EE 493. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. The assessment from Spring 2019 showed no need for changes. Raw results are available in the Student Outcome assessment folder.

Background:

EE 493, Project Software and System Implementation is the third course in a three-quarter senior project sequence. In this course students function as a course-wide team and smaller teams for the software code reviews. The *course participation* score is a measure of the course wide teamwork and the *code review* score is a measure for the code review teamwork. The *project completion* score measures the team's ability of meeting objectives. The *code review* score reflects only the teamwork score in the code review rubric. For the final evaluation the three scores are evaluated individually and as an overall average.

For this assessment, the EE Program at Western looks at the percentage of students who achieved a *satisfactory* or *exemplary* on the scores in each code review team and as an overall course team. Where 2.5/3 and above defines an "exemplary" score, 1.5 to 2.5 "satisfactory," 0.5 to 1.5 "developing," and 0 to 0.5 "unsatisfactory." Attainment of Student Outcome 5 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data (EE 493):

Code Review Team				Result:
Unsatisfactory	0 - 0.5	0	0.000	3
Developing	0.5 - 1.5	0	0.000	
Satisfactory	1.5 - 2.5	10	0.588	
Exemplary	>2.5	4	0.235	

Course Participation				Result:
Unsatisfactory	0 - 0.5	0	0.000	3
Developing	0.5 - 1.5	0	0.000	
Satisfactory	1.5 - 2.5	9	0.529	
Exemplary	>2.5	8	0.471	

Project Completion				Result:
Unsatisfactory	0 - 0.5	0	0.000	2
Developing	0.5 - 1.5	4	0.235	
Satisfactory	1.5 - 2.5	11	0.647	
Exemplary	>2.5	2	0.118	

Overall				Result:
Unsatisfactory	0 - 0.5	0	0.000	3
Developing	0.5 - 1.5	0	0.000	
Satisfactory	1.5 - 2.5	13	0.765	
Exemplary	>2.5	4	0.235	

Discussion:

The results show SO5 was attained in the Code Review, Course Participation, and overall measure. Project completion shows the outcome was marginally attained, however this was the first time Project Completion was measured through verified requirements. This will be watched in the future as it is suspected that this score will improve as the process for requirements writing and verification is improved.

No changes are recommended at this time. A teamwork questionnaire may be considered as an added measure.

Assessment of Student Outcome (5) in EE 473

Instructors: Xichen Jiang, Amr Radwan

Assessors: Xichen Jiang, Amr Radwan

Assessment Quarter and Year: Spring 2019

This report assesses Student Outcome (5), "an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives." The EE program at Western Washington University assessed this outcome in part using student performance in EE 473. This document describes the background, details, and rubric for this outcome assessment and also provides the actual data and data analysis.

Background

EE 473 is the final course in a three course sequence in which students research, design, and implement an energy related project. In this course, the students focus on the implementation of the project. The measure selected for the assessment is from the scores of a student survey given at the end of the quarter (see attached). Each of the 11 survey questions measures teamwork efficacy by having the students rate the statement on a scale of 1 (strongly disagree) to 5 (strongly agree).

Assessment Data

Eight students participated in the survey. A histogram of the average scores for each question is shown in Figure 1. Table 1 shows the percentages of scores for each question.

Discussion

For this assessment, the EE Program looked at the average scores for each of the survey questions. An average score of 3.5 or above with no more than 15% of any questions receiving scores of 2 or lower is considered *satisfactory*. With these criteria, the outcome was attained by the class. However, a detailed analysis of Table 1 shows that some students gave scores of 2 for particular survey questions. The survey questions receiving scores 2 or lower include "Our team has the skills needed to do the jobs effectively" (Question 5) and "Our team addresses and resolves issues quickly" (Question 6). Therefore, the sub-outcomes of "create a collaborative and inclusive environment" and "establish goals, plan tasks, and meet objectives" may necessitate additional observation and monitoring.

While the survey appears to be an accurate measure, the questions are indicators of the team more so than the individuals. The new rubric for MfgE rewords the measures to reflect the individual's effectiveness. This would require a new questionnaire. The EE faculty will investigate using an on-line questionnaire, such as Teammates, or develop a new questionnaire to see if it can provide more insight into the student's effectiveness in functioning as a team member.

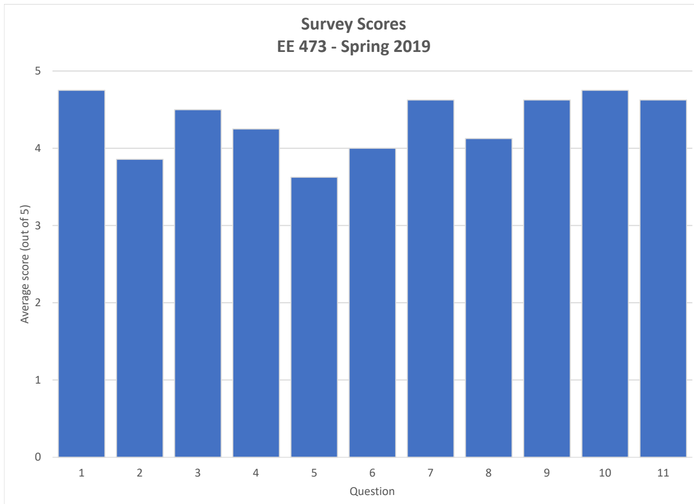


Figure 1: Score distribution.

Table 1: Detailed assessment.

	Scores				
Question	5	4	3	2	1
1	75%	25%	0%	0%	0%
2	28.5%	28.5%	43%	0%	0%
3	50%	50%	0%	0%	0%
4	37.5%	50%	12.5%	0%	0%
5	0%	75%	12.5%	12.5%	0%
6	25%	62.5%	0%	12.5%	0%
7	62.5%	37.5%	0%	0%	0%
8	37.5%	37.5%	25%	0%	0%
9	62.5%	37.5%	0%	0%	0%
10	75%	25%	0%	0%	0%
11	75%	12.5%	12.5%	0%	0%

This survey is for evaluating Student Outcome (5): An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Statement	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. Our team has a meaningful, shared purpose.	5	4	3	2	1
2. Team members clearly understand their roles.	5	4	3	2	1
3. Team members appreciate one another's unique capabilities.	5	4	3	2	1
4. Team members take personal responsibility for the effectiveness of our team.	5	4	3	2	1
5. Our team has the skills needed to do the jobs effectively.	5	4	3	2	1
6. Our team addresses and resolves issues quickly.	5	4	3	2	1
7. Team members are effective listeners.	5	4	3	2	1
8. Team members maintain a can-do approach when they encounter frustrating situations.	5	4	3	2	1
9. Our team has a strong sense of accomplishment relative to our work.	5	4	3	2	1
10. Communication in our group is open and honest.	5	4	3	2	1
11. Members of our team trust each other.	5	4	3	2	1

Student Outcome: SO6: “requires that students have an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.”

Evaluation Date: 06/14/2022, 06/17/2021

Supporting Documents in 2021-22 folder: *EECE471-473_AssessmentEvaluationSO6.docx*

Supporting Documents in 2020-21 folder: *EECE493_AssessmentEvaluationSO6.docx, EECE493_SP21_SO6_Data.xlsx, EECE480_AssessmentEvaluationSO6.docx, EECE480_F20_SO6_Data.xlsx, EECE471-473_AssessmentEvaluationSO6*

Prior Recommendations and attainment: None.

Assessment Methodologies	
1.	EECE 493 Verification plan
2.	EECE 493 Verification execution
3.	EECE 480 DC-DC PI controller lab
4.	EECE 471 Verification plan
5.	EECE 473 Verification execution
6.	EECE 360 Speaker Response Lab

Assessment Targets	
1.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
2.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
3.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
4.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
5.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level
6.	70% of the students attain the outcome at a satisfactory or exemplary level and less than 10% of the students attain the outcome at an unsatisfactory level

Attainment of Outcome	
1.	73% attained outcome at satisfactory level or better, 27% developing
2.	73% attained outcome at satisfactory level or better, 27% developing
3.	97.1% attained outcome at satisfactory level or better, 2.9% attained outcome at unsatisfactory level
4.	100% attained outcome at satisfactory level or better
5.	100% attained outcome at satisfactory level or better
6.	100% attained outcome at satisfactory level or better

Recommended Changes	
1.	Improve requirements curriculum materials
2.	Improve requirements curriculum materials
3.	Physical circuits will be implemented once lab access is available

4.	No exemplary, likely due to pandemic-related issues. No changes.
5.	No exemplary, likely due to pandemic-related issues. No changes.
6.	No changes recommended

Recommended Re-assessment Plan	
1.	Re-assessment needed without COVID restrictions. AY2022-23?
2.	Re-assessment needed without COVID restrictions. AY2022-23?
3.	No reassessment required.
4.	No reassessment required.
5.	No reassessment required.
6.	No reassessment required.

Other Possible Changes	

Assessment of Student Outcome 6 in EECE 360

Instructor: A.G. Klein
Assessor: A.G. Klein

Assessment Quarter: Winter 2020
Date of Assessment: June 2021

This report assesses Student Outcome 6 *"requires that students have an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions"*. The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 360 – Communication Systems. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

Background

EECE 360 is an introductory communication systems course, taken by all students in the EECE program, typically during the third year of study. The course relies on pre-requisite material including LTI signal and system theory and application, and provides students with a system-level introduction to wired and wireless communication systems.

To partially evaluate this outcome, student performance on an inquiry-based laboratory exercise is considered where students are asked to develop an experiment to characterize the frequency response of a very low-cost speaker. The speaker is typically found on PC motherboards and used by the PC BIOS to convey POST error codes through a series of beeps. Such speakers are highly frequency-selective. In this laboratory exercise, the students are given very minimal guidance, and no procedural step-by-step instructions on how to conduct the frequency response characterization. Thus, they must themselves develop and conduct an experiment to characterize the speaker, and subsequently interpret the data. This assessment was made for the EECE 360 class of Winter quarter 2020 since labs were remote in Winter 2021 due to COVID. This was Lab #1 during the Winter 2020 quarter.

For this assessment, the EECE Program at WWU looks at the percentage of students who achieved a satisfactory or exemplary on the average scores. Here, 3 defines an "exemplary" score, 2 is "satisfactory," 1 is "developing," and 0 is "unsatisfactory." Attainment of Student Outcome 1 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data

$N = 31$

Meaning	Score	# of students	Proportion of students
Unsatisfactory	0	0	0.0%
Developing	1	0	0.0%
Satisfactory	2	10	32.3%
Exemplary	3	21	67.7%

Result: 3

Discussion

In EECE 360, 10 of 31 students demonstrated satisfactory performance and 21 of 31 students demonstrated exemplary performance. This represents a very good outcome for the class as a whole and, at least in this category, there were no students who failed that they could design and conduct an experiment on the laboratory exercise.

EECE 360, Winter 2020, Lab 1 scores

Highest possible score: 10

	Score on Lab 1	Score as percentage	Scaled to 0→3 (y=5*x-1.5)	Quantized
Student 1	10	100%	3.5	3
Student 2	8.35	84%	2.675	3
Student 3	9.85	99%	3.425	3
Student 4	6.1	61%	1.55	2
Student 5	9	90%	3	3
Student 6	8.6	86%	2.8	3
Student 7	9.25	93%	3.125	3
Student 8	9.05	91%	3.025	3
Student 9	9.15	92%	3.075	3
Student 10	7.35	74%	2.175	2
Student 11	8.6	86%	2.8	3
Student 12	7.85	79%	2.425	2
Student 13	9.1	91%	3.05	3
Student 14	9.1	91%	3.05	3
Student 15	9.05	91%	3.025	3
Student 16	9	90%	3	3
Student 17	8.85	89%	2.925	3
Student 18	6.1	61%	1.55	2
Student 19	7	70%	2	2
Student 20	7.05	71%	2.025	2
Student 21	8.85	89%	2.925	3
Student 22	7.85	79%	2.425	2
Student 23	8.7	87%	2.85	3
Student 24	7.35	74%	2.175	2
Student 25	8.35	84%	2.675	3
Student 26	9.85	99%	3.425	3
Student 27	9.15	92%	3.075	3
Student 28	7	70%	2	2
Student 29	8.7	87%	2.85	3
Student 30	7.05	71%	2.025	2
Student 31	9.25	93%	3.125	3

Quantized Score	Frequency	Proportion
0	0	0.0%
1	0	0.0%
2	10	32.3%
3	21	67.7%

Number of students	31
Result:	**3**

Assessment of Student Outcome 6 in EECE480

Instructor: Amr Radwan

Assessor: Amr Radwan

Assessment Quarter and Year: Fall 2020

This report assesses Student Outcome 6 "*requires that students have an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.*" The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 480 – Control Systems. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 480 is the control systems course for the senior students in the EECE program. In this class students are introduced to the analog control systems and techniques using operational mathematics, Laplace transforms, transfer functions, stability criteria, frequency response analysis, and PID control design. Students use Laplace transforms to develop transfer functions for mechanical and electrical systems. Then, students apply the stability criteria and use the frequency response analysis to design PID controllers. To evaluate this outcome, one laboratory exercise is used. In lab4, students are required to observe the influence of increasing the switching frequency of a dc-dc converter on the steady-state, the transient performance, and the harmonics of the output voltage. Students should observe that the high switching frequency improves the quality of the output voltage with no significant effect on the average value of the output. Then, students use Laplace transforms and transfer functions to design a PI controller for the output current using the zero-pole cancelation method. The controller parameters are used in a simulation model within Matlab/Simulink to verify the results and observe the output performance. This assessment was made for the EECE 480 class of Fall quarter, 2020.

For this assessment, the EECE program at Western looks at the percentage of students who achieved a satisfactory or exemplary on the average scores. Where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Attainment of SO6 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data

Unsatisfactory	0	1	2.94%	
Developing	1	0	0.00%	
Satisfactory	2	4	11.76%	Result:
Exemplary	3	29	85.29%	3

Discussion:

In EECE 480, 29 students out of 34 demonstrated an exemplary performance and 4 students demonstrated a satisfactory performance. The one student who demonstrated an unsatisfactory performance did not submit the lab report. The assessment data implies a very good performance, but the following should be noted.

- This class was taught for the first time in an online modality during the global pandemic. This lab exercise was delivered remotely using simulations within Matlab/Simulink. Office hours were provided remotely via zoom meetings.
- One student could not submit the lab report due to the global pandemic and so the student's performance was not evaluated.

Future improvements include the experimental verification on physical circuits using op-amps to implement the PID controller and the equivalent transfer function of the dc-dc converter. Then, simulation models can be used as another layer of verification.

EECE 220 Student Outcome 1 Measure
W21 Final Exam - Problem 5: Small signal modeling and analysis of MOSFETs

Total Number of Students:	34
Number Qualified:	34

Max Points	10		
Students	**Points**	%	Scale 0-3
Student1	0	0	0
Student2	7	70	2
Student3	7	70	2
Student4	7	70	2
Student5	7	70	2
Student6	10	100	3
Student7	10	100	3
Student8	10	100	3
Student9	10	100	3
Student10	10	100	3
Student11	10	100	3
Student12	10	100	3
Student13	10	100	3
Student14	10	100	3
Student15	10	100	3
Student16	10	100	3
Student17	10	100	3
Student18	10	100	3
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Student21	10	100	3
Student22	10	100	3
Student23	10	100	3
Student24	10	100	3
Student25	10	100	3
Student26	10	100	3
Student27	10	100	3
Student28	10	100	3
Student29	10	100	3
Student30	10	100	3
Student31	10	100	3
Student32	10	100	3
Student33	10	100	3
Student34	10	100	3

0-40%	Unsatisfactory	0	1	2.94%
41%-60%	Developing	1	0	0.00%
61%-80%	Satisfactory	2	4	11.76%
81%-100%	Exemplary	3	29	85.29%

Assessment of Student Outcome 6 in EECE493

Instructor: Todd Morton

Assessor: Todd Morton

Assessment Quarter and Year: Spring 2021

This report assesses Student Outcome 6 "*requires that students have an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.*"

The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 493 – Project Software and System Implementation. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 493 is the third course in the culminating project sequence. In this class, students complete the design and verification of their senior project. The evaluation of the verification is done in three parts: the verification plan, the verification execution, and the extent to which the verification showed the requirement was met. The first two parts are assessed for SO6, while the last part is assessed for SO2. This assessment was made for the EECE 493 class of spring quarter, 2021.

For this assessment, the EECE program looks at the percentage of students who achieved a satisfactory or exemplary on their average scores. Where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Because each student has a different number of requirements for their project, the average score over all requirements is rounded to 0, 1, 2, or 3. Attainment of SO6 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data

Verification Plan

Unsatisfactory	0	0	0.00%	
Developing	1	6	27.27%	
Satisfactory	2	15	68.18%	Result:
Exemplary	3	1	4.55%	2

Verification

Unsatisfactory	0	0	0.00%	
Developing	1	6	27.27%	
Satisfactory	2	14	63.64%	Result:
Exemplary	3	2	9.09%	2

Discussion:

Verification Planning

The data shows almost 73% of the students demonstrated satisfactory or exemplary performance and no teams demonstrated an unsatisfactory performance. However, more than 27% demonstrated developing performance, which means that the outcome was marginally attained.

Verification Execution

The data shows almost 73% of the students demonstrated satisfactory or exemplary performance and no teams demonstrated an unsatisfactory performance. However, more than 27% demonstrated developing performance, which means that the outcome was marginally attained.

There are two potential causes for this reduction in performance for both the planning and execution of the verification:

- The most obvious cause is that this course was during the COVID pandemic. This course was delivered on-line with the labs made available on Mondays and Fridays. All but a few students did not feel safe or could not get to the labs regularly. This had a major impact on access to the equipment needed for verification therefore on the execution of the verification. It also had an impact on the planning as students had to attempt to develop alternative verification plans using the resources available. Something they have never had to do in previous years.
- The other issue was that this year the students had to spend more time on modifying their requirements, which resulted in a rushed attempt at writing their verification plans. Part of this was due to the pandemic as they had to readjust their goals based on the new realities of working in isolation. We can also do a better job of fully developing requirements in EECE 491.

Improvements to be made: The program will revise the requirements curriculum, primarily the requirements writing and process document and the requirements and verification forms. We will also try to invite a guest speaker to talk about writing requirements in EECE 491. We have done this in the past but were not able to this year because of COVID.

EECE 493 Student Outcome 6 Verification planning (develop), Measure and Conclusion (analyze an
SP21 Verification Plan and Verification.

Total Number of students:	22
Number Qualified:	22

Student	Verification Plan	Verf Pln Mappe	Verification
max	100	3	100.00
T1	41.03	1	58.3
T2	54.90	2	41.2
T3	61.11	2	55.6
T4	61.11	2	55.6
T5	57.78	2	46.7
T6	71.93	2	38.6
T7	71.79	2	74.4
T8	46.67	1	33.3
T9	55.56	2	60.0
T10	63.33	2	60.0
T11	69.23	2	76.9
T12	56.25	2	25.0
T13	43.94	1	50.0
T14	48.72	1	56.4
T15	48.70	1	56.4
T16	69.23	2	76.9
T17	47.06	1	52.9
T18	94.74	3	96.7
T19	66.67	2	91.7
T20	60.00	2	48.9
T21	74.24	2	74.2
T22	61.11	2	55.6

Verification Plan

Unsatisfactory	0	0	0.00%
Developing	1	6	27.27%
Satisfactory	2	15	68.18%
Exemplary	3	1	4.55%

Verification

Unsatisfactory	0	0	0.00%
Developing	1	6	27.27%
Satisfactory	2	14	63.64%
Exemplary	3	2	9.09%

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Assessment of Student Outcome 6 in EECE 471 and 473

Instructor: Amr Radwan

Assessor: Amr Radwan

Assessment Quarter and Year: Fall 2021 (EECE 471) and Spring 2022 (EECE 473)

This report assesses Student Outcome 6 "*requires that students have an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.*"

The EECE program at Western Washington University assessed this outcome, in part, using student performance in EECE 471 – Energy Project Proposal and EECE 473 – Energy Project Implementation. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. Raw results are available in the Student Outcome assessment folder.

EECE 471 is the first of three courses for the interdisciplinary culminating project in the electrical engineering – energy option. Students define objectives, perform research, and prepare project proposals and testing plan. This class is used to assess the ability of students to develop a verification plan. The data is taken from two components in the grading rubrics of midterm proposal report that measure the "detailed description of design and testing plan" and "contingency plan and timeline". The former measures the ability of students to develop a detailed testing plan following pre-defined objectives whereas the later measures the ability of students to develop a timeline and a backup (contingency) plan for potential sudden modality change due to covid. The assessment was made for the EECE 471 class of fall quarter, 2021.

EECE 473 is the third of three courses for the interdisciplinary energy project. Students complete the implementation of an energy related project as previously defined in EECE 471. This class is used to assess the ability of students to execute the verification plan that was developed in EECE 471 and evaluating that the pre-defined senior project requirements were met. The data is taken from three components in the grading rubrics of final report evaluation sheet that measure "execution of the verification plan as initially proposed", "meeting the project requirements as initially proposed" and "completeness of implementation". The assessment was made for EECE 473 class of spring quarter, 2022.

For this assessment, the EECE program looks at the percentage of students who achieved a satisfactory or exemplary on their average scores. Where 3 defines an "exemplary" score, 2 "satisfactory," 1 "developing," and 0 "unsatisfactory." Because each student has a different number of requirements for their project, the average score over all requirements is rounded to 0, 1, 2, or 3. Attainment of SO6 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data

EECE 471 Verification Plan		Teams			
Unsatisfactory	0		0	0.00%	
Developing	1		0	0.00%	
Satisfactory	2		3	100%	Result:
Exemplary	3		0	0.00%	3

EECE 473 Execution				
Unsatisfactory	0	0	0.00%	
Developing	1	0	0.00%	
Satisfactory	2	3	100%	Result:
Exemplary	3	0	0.00%	3

Discussion:

EECE 471 Verification Planning

The data shows 100% of the students demonstrated satisfactory performance and no teams demonstrated an unsatisfactory or exemplary performance. The outcome is attained but again, no exemplary performance was achieved. The potential cause is that students were just coming out of the global covid pandemic with transition from online to face-to-face modality. An exemplary performance is therefore expected in future assessments.

EECE 473 Verification Execution

The data shows 100% of the students demonstrated satisfactory performance and no teams demonstrated an unsatisfactory or exemplary performance. The outcome is attained but again, no exemplary performance was achieved. Further, one team is on the margin of "developing" performance which would have resulted in an overall score of 1. This team did not have time to work on the implementation to the end and faced unexpected short circuit failures within the last two weeks of the spring quarter. With the introduced new senior project proposal class in the spring before the senior year, students will have more time to think about the project over the summer and so they can start right away in the fall of the senior year on development and implementation, which will indeed save a lot of time.

EECE 471 Student Outcome 6 Measure
EECE 471 F21: Development of Objectives, Testing and Verification Plan

Total Number of Teams:
Number Qualified:

Max Points	10	5	15
Teams	**Measure 1**	**Measure 2**	**Total**
	detailed description of design and testing plan	contingency plan and timeline	
Team1	6	3	9
Team2	7	2	9
Team3	8	1	9

3	3 students/team				
3					
%	Scale 0-3 (round)	Unsatisfactory	0	0	0.00%
60	2	Developing	1	0	0.00%
60	2	Satisfactory	2	3	100.00%
60	2	Exemplary	3	0	0.00%

EECE 473 Student Outcome 6 Measure
EECE 473 S22: Execution of Testing and Verification Plan

Total Number of Teams:
Number Qualified:

Max Points	10	5	5
Teams	**Measure 1**	**Measure 2**	**Measure 3**
	Execution of the Verification Plan as Initially Proposed	Meeting the Project Requirements as Initially Proposed	Completeness of Implementation
Team1	8	4	4
Team2	6	2.5	3
Team3	8	4	4

3 3 students/team

3

Total	20	%	Scale 0-3 (round)	Unsatisfactory	0
	16	80	2	Developing	1
	11.5	57.5	2	Satisfactory	2
	16	80	2	Exemplary	3

0	0.00%		
0	0.00%		
3	100.00%		Result:
0	0.00%		3

Student Outcome Assessment Evaluation

Student Outcome: (SO7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Evaluation Date: 06/18/2020

Supporting Documents: *Assessment of Student Outcome 1 – EE492 – 2018.docx, AssessmentEvaluationSO7-EE491-3.docx, EE471_7.pdf, EE472_7.pdf, EE473_7.pdf, EE491-493-SO7.xlsx, EE492 SO7.xlsx, Score Distribution Plot_471_7.xlsx, Score Distribution Plot_472_7.xlsx, Score Distribution Plot_473_7.xlsx*

Prior Recommendations and attainment: Assessed 06/15/2016 as student outcome (i). No changes were recommended.

Assessment Methodologies	
1.	EE491 Proposal Bibliography, EE493 New parts/technology used for project
2.	EE492 Part Selection Investigation Report
3.	EE471 Proposal Research – midterm and final proposal scores
4.	EE472 Investigation and report – Initial design report
5.	EE473 New parts/technology used for project – Final project demonstration

Assessment Targets	
1.	70% of the student attain the outcome at a satisfactory or exemplary level
2.	70% of the student attain the outcome at a satisfactory or exemplary level
3.	70% of the student attain the outcome at a satisfactory or exemplary level
4.	70% of the student attain the outcome at a satisfactory or exemplary level
5.	70% of the student attain the outcome at a satisfactory or exemplary level

Attainment of Outcome	
1.	94% attained outcome at satisfactory level or better.
2.	86% attained outcome at satisfactory level or better (average of 3 scores).
3.	100% attained outcome at satisfactory level or better
4.	100% attained outcome at satisfactory level or better
5.	100% attained outcome at satisfactory level or better

Recommended Changes	
1.	None
2.	It is recommended given the impact this lack of consideration had on student performance, that the curriculum for EE492 include additional details on the variability of part lifecycles.
3.	No recommended changes (add to evaluation)
4.	No recommended changes (add to evaluation)
5.	No recommended changes (add to evaluation)

Recommended Re-assessment Plan	
1.	No re-assessment needed.
2.	No re-assessment needed.
3.	No re-assessment needed.
4.	No re-assessment needed

5.	No re-assessment needed

Other Possible Changes	

Assessment of Student Outcome 7 in EE 491 and 493

Instructor: Todd Morton

Assessor: Todd Morton

Assessment Quarter and Year: Fall 2018 and Spring 2019

This report assesses Student Outcome 7 "*an ability to acquire and apply new knowledge as needed, using appropriate learning strategies*" This is the new student outcome, which mapped from the old student outcome (i). The EE program at Western Washington University assessed this outcome in part using student performance in EE EE491 and EE493. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis. The assessment from EE 491 in Fall 2018 and EE493 in Spring 2019 showed no need for changes. Raw results are available in the Student Outcome assessment folder.

Background:

EE 491, Project Proposal, is the first course in a three-quarter senior project sequence. In this course students create a project proposal, requirements, and a first iteration of a system-level design. The *proposal is* scored based on a rubric, *ProjectProposalRubricF18.pdf*. Part of this score is based on the bibliography containing the documents used in researching new technology and formulating the project requirements.

EE 493, Project Software and System Implementation is the third course in a three-quarter senior project sequence. The measure used for SO7 is the successful application of new technology in the student's project.

For this assessment, the EE Program at Western looks at the percentage of students who achieved a *satisfactory* or *exemplary* on the scores project proposal rubric and an evaluation of the final project. Where 2.5/3 and above defines an "exemplary" score, 1.5 to 2.5 "satisfactory," 0.5 to 1.5 "developing," and 0 to 0.5 "unsatisfactory." Attainment of Student Outcome 5 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data:

EE491 - Proposal Bibliography				Result:
Unsatisfactory	[0,0.5)	0	0.000	2
Developing	[0.5,1.5)	4	0.235	
Satisfactory	[1.5,2.5)	8	0.471	
Exemplary	[2.5,∞)	5	0.294	

EE493 - New technology in project				Result:
Unsatisfactory	[0,0.5)	0	0.000	3
Developing	[0.5,1.5)	3	0.176	
Satisfactory	[1.5,2.5)	5	0.294	
Exemplary	[2.5,∞)	9	0.529	

Overall					Result:
	Unsatisfactory	[0,0.5)	0	0.000	3
	Developing	[0.5,1.5)	1	0.059	
	Satisfactory	[1.5,2.5)	8	0.471	
	Exemplary	[2.5,∞)	8	0.471	

Discussion:

The results show SO7 was attained in these measures. The proposal bibliography was marginally attained so this will be watched for the next assessment.

No changes or reassessments are recommended at this time.

EE 491 and EE493 Outcome 7 Measures
EE491 - Proposal Bibliography
EE493 - Development of new technology in project

Total Number of students:	17
Number Qualified:	17

Student		Proposal Bibliography	System Software Presentation	Ave Score
	max	3	3	3
S1		3.00	2.00	2.50
S2		3.00	3.00	3.00
S3		2.00	2.00	2.00
S4		3.00	3.00	3.00
S5		3.00	3.00	3.00
S6		2.00	3.00	2.50
S7		2.00	3.00	2.50
S8		1.00	3.00	2.00
S9		2.00	3.00	2.50
S10		2.00	2.00	2.00
S11		1.00	3.00	2.00
S12		3.00	3.00	3.00
S13		1.00	2.00	1.50
S14		2.00	1.00	1.50
S15		1.00	1.00	1.00
S16		2.00	1.00	1.50
S17		2.00	2.00	2.00

EE491 - Proposal Bibliography				
	Unsatisfactory	[0,0.5)	0	0.000
	Developing	[0.5,1.5)	4	0.235
	Satisfactory	[1.5,2.5)	8	0.471
	Exemplary	[2.5,∞)	5	0.294
EE493 - New technology in project				
	Unsatisfactory	[0,0.5)	0	0.000
	Developing	[0.5,1.5)	3	0.176
	Satisfactory	[1.5,2.5)	5	0.294
	Exemplary	[2.5,∞)	9	0.529
Overall				
	Unsatisfactory	[0,0.5)	0	0.000
	Developing	[0.5,1.5)	1	0.059
	Satisfactory	[1.5,2.5)	8	0.471
	Exemplary	[2.5,∞)	8	0.471

Result:

2

Result:

3

Result:

3

	score	
S1	2	LoRa, IP67
S2	3	Vehicle sensors, CAN, SD card, Accelerometer, IP67, vehicle power
S3	2	Vehicle sensors, CAN, IP67, vehicle power
S4	3	Heartrate sensor for animals, cellular networking, IP57, SMS,
S5	3	Heartrate sensor for animals, cellular networking, IP57, SMS,
S6	3	802.15.4 wireless networking, light color temperatures, presence
S7	3	802.15.4 wireless networking, light color temperatures, presence
S8	3	Accelerometer, USB charging, Bluetooth wireless, bluetooth securi
S9	3	interferential (IF) stimulation therapy, MCU Timers, touch screen,
S10	2	DC-AC inverter, USB charging, Solar panel, IP51
S11	3	GPS navigation, wind scales, IP67, ASTM water resistance, Dallas 1-
S12	3	GPS navigation, wind scales, IP67, ASTM water resistance, Dallas 1-
S13	2	External ADC w/ I2C and I2S, USB Audio device, Matlab data acq.,
S14	1	Norm. motors for robotics and drivers,
S15	1	BDLC motor design and driver,
S16	1	IP54, MIL std for vibration
S17	2	Wireless charging, IEEE 802.15.1 wireless

detection using wireless network signals, network security, home networking hub,
detection using wireless network signals, network security, home networking hub,
ty, IP65, gyroscope
graphical LCD, USB charging, FDA 501k reqs,

wire bus, external SPI flash
wire bus, external SPI flash

Assessment of Student Outcome (7) in EE 492

Instructor: John Lund

Assessor: John Lund

Assessment Quarter and Year: Winter 2018

This report assesses Student Outcome (7) "an ability to acquire and apply new knowledge as needed, using appropriate learning strategies." The EE program at Western Washington University assess this outcome in part using student performance in EE 492. This document is designed to describe the background, details, and rubric for this outcome assessment and then provide the actual data and data analysis.

Background:

EE 492 is the project hardware development portion of the Senior Design sequence. In this course students select components, prototype the hardware elements of their design, troubleshoot hardware design issues, and ultimately produce a final assembled printed circuit board (PCB) solution. One aspect of the component selection process is the identification of parts that best meet their project design requirement constraints. Often students decide from amongst familiar components discovered throughout the core EE curriculum. One challenge students face is identifying brand new components that may be the most suitable choice for their design. In this vein, an assignment included in the EE 492 course is a report where students must do a "deep dive" into alternatives for at least one component of their design. They must identify prominent newly-released alternative choices, weigh the pros and cons of this new solution versus a more traditional design solution, and from that new knowledge make an appropriate part selection. SO7 is assessed in this assignment because the students are acquiring knowledge about hardware elements not covered in the curriculum and applying that knowledge to make a design decision.

Assessment:

The aforementioned reporting assignment is evaluated based on proper student knowledge acquisition and application broken down into three categories:

Identify: the ability of students to correctly and thoroughly identify newly-released component options for their project design. An example would be a new form of USB connector used for recharging their device.

Assess: using the acquired knowledge about the new component, are the students able to correctly and thoroughly identify advantages and disadvantages of the component vis-à-vis their original design choice? An example would be noting that the new USB connector costs $0.56 more and is rated to 2000 fewer connection cycles but is reversible.

Decide: based on the identified advantages and disadvantages, which component best meets the overall system's design requirements. An example would be a system where cost and reliability are critical design requirements, but ease of use is not, resulting in the designer choosing the original USB connector.

For this assessment, the EE Program at Western looks at the percentage of students who achieved a *satisfactory* or *exemplary* on the scores in each assessment category of new knowledge acquisition and application. Where 2.5/3 and above defines an "exemplary" score, 1.5 to 2.5 "satisfactory," 0.5 to 1.5 "developing," and 0 to 0.5 "unsatisfactory." Attainment of Student Outcome 7 is defined as 70% of students meeting the satisfactory or exemplary threshold and not more than 10% not meeting developing threshold.

Assessment Data:

Identify					Result:
	Unsatisfactory	[0,0.5)	0	0.000	3
	Developing	[0.5,1.5)	1	0.063	
	Satisfactory	[1.5,2.5)	3	0.188	
	Exemplary	[2.5,∞)	12	0.750	
Assess					Result:
	Unsatisfactory	[0,0.5)	0	0.000	2
	Developing	[0.5,1.5)	4	0.267	
	Satisfactory	[1.5,2.5)	10	0.667	
	Exemplary	[2.5,∞)	1	0.067	
Decide					Result:
	Unsatisfactory	[0,0.5)	0	0.000	3
	Developing	[0.5,1.5)	1	0.067	
	Satisfactory	[1.5,2.5)	3	0.200	
	Exemplary	[2.5,∞)	11	0.733	

Discussion:

For all three categories, the attainment of Student Outcome 7 was met. The task testing a student's ability to assess the advantages and disadvantages of a component based on newly acquired knowledge about that component was borderline, however. This result was primarily due to many students erroneously concluding that newer components necessarily have a longer part lifecycle. Specifically, students incorrectly concluded that the time for a new part transitioning to a status of "not for new designs" was a fixed time period independent of part adoption. Although component lifecycles are an element of the curriculum, the factors which broaden or narrow the lifecycle curve are not an included curricular topic. **It is recommended given the impact this lack of consideration had on student performance, that the curriculum for EE492 include additional details on the variability of part lifecycles.**

Student	ID	Identify	Assess	Decide
Points Possible		3	2	3
Amitai, Tan	3355416	3	2	3
Cronkhite,	3433263	2	1	3
DeWitte, K	3409544	3	1	2
Eason, Bryc	3574070	3	2	3
Fernandez,	3352931	2	2	2
Gregory, Ke	3491537	3	3	3
Hing, Vince	3431342	1	2	1
Kowalski, D	3432010	3	2	3
Melloh, Jan	3488883	3	1	3
Metcalf, Ja	3592358	3	2	3
Reiner, Josh	3433845	2	1	3
Richardson	3482441	3	2	3
Waggoner,	3433827	3	2	3
Warmenho	3406943	3	2	3
Welch, Juli	3482425	3	2	2

Identify				
	Unsatisfactory	[0,0.5)	0	0.000
	Developing	[0.5,1.5)	1	0.063
	Satisfactory	[1.5,2.5)	3	0.188
	Exemplary	[2.5,∞)	12	0.750
Assess				
	Unsatisfactory	[0,0.5)	0	0.000
	Developing	[0.5,1.5)	4	0.267
	Satisfactory	[1.5,2.5)	10	0.667
	Exemplary	[2.5,∞)	1	0.067
Decide				
	Unsatisfactory	[0,0.5)	0	0.000
	Developing	[0.5,1.5)	1	0.067
	Satisfactory	[1.5,2.5)	3	0.200
	Exemplary	[2.5,∞)	11	0.733

Assessment of Student Outcome (7) in EE 471

Instructor: Xichen Jiang

Assessor: Xichen Jiang

Assessment Quarter and Year: Fall 2018

This report assesses Student Outcome (7), "an ability to acquire and apply new knowledge as needed, using appropriate learning strategies." The EE program at Western Washington University assessed this outcome in part using student performance in EE 471. This document describes the background, details, and rubric for this outcome assessment and also provides the actual data and data analysis.

Background

EE 471 is the first course in a three course sequence in which students research, design, and implement an energy related project. In this course, the students focus on the research and development of the project. The measure selected for the assessment is from the Midterm and Final Proposal **Introduction** scores the students received (see attached rubrics). The students were graded out of 25 points for a) performing a thorough background research of existing technology and justifying the need for the proposed project, and b) formulating a viable project design and plan.

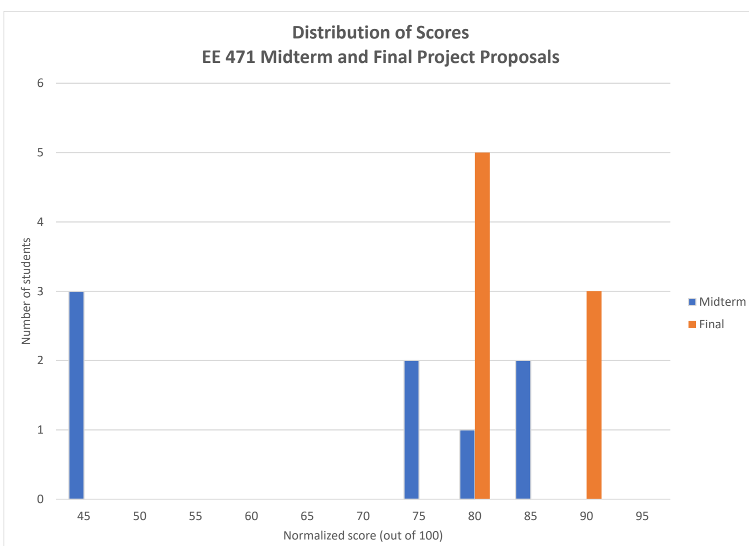


Figure 1: Score distribution.

Assessment Data

A histogram of the student scores from both the Midterm and Final Proposals (normalized to 100) is shown in Figure 1 for comparison. The statistics of scores from the Final Proposal are summarized in Table 1. It is worth noting that all students within the same group received the same scores.

Table 1: Statistics.

Total number of students	8
Mean Presentation Score	86
Standard Deviation	3.8
Mean Percent Change	19

Discussion

The scores for the Final Proposal **Introduction** were scaled down to 0 through 3 for this assessment. Scores above 2.5 is defined as *exemplary*, 1.5 to 2.5 *satisfactory*, 0.5 to 1.5 *developing*, and 0 to 0.5 *unsatisfactory*. Attainment of Student Outcome 7 is defined as 70% or more of students being in the *satisfactory* or *exemplary* categories and no more than 10% being in the *unsatisfactory* or *developing* categories. Table 2 shows that Student Outcome 7 was attained based on these criteria.

Table 2: Assessment data.

Performance	Range	Count
Exemplary	$(2.5, 3.0]$	5
Satisfactory	$(1.5, 2.5]$	3
Developing	$(0.5, 1.5]$	0
Unsatisfactory	$[0.0, 0.5]$	0

Groups' Names ______________________ **Title _________________**
Evaluator's Name ____________________ **Date _________________**

EE 471 Midterm Proposal Evaluation Sheet

Introduction

Abstract / Motivation / Background Research _____ / 15

Problem Statement and Proposed Solution _____ / 10

Body

General Design Philosophy and Alternatives _____ / 10

Figures / Tables / Diagrams / Flowcharts _____ / 5

Detailed Description of Design / Testing Plan _____ / 10

Technical Soundness / Complexity of Project _____ / 5

Costs / Power Budget _____ / 5

Constraints / Challenges / Ethical Considerations _____ / 5

Conclusion

Summary _____ / 5

Future Work Plan / Detailed Timeline _____ / 10

General

Organization and Flow _____ / 5

Grammar / Spelling/ Overall Writing _____ / 5

Formatting _____ / 5

References _____ / 5

Other Factors: _____ / ±5[*]

Comments:

Total **_____ / 100**

[*] Usually this will be 0 unless there is an exceptional case

Groups' Names ________________________ **Title ___________________**
Evaluator's Name ______________________ **Date ___________________**

EE 471 Final Proposal Evaluation Sheet

Introduction

Abstract / Motivation / Background Research	_____ / 15
Problem Statement and Proposed Solution	_____ / 10

Body

General Design Philosophy and Alternatives	_____ / 10
Figures / Tables / Diagrams / Flowcharts	_____ / 5
Detailed Description of Design / Testing Plan	_____ / 10
Technical Soundness / Complexity of Project	_____ / 5
Costs / Power Budget	_____ / 5
Constraints / Challenges / Ethical Considerations	_____ / 5

Conclusion

Summary	_____ / 5
Future Work Plan / Detailed Timeline	_____ / 10

General

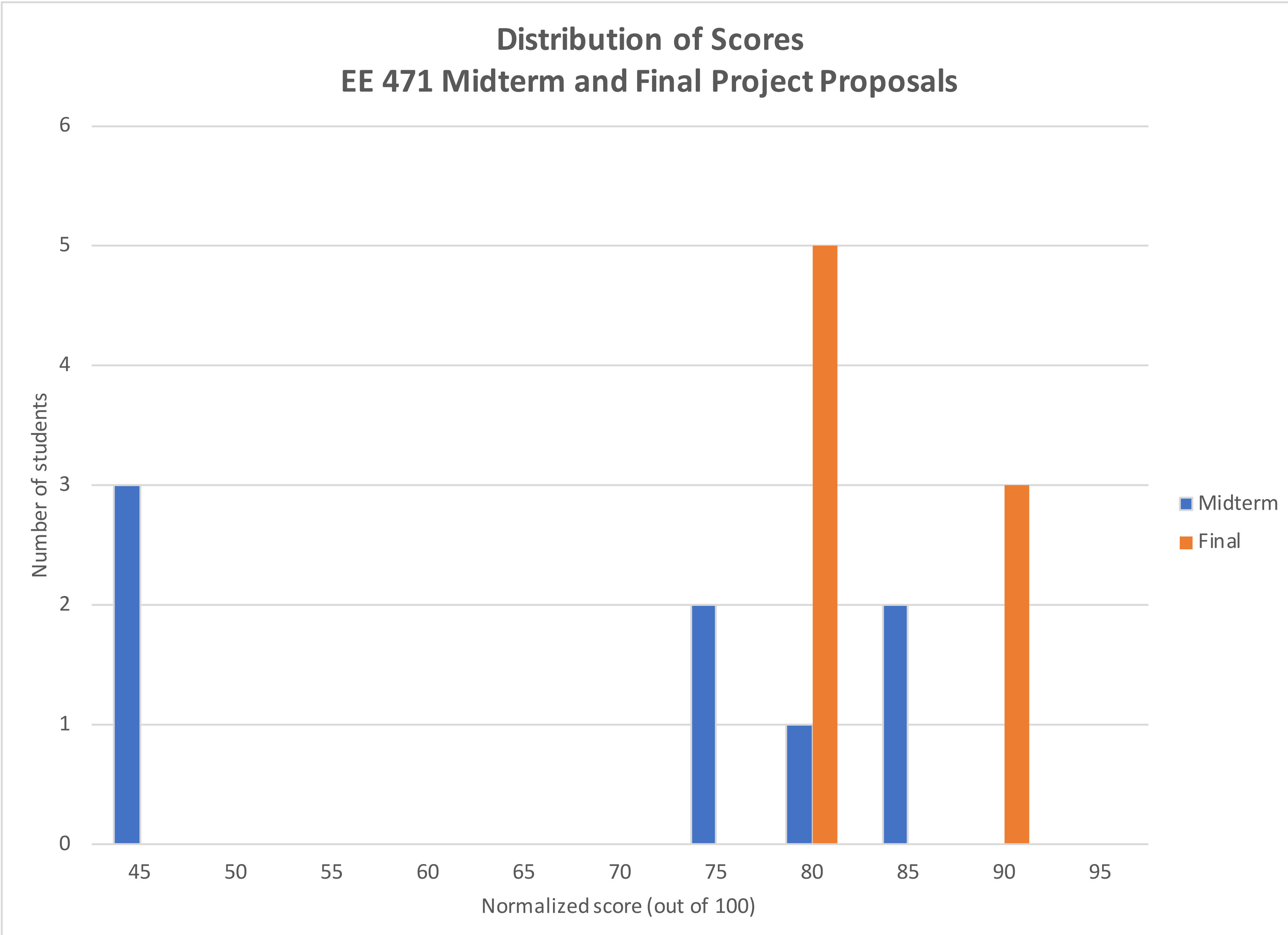
Organization and Flow	_____ / 5
Grammar / Spelling/ Overall Writing	_____ / 5
Formatting	_____ / 5
References	_____ / 5

Other Factors: _____ / ±5*

Comments:

Total **_____ / 100**

* Usually this will be 0 unless there is an exceptional case


Distribution of Scores
EE 471 Midterm and Final Project Proposals
Number of students
0
1
2
3
4
5
6
45
50
55
60
65
70
75
80
85
90
95
Normalized score (out of 100)
Midterm
Final

Out of	Midterm	Final	Normalized Midterm	Normalized Final
25	21.5	22.5	86	90
	21.5	22.5	86	90
	19	21	76	84
	19	21	76	84
	12	20.5	48	82
	12	20.5	48	82
	12	20.5	48	82
	21	22.5	84	90
Averages	17.25	21.375	69	85.5
Percent Change	19.29824561		Standard Deviation	3.817254062

0-3 Scale Final	x-axis	y-axis Midterm	y-axis Final		Points
2.7	45	3	0		25
2.7	50	0	0		
2.52	55	0	0		
2.52	60	0	0		
2.46	65	0	0		
2.46	70	0	0		
2.46	75	2	0		
2.7	80	1	5		
	85	2	0		
	90	0	3		
	95	0	0		
	count	8			

Assessment of Student Outcome (7) in EE 472

Instructor: Xichen Jiang

Assessor: Xichen Jiang

Assessment Quarter and Year: Winter 2019

This report assesses Student Outcome (7), "an ability to acquire and apply new knowledge as needed, using appropriate learning strategies." The EE program at Western Washington University assessed this outcome in part using student performance in EE 472. This document describes the background, details, and rubric for this outcome assessment and also provides the actual data and data analysis.

Background

EE 472 is the second course in a three course sequence in which students research, design, and implement an energy related project. In this course, the students focus on the development and implementation of the project. The measure selected for the assessment is from the Initial Design Report **Introduction** scores the students received (see attached rubric). The students were graded out of 10 points for a) performing a thorough background research of existing technology and justifying the need for the proposed project, and b) formulating a viable project design and plan.

Assessment Data

A histogram of the student scores from the Initial Design Report **Introduction** is shown in Figure 1. It is worth noting that all students within the same group received the same scores.

Discussion

The scores for the Initial Design Report **Introduction** were scaled down to 0 through 3 for this assessment. Scores above 2.5 is defined as *exemplary*, 1.5 to 2.5 *satisfactory*, 0.5 to 1.5 *developing*, and 0 to 0.5 *unsatisfactory*. Attainment of Student Outcome 7 is defined as 70% or more of students being in the *satisfactory* or *exemplary* categories and no more than 10% being in the *unsatisfactory* or *developing* categories. Table 1 shows that Student Outcome 7 was attained based on these criteria.

Table 1: Assessment data.

Performance	Range	Count
Exemplary	$(2.5, 3.0]$	6
Satisfactory	$(1.5, 2.5]$	2
Developing	$(0.5, 1.5]$	0
Unsatisfactory	$[0.0, 0.5]$	0

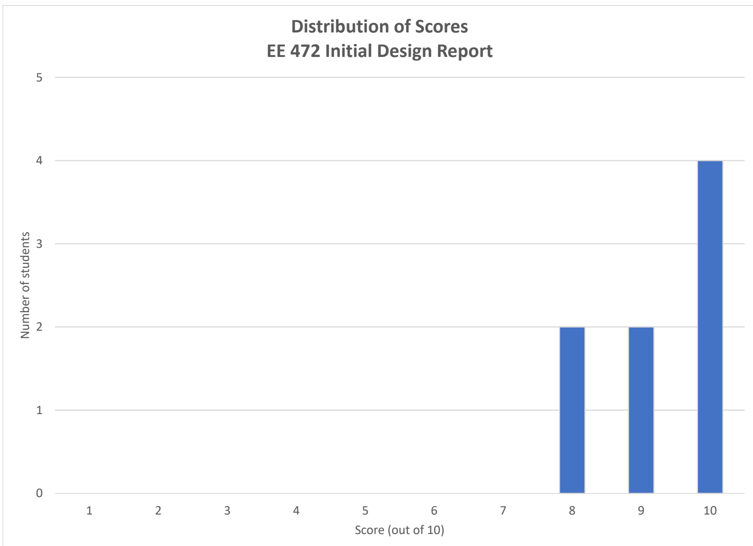


Figure 1: Score distribution.

Groups' Names ______________________ **Title _________________**
Evaluator's Name ____________________ **Date _________________**

EE 472 Initial Design Report Evaluation Sheet

Introduction

Motivation / Background Research	_____ / 5
Problem Statement and Proposed Solution	_____ / 5

Body

General Design Philosophy and Alternatives	_____ / 5
Equations / Figures / Tables / Diagrams / Flowcharts	_____ / 10
Detailed Description of Design	_____ / 25
Simulation / Testing Results	_____ / 13
Technical Soundness / Complexity of Project	_____ / 5
Constraints: Cost, Power Budget, Etc.	_____ / 5

Conclusion

Summary	_____ / 5
Ethical Considerations	_____ / 2
Future Work Plan / Timeline	_____ / 10

General

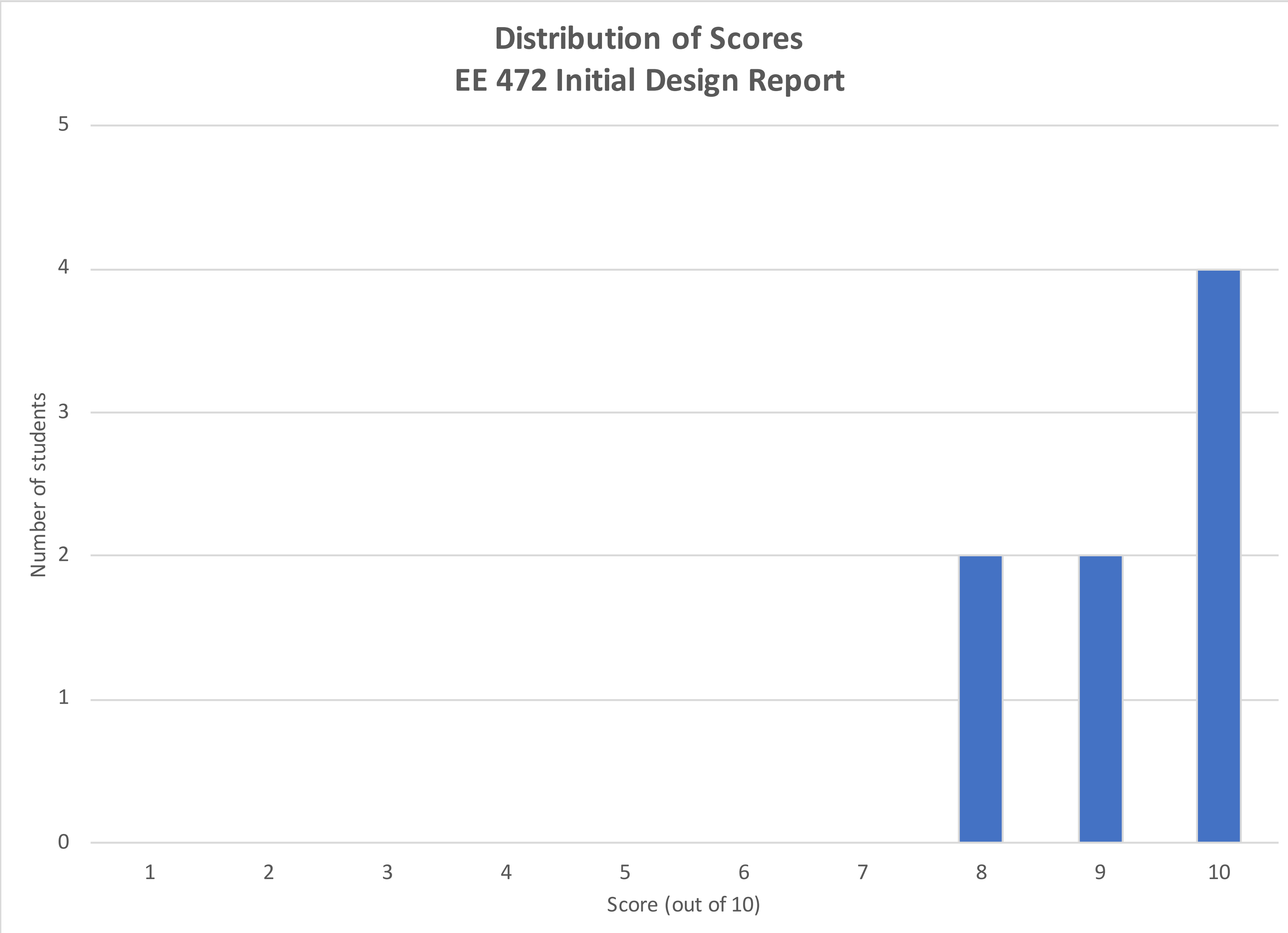
Organization and Flow	_____ / 5
Grammar / Spelling / Overall Writing	_____ / 5
Formatting	_____ / 5
References	_____ / 5

Other Factors: _____ / ±10*

Comments:

Total **_____ / 110**

* Usually this will be 0 unless there is an exceptional case



Distribution of Scores
EE 472 Initial Design Report
Number of students
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
Score (out of 10)

Out of	Scores	0-3 Scale	x-axis	y-axis
10	10	3	1	0
	10	3	2	0
	10	3	3	0
	10	3	4	0
	8	2.4	5	0
	8	2.4	6	0
	9.5	2.85	7	0
	9.5	2.85	8	2
			9	2
			10	4
Average	9.375		count	8

Assessment of Student Outcome (7) in EE 473

Instructors: Xichen Jiang, Amr Radwan

Assessors: Xichen Jiang, Amr Radwan

Assessment Quarter and Year: Spring 2019

This report assesses Student Outcome (7), "an ability to acquire and apply new knowledge as needed, using appropriate learning strategies." The EE program at Western Washington University assessed this outcome in part using student performance in EE 473. This document describes the background, details, and rubric for this outcome assessment and also provides the actual data and data analysis.

Background

EE 473 is the final course in a three course sequence in which students research, design, and implement an energy related project. In this course, the students focus on the implementation of the project. The measure selected for the assessment is the Final Project Demonstration scores the students received (see attached rubric). The students were graded out of 52 points for the successful completion of their project.

Assessment Data

A histogram of the student scores (normalized to 100) for the Final Project Demonstration is presented in Figure 1. It is worth noting that all students within the same group received the same scores.

Discussion

The scores for the Final Project Demonstration were scaled down to 0 through 3 for this assessment. Scores above 2.5 is defined as *exemplary*, 1.5 to 2.5 *satisfactory*, 0.5 to 1.5 *developing*, and 0 to 0.5 *unsatisfactory*. Attainment of Student Outcome 7 is defined as 70% or more of students being in the *satisfactory* or *exemplary* categories and no more than 10% being in the *unsatisfactory* or *developing* categories. Table 1 shows that Student Outcome 7 was attained based on these criteria.

Table 1: Assessment data.

Performance	Range	Count
Exemplary	$(2.5, 3.0]$	8
Satisfactory	$(1.5, 2.5]$	0
Developing	$(0.5, 1.5]$	0
Unsatisfactory	$[0.0, 0.5]$	0

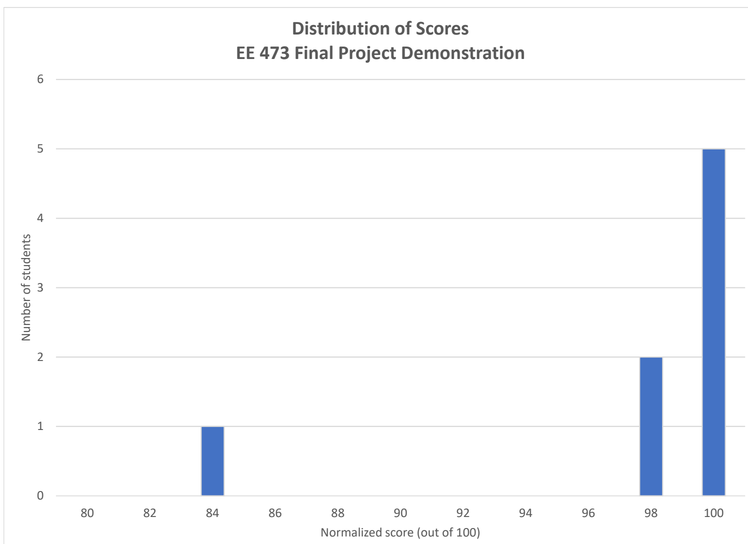


Figure 1: Score distribution.

Presenters' Names ____________________ **Title _________________**
Evaluator's Name (write on back of this page) **Date _________________**

EE 473 Final Presentation / Demonstration Evaluation Sheet

Presentation

Professionalism	_____ / 3
Clarity in Delivery	_____ / 6
Technical Soundness	_____ / 3
Organization of Slides	_____ / 6
Equations / Simulations / Testing Results	_____ / 6
Figures / Tables	_____ / 3
Schematics / Diagrams / Flowcharts	_____ / 5
Ability to Answer Questions	_____ / 6

Demonstration

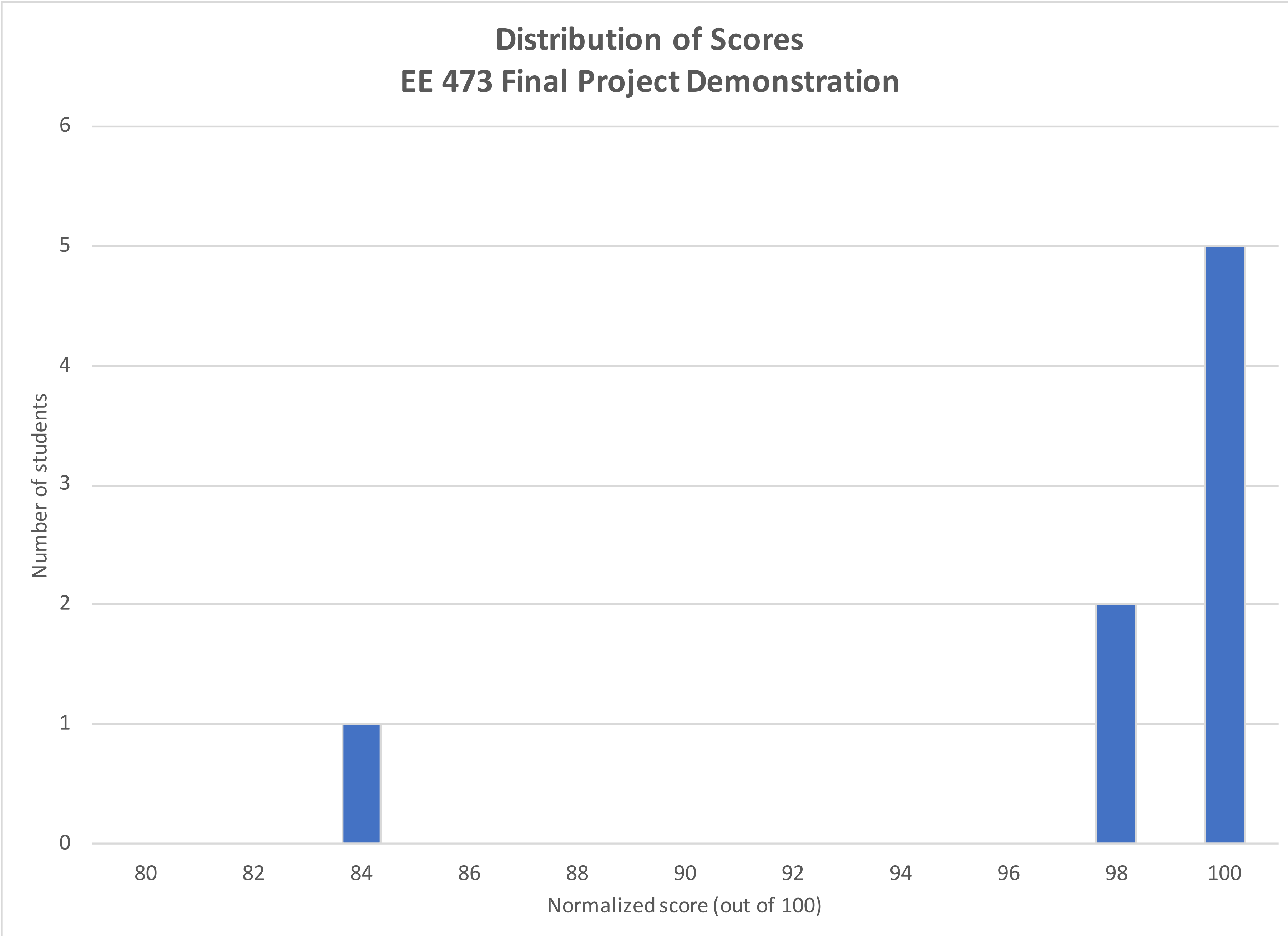
System Functionality / Completion of Project	_____ / 30
Explanation for Problems / Issues / Challenges	_____ / 12
Complexity of Project	_____ / 10

Other Factors: _____ / ±5*

Comments (please write on the back of this page if you want to remain anonymous):

Total **_____ / 90**

* Usually this will be 0 unless there is an exceptional case.


Distribution of Scores
EE 473 Final Project Demonstration
Number of students
0
1
2
3
4
5
6
80
82
84
86
88
90
92
94
96
98
100
Normalized score (out of 100)

Out of	Scores	Normalize score	0-3 Scale	x-axis	y-axis
52	51	98.07692308	2.942307692	80	0
	51	98.07692308	2.942307692	82	0
	44	84.61538462	2.538461538	84	1
	52	100	3	86	0
	52	100	3	88	0
	52	100	3	90	0
	52	100	3	92	0
	52	100	3	94	0
				96	0
				98	2
				100	5
Average		97.59615385		count	8

Appendix F

Advising and Promotional Materials

2021-2022 Academic Year

Electrical and Computer Engineering, BS

Electronics Concentration

(students graduating 2022 or 2023)

WESTERN WASHINGTON UNIVERSITY
ENGINEERING AND DESIGN

ABET accredited
Course offerings subject to change
Major credits: 146 (not including GURs)

Admissions information - https://engineeringdesign.wwu.edu/
Academic advising available - see contact information below
Pre-major coursework in grey area.
Courses in **BOLD** required to apply to full major.

	Fall	Winter	Spring
First Year	**MATH 124 (5) Calculus I**	**MATH 125 (5) Calculus II**	**APPLY TO MAJOR**
	PHYS 161 (5) Physics w/ Calc I	**PHYS 162 (5) Physics w/ Calc II**	**EECE 111 Circuits Analysis I**
	CSCI 140 or 141 (4) Programm. Fundamen.	**EECE 108 & 109 (2) Intro to Elect. & Comp**	**MATH 204 (4) Linear Algebra**
	ENGR 101 (2) Engineering, Design, Society	CHEM 161 (5) General Chemistry I	PHYS 163 (5) Physics w/ Calc III

ENGR 101 is optional but highly recommended

	Fall	Winter	Spring
Second Year	**MAJOR COURSES BEGIN**	EECE 220 (4) Electronics I	EECE 310 (4) Continuous Systems
	EECE 210 (4) Circuit Analysis II	EECE 244 (4) Embedded Microcontrollers	EECE 333 (4) or EECE 397A (4)
	EECE 233 (4) Digital Electronics	MATH 331 (4) Differential Equations	MATH 345 (4) Engineering Statistics
	MATH 224 (5) Multivariable Calculus		
Third Year	EECE 311 (4) Discrete Systems	EECE 360 (4) Communication Systems	EECE 433 (4) Digital Signal Processing
	EECE 344 (4) Embedded Microcontrollers II	EECE 444 (4) Embedded Systems	EECE 460 (4) Digital Comm. Systems
	EECE 320 (4) Electronics II	EECE 321 (4) or EECE 397B (4)	EECE 361 (4) or 397A (4) or 397C (4)
Fourth Year	EECE 372 (4) Electromechanical Devices	EECE 492 (4) Project Hardware Design	EECE 493 (4) Project System Implementation
	EECE 480 (4) Control Systems	ENG 302 (WP) Technical Writing	Tech Elective
	EECE 491 (2) Project Proposal	Tech Elective	

Engineering & Design
516 High Street, Bellingham, WA 98229
ENGD@wwu.edu | 360.650.3380
http://engineeringdesign.wwu.edu

Pre-major Advisor:
Lisa Ochs lisa.ochs@wwu.edu

NOTES & EXCEPTIONS

Pre-majors apply for the major at the end of spring and/or summer quarters
Students not enrolled in MATH 124 and PHYS 161 fall quarter may not finish in four years
Math 341 may be substituted for MATH 345; CSCI 141 may be substituted for CSCI 140
Must complete three of the six courses: EECE 321, 333, 361, 397A, 397B, or 397C
Students must complete General University Requirements in addition to major courses

Electrical and Computer Engineering, BS
Electronics Concentration

WESTERN WASHINGTON UNIVERSITY
ENGINEERING AND DESIGN

Admissions

Students must first be accepted by the university. The program accepts major applications at the end of spring and summer quarters. Accepted students start major coursework fall quarter.

Required coursework to apply

MATH 124	Calculus II
MATH 125	Calculus II
MATH 204	Linear Algebra
PHYS 161	Physics w/ Calc I
PHYS 162	Physics w/ Calc II
CSCI 140 or 141	Programming Fundamentals
EECE 111	Circuit Analysis I
EECE 108/109*	Intro to Electrical & Computer Engineering

* may be waived for transfer student admissions

EECE 108 must be taken at next opportunity

Other courses considered, but not required to apply

MATH 224	Multivariable Calc and Geometry I
MATH 331	Differential Equations
MATH 345	Engineering Statistics
PHYS 163	Physics w/ Calc III
CHEM 161	General Chemistry I

Required questionnaire

Applications will include a required questionnaire. The questionnaire will ask about the applicant's goals, demonstrated leadership experiences, collaboration and teamwork examples, strategies for studying, and ability to overcome adversity.

Applications due

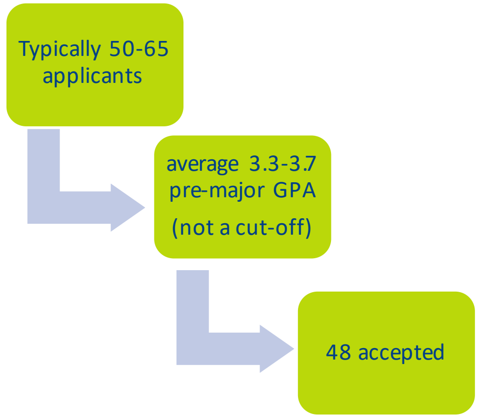
Applications are accepted at the end of every spring quarter and the beginning of fall quarter. Accepted students start major coursework fall quarter. See department website for specific dates.

Transfer students

Transfer students are encouraged to contact the pre-major advisor to discuss equivalencies and transfer timing.

Admissions statistics

The program typically accepts 48 students annually; 36 Electronics and 12 Energy students.



Technical Electives

Majors are required to complete 6 credits of technical electives before graduation. Check the website for approved courses.

Faculty Contact Information

Associate Professor Xichen Jiang, jiangx2@wwu.edu
Assistant Professor Junaid Khan, khanj@wwu.edu
Professor Andy Klein, kleina5@wwu.edu
Associate Professor Ying Lin, liny4@wwu.edu
Associate Professor John Lund, lundj9@wwu.edu
Professor Todd Morton, toddm@wwu.edu
Assistant Professor Amr Radwan, radwana@wwu.edu
Assistant Professor Bhaskar Ramasubramanian, ramasub@wwu.edu

updated: October 2021

2021-2022 Academic Year

Electrical and Computer Engineering, BS

Energy Concentration

(students graduating 2022 or 2023)

Western Washington University — Engineering and Design

ABET accredited
Course offerings subject to change
Major credits: 146 (not including GURs)

Admissions information - https://engineeringdesign.wwu.edu/
Academic advising available - see contact information below
Pre-major coursework in grey area.
Courses in **BOLD** required to apply to full major.

	Fall	Winter	Spring
First Year	**MATH 124 (5) Calculus I**	**MATH 125 (5) Calculus II**	**APPLY TO MAJOR**
	PHYS 161 (5) Physics w/ Calc I	**PHYS 162 (5) Physics w/ Calc II**	**MATH 204 (4) Linear Algegra**
	CSCI 140 or 141 (4) Programm. Fundamen.	**EECE 108 & 109 (2) Intro to Elect. & Comp**	**EECE 111 (4) Circuit Analysis I**
	ENGR 101 (2) Engineering, Deisgn, Society	CHEM 161 (5) General Chemistry I	PHYS 163 (5) Physics w/ Calc III
	ENGR 101 is optional but highly recommended		
Second Year	**MAJOR COURSES BEGIN**	EECE 220 (4) Electronics I	EECE 310 (4) Continuous Systems
	EECE 210 (4) Circuit Analysis II	EECE 244 (4) Embedded Microcontrollers	ECON 206 (4) Microeconomics
	EECE 233 (4) Digital Electronics	MATH 331 (4) Differential Equations	MATH 345 (4) Engineering Statistics
	MATH 224 (5) Multivariable Calculus	ENRG 380 (4) Energy & Environment F or W	
Third Year	EECE 372 (4) Electromechanical Devices	EECE 374 (4) Energy Processing	EECE 378 (4) Smart/Renewable Power
	EECE 344 (4) Embedded Microcontrollers II	EECE 360 (4) Communication Systems	ENRG 386 (4) Electricity Economics
	EECE 320 (4) Electronics II	EECE 444 (4) Embedded Systems	EECE 361 (4) or EECE 397A (4) or EECE 397C (4)*
	ENRG 320 (4) Energy Science (fall or winter)	EECE 397B (4) Machine Learning*	
Fourth Year	ENG 302 (5) (WP) Technical Writing	EECE 472 (4) Project Research and Develop.	EECE 473 (4) Project Implementation
	EECE 480 (4) Control Systems	Tech Elective	Tech Elective
	EECE 471 (2) Project Proposal		

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http://engineeringdesign.wwu.edu

Pre-major Advisor:
Lisa Ochs lisa.ochs@wwu.edu

Notes and Exceptions

Pre-majors apply for the major at the end of spring and/or summer quarters
Students not enrolled in MATH 124 and PHYS 161 fall quarter may not finish in four years
Math 341 may be substituted for MATH 345; CSCI 141 may be substituted for CSCI 140
*Must complete one of four courses: EECE 361, EECE 397A, EECE 397B, or EECE 397C
Studens must complete General Univesity Requirements in addtion to major courses

Electrical and Computer Engineering, BS
Energy Concentration

WESTERN WASHINGTON UNIVERSITY
ENGINEERING AND DESIGN

Admissions

Students must first be accepted by the university. The program accepts major applications at the end of spring and summer quarters. Accepted students start major coursework fall quarter.

Required coursework to apply

MATH 124	Calculus II
MATH 125	Calculus II
MATH 204	Linear Algebra
PHYS 161	Physics w/ Calc I
PHYS 162	Physics w/ Calc II
CSCI 140 or 141	Programming Fundamentals
EECE 111	Circuit Analsis I
EECE 108/109*	Into to Electrical and Computer Engineering

*may be waived for transfer student admissions

EECE 108 must be completed at next opportunity

Other courses considered, but not required to apply

MATH 224	Multivariable Calc and Geometry I
MATH 331	Differential Equations
MATH 345	Engineering Statistics
PHYS 163	Physics w/ Calc III
CHEM 161	General Chemistry I

Required questionnaire

Applications will include a required questionnaire. The questionnaire will ask about the applicant's goals, demonstrated leadership experiences, collaboration and teamwork examples, strategies for studying, and ability to overcome adversity.

Applications due

Applications are accepted at the end of every spring quarter and the beginning of fall quarter. Accepted students start major coursework fall quarter. See department website for specific dates.

Transfer students

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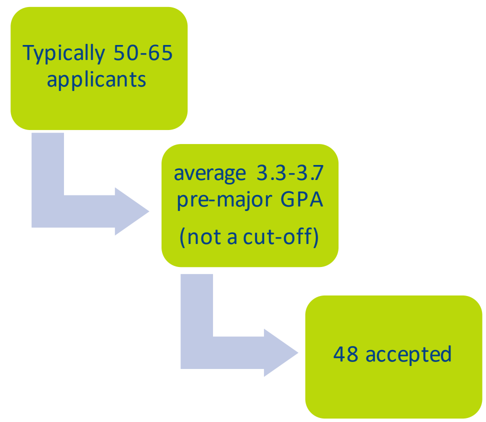

Technical Electives

Majors are required to complete 6 credits of technical electives before graduation. Check the website for approved courses.

Faculty Contact Information

Associate Professor Xichen Jiang, jiangx2@wwu.edu
Assistant Professor Junaid Khan, khanj@wwu.edu
Professor Andy Klein, kleina5@wwu.edu
Associate Professor Ying Lin, liny4@wwu.edu
Associate Professor John Lund, lundj9@wwu.edu
Professor Todd Morton, toddm@wwu.edu
Assistant Professor Amr Radwan, radwana@wwu.edu
Assistant Professor Bhaskar Ramasubramanian, ramasub@wwu.edu

updated: October 2021

EECE Advising Form
Electronics Concentration – Class of 2023

Student Name:
W #:
Anticipated Quarter of Completion: Spring 2023

Instructions: Enter your grades for each of the courses you have completed below. If you did not complete the course in the quarter indicated under "Normal Plan", indicate the grade and quarter under "Variations". For courses you have not yet taken, either put an asterisk (*) in for the grade if you plan to take it on the normal schedule or note any planned deviations from the normal schedule under "Variations".

	Normal Plan		Variations		
Course - Description	**Term**	**Grade**	**Term**	**Grade**	**Notes**
EECE Core (54crs)					
EECE 108 - Intro to EECE Seminar	W20				
EECE 109 - Intro to EECE Lab	W20				
EECE 111 - Circuit Analysis I	SP20				
EECE 210 - Circuit Analysis II	F20				
EECE 220 - Electronics I	W21				
EECE 233 - Digital Electronics	F20				
EECE 244 - Embedded Microcontrollers I	W21				
EECE 310 - Continuous Systems	SP21				
EECE 320 - Electronics II	F21				
EECE 344 - Embedded Microcontrollers II	F21				
EECE 360 - Communication Systems	W22				
*EECE 361 - Signal Propagation	SP22				Can take 397A (SP), 397B (W), or 397C (SP) instead
EECE 372 - Elec. Power and EM Devices	F22				
EECE 444 - Embedded Systems	W22				
EECE 480 - Control Systems	F22				
Electronics Concentration (30crs)					
EECE 311 - Discrete Systems	F21				
*EECE 321 - Electronic Systems	W22				Can take 397A (SP), 397B (W), or 397C (SP) instead
*EECE 333 - Digital Systems	SP21				Can take 397A (SP), 397B (W), or 397C (SP) instead
EECE 433 - Digital Signal Processing	SP22				
EECE 460 - Digital Communications	SP22				
EECE 491 - Project Proposal	F22				
EECE 492 - Project Hardware Design	W23				
EECE 493 - Project System Implementation	SP23				
Technical Electives (Minimum 6crs)					
Supporting Courses (56crs)					
CHEM 161 - General Chemistry I	F19				
CSCI 140 - Programming Fundamentals	W20				
MATH 124 - Calculus & Analytic Geometry I	F19				
MATH 125 - Calculus & Analytic Geometry II	W20				
MATH 204 - Linear Algebra	SP20				
MATH 224 - Multi Calculus and Geometry I	F20				
MATH 331 - Differential Equations	W21				
MATH 345 - Engineering Statistics	SP21				
PHYS 161 - Physics w/ Calculus I	F19				
PHYS 162 - Physics w/ Calculus II	W20				
PHYS 163 - Physics w/ Calculus III	SP20				
ENG 302 - Technical Writing	SP22				

Advisor Signature: ______________________ **Date:**__________________________________

Student Signature: ______________________ **Date:**__________________________________

EECE Advising Form
Energy Concentration – Class of 2023

Student Name:
W #:
Anticipated Quarter of Completion: Spring 2023

Instructions: Enter your grades for each of the courses you have completed below. If you did not complete the course in the quarter indicated under “Normal Plan”, indicate the grade and quarter under “Variations”. For courses you have not yet taken, either put an asterisk (*) in for the grade if you plan to take it on the normal schedule or note any planned deviations from the normal schedule under “Variations”.

	Normal Plan		**Variations**		
Course - Description	**Term**	**Grade**	**Term**	**Grade**	**Notes**
EECE Core (54crs)					
EECE 108 - Intro to EECE Seminar	W20				
EECE 109 - Intro to EECE Lab	W20				
EECE 111 - Circuit Analysis I	SP20				
EECE 210 - Circuit Analysis II	F20				
EECE 220 - Electronics I	W21				
EECE 233 - Digital Electronics	F20				
EECE 244 - Embedded Microcontrollers I	W21				
EECE 310 - Continuous Systems	SP21				
EECE 320 - Electronics II	F21				
EECE 344 - Embedded Microcontrollers II	F21				
EECE 360 - Communication Systems	W22				
*EECE 361 - Signal Propagation	SP22				Can take 397A (SP), 397B (W), or 397C (SP) instead
EECE 372 - Elec. Power and EM Devices	F21				
EECE 444 - Embedded Systems	W22				
EECE 480 - Control Systems	F22				
Energy Concentration (30crs)					
EECE 374 - Energy Processing	W22				
EECE 378 - Smart and Renewable Power	SP22				
EECE 471 - Energy Project Proposal	F22				
EECE 472 - Energy Project R&D	W23				
EECE 473 - Energy Project Implementation	SP23				
ENRG 320 - Energy Resources & Proc	W22				
ENRG 386 - Economics of Elec. Mkts	SP22				
ENRG 380 - Energy and Environment	F20				
Technical Electives (Minimum 6crs)					
Supporting Courses (60crs)					
CHEM 161 - General Chemistry I	F19				
CSCI 140 - Programming Fundamentals	W20				
ECON 206 - Microeconomics	SP21				
MATH 124 - Calculus & Analytic Geometry I	F19				
MATH 125 - Calculus & Analytic Geometry II	W20				
MATH 204 - Linear Algebra	SP20				
MATH 224 - Multi Calculus and Geometry I	F20				
MATH 331 - Differential Equations	W21				
MATH 345 - Engineering Statistics	SP21				
PHYS 161 - Physics w/ Calculus I	F19				
PHYS 162 - Physics w/ Calculus II	W20				
PHYS 163 - Physics w/ Calculus III	SP20				
ENG 302 - Technical Writing	F22				

Advisor Signature: ______________________ **Date:**_________________________________

Student Signature: ______________________ **Date:**_________________________________

Electrical and Computer Engineering

"WWU's EECE program is an intense yet thoroughly rewarding program. It is a lab-based curriculum rather than one purely focused on theory."

Riley Hernandez, Class of 2020
Electrical Engineer, Anvil Corp.

ABET Accredited | 146 credits | Bachelor of Science

By the Numbers

48 majors admitted per year

9 full-time faculty

24-48 class sizes, most with associated lab

95% alumni employed or in graduate school

$74,000 average starting salary

Why study EECE at WWU?

- Hands-on curriculum culminating in a year-long design project
- Cohort-based with small class sizes
- Individualized, student-centered instruction
- State-of-the-art teaching laboratories with modern, industry-standard equipment
- Leads to a job using creativity to design and improve systems, products, and technologies
- New building scheduled for completion in 2024!

Electrical and Computer Engineering

Get Involved

Students have the opportunity to conduct novel research alongside faculty who are recognized experts in such areas as:

- embedded systems
- power systems
- renewable energy and smart grids
- connected autonomous vehicles
- artificial intelligence

Hands-on Learning

Western's engineering programs have long been known for their strong emphasis in hands-on learning. Nearly every course in the EECE program provides laboratory experience. Throughout the entire curriculum, students are continually prompted to apply the theory learned in the classroom by designing, testing, and experimenting in the lab with real hardware and instrumentation.

Admissions

- Spend year one as a pre-major
- Apply to major at the end of year one
- 48 new majors admitted annually

Sample job placements
Fluke - Hardware Engineer
Powin Energy - Systems Ops. Engineer
Boeing - Lead Avionics Engineer
PACCAR - Embedded Software Engineer

Contact information
Engineering & Design Department
Western Washington University
516 High Street
MS 9086
Bellingham, WA 98225

360.650.3380
ENGD@wwu.edu

What our alumni say

"If you're willing to work hard, you'll go far. Don't be afraid to ask for help, it's all around you in this program. There is a strong sense of community at Western and it is a really valuable experience if you embrace it."

Evan Sacker, Class of 2021
System Operations Engineer, Powin Energy

"Deciding to study EECE at WWU was one of the best choices I have ever made. Phenomenal faculty, hands on lab experiences, and engaging research opportunities are just a portion of what makes the program so incredible. I can say without a doubt that this amazing program has made me the person I am today."

Arick Grootveld, Class of 2021
Graduate student, Syracuse University

Engineering & Design

WESTERN WASHINGTON UNIVERSITY

Active Minds Changing Lives

WHAT SETS US APART

Small class sizes

Hands on experiential learning

Undergraduate research opportunities

Connections with industry partners

Engineering & Design

College of Science & Engineering

WESTERN WASHINGTON UNIVERSITY

Electrical Engineering, BS

The Electrical Engineering major prepares graduates to conduct research, and design, develop, test and oversee the development of electronic systems and the manufacture of electrical and electronic equipment and devices. This includes a broad range of applications and specializations that generally involve both hardware and software—areas such as power systems, communications, analog and digital signal processing, embedded systems, and control systems. This major offers two concentrations; Electronics and Energy. The program is accredited by the Engineering Accreditation Commission of ABET.

Manufacturing Engineering, BS

The Manufacturing Engineering major prepares graduates to work in different manufacturing practices and includes research, design, and development of systems, processes, tools and equipment. A Manufacturing Engineer's focus is to turn raw materials into a new or updated product in the most economic and efficient way possible. Manufacturing Engineers get opportunities to be innovative in design and manufacturing that can lead to patenting and start-up companies. This program develops these skills with the help of intensive laboratory components spread throughout its courses. The program is accredited by the Engineering Accreditation Commission of ABET.

Plastics & Composites Engineering, BS

The Plastics & Composites Engineering major prepares graduates to develop, process, and test materials used to create a range of polymer products from computer chips to aircraft wings. Extensive laboratory experience in design, materials, processing, economics, testing, and analysis is a crucial part of the hands-on curriculum. Sustainable design and materials development is increasingly emphasized. Through these experiences, students learn to apply theoretical knowledge learned in the classroom to solve practical, application-based problems in industry. The program is accredited by the Engineering Accreditation Commission of ABET.

Industrial Design, BS

The Industrial Design program prepares graduates to begin work as professional designers in corporate, consulting, or entrepreneurial positions. Students learn creative problem-solving methodologies, user-centered design, drawing and rendering skills, three dimensional model-making techniques, materials, manufacturing processes, ergonomics, design principles, and design thinking. These skills and techniques are applied in the design of many products that comprise a student's portfolio. The program is accredited through the National Association of Schools of Art and Design (NASAD).

Industrial Technology-Vehicle Design, BS

This program will be placed in moratorium beginning Fall 2019 and is no longer accepting new students. Students are encouraged to seek advising about other opportunities in the department.

Ross Engineering Building 360.650.3380 cse.wwu.edu/engd

STUDENT CLUBS

There are many student clubs affiliated with the Engineering & Design Department. Student Clubs provide excellent professional development and networking opportunities. Students are strongly encouraged to participate.

INTERNSHIPS

Although not required, internships offer an invaluable way to gain work experience, sample potential career areas, and help build a resume and/or a portfolio. Students are encouraged and assisted with applying for internships. Attending career fairs and participating in field trips are a good way to get in touch with employers.

RESEARCH OPPORTUNITIES

Students have numerous opportunities to participate in interdisciplinary projects and undergraduate research with faculty. Additionally, students can choose to work on projects directly with industry partners as part of their coursework.

Why Western Washington University?

Western's Engineering & Design programs place an emphasis on practical, hands-on laboratory experiences, in addition to strong theoretical course work. Each program's curriculum is designed with input from an industrial advisory committee to prepare graduates for professional positions in industry.

Where are our graduates working?

Graduates of the programs have consistently been placed in positions appropriate to their field of study.

Job titles of some of our graduates:

- Electronic Design Engineer
- Electrical Engineer
- Industrial Designer
- User Experience Designer
- Composite Design Engineer
- Manufacturing Planner
- Material Scientist
- Manufacturing Engineer
- Process Engineer
- Ski Boot Design Engineer
- Hardware Design Engineer
- Test Engineer

Recent graduates are employed by the following companies:

- ⇒ Alcoa
- ⇒ Architectural Elements
- ⇒ Boeing
- ⇒ Blue Origin
- ⇒ Fluke
- ⇒ Hexcel
- ⇒ Honeywell Aerospace
- ⇒ Janicki Industries
- ⇒ Microsoft
- ⇒ Nike
- ⇒ Oculus
- ⇒ PACCAR
- ⇒ R & D Plastics
- ⇒ Safran
- ⇒ SpaceX
- ⇒ Teague
- ⇒ Terex Corporation
- ⇒ Tesla Motors

Advising and Admissions

After acceptance to WWU, students start out as a **pre-major** and then **apply to their major of interest**. Our programs are competitive and require specific prerequisite courses. **Seek advising early from the pre–major advisor for curriculum questions and major admission requirements.**

Visiting Campus

To schedule a tour of the facilities and get advising questions answered in person, contact the pre-major advisor to schedule an appointment.

Lisa Ochs, Pre-major Advisor

360.650.4132 lisa.ochs@wwu.edu

Western Washington University does not discriminate on the basis of race, color, creed, religion, national origin, sex (including pregnancy and parenting status), disability, age, veteran status, sexual orientation, gender identity or expression, marital status or genetic information in its programs or activities.

Western Washington University

Bellingham, Washington

WESTERN WASHINGTON UNIVERSITY

Engineering & Design

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