ABET
Self-Study Report

for the

Bachelor of Science in Computer Engineering

program at

Weber State University

Ogden, Utah

June 2024

CONFIDENTIAL

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

BACKGROUND INFORMATION

A. Contact Information

Prof. Fon Brown, PhD
Chair, Department of Electrical and Computer Engineering
1465 Edvalson Street, Dept. 1803
Weber State University
Ogden, Utah 84408-1803

801-626-7781 (phone)
fonbrown@weber.edu

B. Program History

In 2010, the Utah State Board of Regents granted WSU a Bachelor of Science in Electronics Engineering to address the acute demand for electrical and electronics engineers in the Northern Utah aerospace industry. The new EE program was housed (along with an existing Associate of Pre-Engineering program) in the Department of Engineering, which was formed July 1, 2011 as part of a reorganization in the College of Applied Science and Technology.

Upon recommendation of the EE Industrial Advisory Board (IAB), the program name Electronics Engineering was changed in 2015 to Electrical Engineering to give the program better name recognition and to more accurately reflect its academic and professional content. The same year, the name of the college was changed to Engineering, Applied Science &Technology (EAST).

To help meet the acute demand for local graduates in Computer Engineering, two new engineering programs were added to the Department of Engineering in 2016, a BS in Computer Engineering and a MS in Computer Engineering.

The BS Computer Engineering (CE) degree was designed primarily from existing courses in Electrical Engineering and Computer Science. The CE degree was housed in the Department of Engineering, but the School of Computing was and still is closely involved because a significant portion of the curriculum is taught by Computer Science faculty. The creation of the CE degrees prompted a course prefix change to ECE for all EE and CE courses in the Department of Engineering.

In 2018 a BS Degree in Mechanical Engineering and an MS degree in Electrical Engineering was approved. In 2019, the Department of Engineering was split into the Department of Electrical and Computer Engineering and the Department of Mechanical Engineering. The Department of Electrical and Computer Engineering (ECE) retained the BS and MS degrees in both electrical and computer engineering while the department of Mechanical Engineering took control of the Pre-Engineering and the Mechanical Engineering degrees.

In 2022, a BS degree in Biomedical Engineering was approved and was housed in the ECE Department.

As of June 2024, the Computer Engineering program has produced 32 graduates...

C. Options

There are no special options, tracks or concentrations in the Computer Engineering program.

D. Program Delivery Modes

All Computer Engineering courses are taught in a traditional face-to-face lecture or lecture/laboratory format. Computer Engineering courses are typically taught during the day, but limited rotating day/evening course offerings facilitate the schedules of students who are employed full time.

The program has a required internship, ECE 3890, in which the student works at an engineering company off campus. The company, which is typically selected by the student, must be approved by program faculty.

E. Program Locations

All day-time and evening courses are offered at the main Ogden campus. The address of the Ogden campus is:

Weber State University
3750 Harrison Blvd.
Ogden, Utah 84408

The Department of Electrical and Computer Engineering office is located in Room 245 of the Noorda Engineering (NB) Building at the main Ogden campus.

F. Public Disclosure

Program Educational Objectives (PEOs), Student Outcomes (SOs), annual student enrollment and graduation data are posted annually on the Department of Electrical and Computer Engineering website: http://weber.edu/ece/abet.html.

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

2018 Evaluation

The WSU Electronics Engineering program received its first on-site accreditation visit September 30 through October 2, 2018. The accreditation team cited two weaknesses, which are quoted verbatim below from the ABET Final Statement.

Weakness 1
Criterion 2. Program Educational Objectives
"*This criterion requires that the program have published program educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies, and the engineering accreditation criteria. Program educational objectives are defined as broad statements that describe what graduates are expected to attain within a few years after graduation. Some of the published program educational objectives describe abilities that students have immediately upon graduation rather than what they are expected to attain within a few years after graduation. Therefore, the program lacks strength of compliance with this criterion*."

Corrective Action Taken

The program education objectives have been changed to align with the definition described in the criterion. They are broad statements consistent with the university mission, the mission of our college, and our constituencies. The updated PEOs reviewed and approved by the faculty and industrial advisory board are listed below:

> *The Objectives of the ECE undergraduate programs in Electrical and Computer Engineering are to educate graduates to become productive, accountable, and responsible professionals in engineering who will:*
> *1. apply their engineering skills, through theory and application, in industry, government, society, or in graduate school;*
> *2. practice high technical and ethical standards and communicate their work to colleagues, industry, and professional organizations;*
> *3. work effectively and contribute in interdisciplinary fields while encouraging expression and valuing diversity;*
> *4. understand the importance of lifelong learning and continuous professional growth in a changing world as shown through self-directed learning, specialized trainings, certifications, licensing, and graduate programs.*

Weakness 2

Criterion 4. Continuous Improvement

"*This criterion requires that the program regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program. The program's continuous improvement process includes the collection of some student outcomes data from courses taken by both electrical engineering and computer engineering students. It is not clear that the collected data were disaggregated and evaluated by program. As a result, the program is unable to reliably demonstrate the degree to which the student outcomes are being attained by electrical engineering students. Additionally, the lack of program-specific data could result in missed opportunities to identify changes that could lead to program improvements. Thus, strength of compliance with this criterion is lacking*."

Corrective Action Taken

The data on all evaluation instruments is now disaggregated by major to identify the level at which the students in each program are attaining the student outcomes. Courses are assessed independently for each major and the course assessment instruments now include the number of students for statistical significance. Internship and graduate surveys have been updated to include declared major. The data collected from these instruments is now organized and tracked by major.

GENERAL CRITERIA

CRITERION 1. STUDENTS

A. Student Admissions

New students who are accepted into the Computer Engineering Program fall into one of three general categories:

1. Recent high school graduates

2. Current students at WSU

3. Transfer students

Any student who wishes to major in Computer Engineering is first admitted to WSU. The university admission process is handled centrally. The student then meets with either the ECE advisor (See Section D, below) or the Computer Engineering Program Coordinator (an assigned faculty member who is given three credit hours of release time per semester to advise students). The advisor (or program coordinator) extensively uses *Cattracks*, a WSU computer-based degree evaluation and planning tool. *Cattracks* enables the advisor to track the student's progress toward graduation by showing the courses taken and grades received, courses still required, grade point average, transfer credits and other pertinent information. As a general rule, the ECE advisor works more closely with lower division students and the program coordinator works more closely with upper division students, but students may meet with either advisor depending on availability.

1. Recent high school graduates

A recent high school graduate who desires to major in Computer Engineering meets with the ECE advisor (or program coordinator) who determines the preparation of the student in college-level mathematics. If the student is not prepared to take college-level mathematics courses, developmental mathematics is required to bring the student up to the Calculus I level before the student can take the first course in circuits or the first course in physics. The advisor meets personally with the student to evaluate his or her academic record and to map a plan of course work. The Computer Engineering major is then officially declared on the student's record in the WSU Banner system.

2. Current students at WSU

Any current student, traditional or non-traditional, at WSU can be accepted into the Computer Engineering Program, as there are no special entrance requirements. However, like the recent high school graduate, if the student is not prepared to take college level mathematics courses, developmental mathematics is required to bring the student up to the Calculus I level before the student can take the first circuits course or the first calculus-based physics course.

The process for accepting recent high school graduates and current WSU students into the program is the same. Paying particular attention to previous courses taken in college level mathematics, the advisor (or program coordinator) meets personally with the student to evaluate his or her academic record and to map a plan of course work. The Computer Engineering major is then officially declared on the student's record in the WSU Banner system.

3. Transfer students

A student who transfers to WSU from another institution meets personally with the ECE advisor or program coordinator who evaluates the student's courses taken at the transfer institution(s). Particular attention is given to transfer courses in engineering, mathematics and science. The majority of transfer students come to WSU from institutions within Utah, where lower division courses transfer as part of a state-wide articulation agreement. If a student transfers from an institution outside Utah or the United States, the program coordinator (or the department chair if the program coordinator is not available) evaluates each course individually and may ask the student to provide course syllabi, textbooks or other materials to show equivalence with WSU courses. Once the transfer courses are recorded in *Cattracks*, the advisor or program coordinator maps a plan of course work for the student.

B. Evaluating Student Performance

Students are evaluated in each course they complete by assigning them a letter grade corresponding to a standard 0.0 to 4.0 scale. Grades are assigned by the course instructor. A grade of C (2.0) is required in all courses required by the major. If a student receives a grade of C− or lower in any of these courses, the student must repeat the course.

The program coordinator uses *Cattracks*, a WSU computer-based degree evaluation and planning tool, to monitor student progress. *Cattracks* is programmed to track student advancement in the declared major by showing which courses have been taken and which courses are still required for graduation. Because the WSU general catalog constitutes the official contract between the institution and student, *Cattracks* is programmed to precisely match the degree requirements stated in the student's contract-year catalog. Within *Cattracks* the program coordinator can perform course substitutions or forced completions if warranted. The program coordinator can also record dated notes in order to document advisement meetings with and recommendations to the student.

The program ensures that students meet prerequisites by integrating them directly into the Banner registration system. If a student attempts to register for a course without the prerequisite(s) stated in the catalog, the system will not allow the student to register for the course. However, the program coordinator can perform a prerequisite override if it is justified.

C. Transfer Students and Transfer Courses

Transfer students are admitted to WSU through the same admission process as new high school graduates, with the exception that transcripts from previously attended colleges and universities are included. The Utah State Board of Regents mandates a state-wide articulation in which specific courses transfer between the nine state-operated institutions.

Faculty in all disciplines from all nine institutions meet annually in the state-wide "Majors Meetings" to coordinate and maintain articulation agreements. In these annual meetings, engineering faculty focus on the articulation of lower division courses since these courses are common across all institutions, including the four-year schools and community colleges. Faculty strive to maintain consistency in the content and course number for every lower division engineering course, assuring a smooth transfer of credit when a student transfers from one state institution to another. State institutions maintain articulation lists that define course equivalencies.

D. Advising and Career Guidance

Academic Advising

The ECE advisor (a college advisor from the Dean's office assigned to the department of Electrical and Computer Engineering) is the primary advisor for lower division students (freshmen and sophomores). In the event that the ECE advisor is unavailable, there is also a backup advisor (also from the Dean's office) who is trained for the Computer Engineering program but who serves as the primary advisor to another department. For upper division students, the primary advisor is the program coordinator (an assigned faculty member who is given three credit hours of release time per semester for this duty). The ECE advisor, the backup advisor and the program coordinator are fully trained to advise students throughout the entire program.

The advisors (ECE advisor, ECE backup advisor and/or program coordinator) are responsible for advising Computer Engineering students with respect to courses within the major and technical support courses. Students are required to meet with an advisor annually. The advisement with respect to general education and other university requirements is augmented by that of advisors in the WSU Student Success Center. Cursory advising (supplying students with informational brochures, directing students to faculty, scheduling advising appointments, etc.) may be performed by the department administrative assistant.

As stated in Section 1.A, the advisors extensively use *Cattracks*, a WSU computer-based degree evaluation and planning tool. *Cattracks* enables the advisors to track the student's progress toward graduation by showing the courses taken and grades received, courses still required, grade point average, transfer credits and other pertinent information. Students can also access *Cattracks* for the purpose of monitoring their progress in the program, but students cannot make changes of any kind to their academic record.

Career Guidance

A staff member in the Dean's office serves as a career advisor for all departments in the College of Engineering, Applied Science & Technology. The duties of this staff member are to provide career counseling to students, forward employment opportunities to students for full-time and part-time work and internships, help the WSU Career Services Department conduct job fairs and interviews on campus and promote WSU students and graduates to local companies. Because all our engineering faculty have industrial experience with local engineering firms, they may also offer career guidance to students.

E. Work in Lieu of Courses

Credit for Calculus I and Calculus II may be granted through Advanced Placement (AP) examinations. These mathematics courses, among others, are required for the BS in Computer Engineering. There are no advanced placement courses for Computer Engineering courses per se. Course credit for life experience is not given. While rare, a challenge examination for a course may be given a student at the discretion of the program coordinator and the faculty member who teaches the course in question.

Typically, industrial work experience does not count for credit in Computer Engineering courses. Industrial work in lieu of a course is considered only in exceptional cases in which the quality and quantity of the work closely corresponds with the content of the course. This work may be in the military or the private sector. For work to be substituted for course credit, the student must supply evidence (design documents, test reports, employer's letter, etc.) to support the substitution. The program coordinator decides whether the substitution is warranted based on the evidence supplied by the student.

F. Graduation Requirements

The name of the degree awarded is the Bachelor of Science in Computer Engineering.

As of the 2023-2024 academic year, the degree has the following graduation requirements:

Total credit hours: 125

Pre-professional courses (Lower Division), credit hours: 52

Professional courses (Upper Division), credit hours: 42

Support courses, credit hours: 12

Other General Education[1] courses, credit hours: 19

Upper division credit hours: 40

Residency credit hours: 30

Minimum overall GPA: 2.5

Minor: not required[2]

[1] 3 credits each are required in English, Creative Arts, Humanities, Social Science and American Institutions. 4 credits are required in Life science.

The above information was obtained from the 2023-2024 WSU general catalog, which is published online: catalog.weber.edu.

Specific courses required for graduation are listed in the catalog and the program web site. A student must earn a grade of C or better in all courses required by the major. If a student gets a C− or lower in any of these courses, the student must repeat the course. This policy is enforced by the university's ERP system, BANNER.

After registering for courses in the final semester of the program (but before that semester starts), each student meets with the program coordinator in a concluding advising session to assure that all degree requirements will be met by the time of graduation. As with all advising sessions conducted by the program coordinator, *Cattracks* is used to check the student's progress. After the student's final semester has commenced but prior to the graduation application deadline, the program coordinator conducts a final check of the student's progress. In order to graduate, the student must still pass his or her "in-progress" courses.

G. Transcripts of Recent Graduates

Transcripts of recent graduates will be submitted to the visiting team upon request. Detailed explanations of the transcripts will be given at that time.

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

A. Mission Statement

The mission statement of Weber State University (weber.edu/accreditation/mission.html) is:

> *Weber State University provides transformative educational experiences for students of all identities and backgrounds through meaningful personal connections with faculty and staff in and out of the classroom. The university promotes student achievement, equity and inclusion, and vibrant community relationships through multiple credentials and degree pathways, experiential learning, research, civic engagement, and stewardship.*

The three core themes of the mission, and the objectives of each are outlined below:

1. Learning

a. Students experience an engaging learning environment founded on extensive personal contact among faculty, staff and students in and out of the classroom.

b. Students receive effective educational support in multiple modalities.

c. Students learn to succeed as educated persons and professionals.

d. Students and faculty learn, explore and create in an environment that sustains free inquiry and free expression.

2. Access

a. Weber State University offers transformative educational experiences for students of all identities and backgrounds

b. Students are able to progress in various programs of study.

c. Weber State University provides access to higher educational opportunities.

3. Community

a. Weber State University supports civic engagement.

b. Weber State University contributes to the richness of the regional culture.

c. Weber State University contributes to the economic development of the region.

B. Program Educational Objectives

Program educational objectives are career and life accomplishments that the program prepares graduates to achieve within a few years after graduation. The program educational objectives were defined by the faculty and approved by our Industrial Advisory Board, which consists of faculty, local engineering employers and at least one senior student in the program. The educational objectives of the Computer Engineering program are to produce graduates who are able to:

- Apply their engineering skills, through theory and application, in industry, government, society, or in graduate school;
- Practice high technical and ethical standards and communicate their work to colleagues, industry, and professional organizations;

- Work effectively and contribute in interdisciplinary fields while encouraging expression and valuing diversity;
- Understand the importance of lifelong learning and continuous professional growth in a changing world as shown through self-directed learning, specialized trainings, certifications, licensing, and graduate programs.

The program educational objectives are publicly available on the Electrical and Computer Engineering web site: https://www.weber.edu/ece/abet.html.

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

Objective 1. Apply their engineering skills, through theory and application, in industry, government, society, or in graduate school.

This objective is strongly connected to the first core theme, learning. The institution fosters an environment conducive to learning by providing extensive contact with faculty in and out of the classroom. Weber State University is first and foremost a teaching institution that focuses on student learning and the development of students into educated, capable professionals in their field.

This educational objective is also associated with the second core theme, access. Weber State University offers the Computer Engineering degree to satisfy the demand for engineers who can develop new computer systems for local engineering companies. Being strategically located near those companies, WSU provides access to the education that industry requires and that will benefit student livelihoods.

Objective 2. Practice high technical and ethical standards and communicate their work to colleagues, industry, and professional organizations.

Two core themes, learning and community, align with this objective. In engineering seminar, internship and senior project courses, students learn both communication skills as well as their ethical and professional responsibilities. A strong ethical basis is a benefit to both the engineering community and society at large.

Objective 3. Work effectively and contribute in interdisciplinary fields while encouraging expression and valuing diversity.

This objective aligns primarily with the community theme. Students are encouraged to participate in capstone projects with other engineering and science-related disciplines. Further, students are encouraged to work in diverse teams throughout the program. As students transition from the university to the industrial community, they contribute to a strong, diverse community and enrich the regional culture.

Objective 4. Understand the importance of lifelong learning and continuous professional growth in a changing world as shown through self-directed learning, specialized trainings, certifications, licensing, and graduate programs.

This objective is strongly connected to the learning theme, but is focused on the learning that happens after the university experience. In the Computer Engineering Program, students are taught to continue their learning through involvement with professional engineering societies, attendance at technical presentations and seminars and reading professional publications. Through continued industrial practice, graduates learn procedures and practices of the industry in which they are employed. All of the Computer Engineering courses teach students how to learn to some extent, but the internship, project and independent study courses focus on that

aspect primarily. Students in the seminar course also learn the value of professional growth and various avenues for career advancement.

D. Program Constituencies

There are two constituencies of the WSU Computer Engineering Program, students and engineering employers.

Students

At WSU, students are considered our “customers” in the sense that our institution is a student-centered university focused on the progress and success of students. The Computer Engineering Program was established in part due to the desire of many Pre-Engineering students, who would otherwise transfer to another institution to complete their BS degree, to remain at WSU.

The first program educational objective is central to furnishing students with the knowledge and ability to apply their engineering skills wherever they go. Students learn the skill of design in the project management and senior project courses, and they learn the skill of analysis in virtually every other course except seminar and internship.

Like engineering design, communication and ethical standards (the second program educational objective) is central to the education of an engineering student. Students make presentations in the seminar course, the project management course, and as part of their senior project. Senior project teams must also communicate with each other and maintain ethical standards to be successful.

Professional ethics and social awareness are attributes of a successful, ethical and educated person in engineering or any other field. Students are exposed to this part of the objective primarily in the engineering seminar and internship courses.

The third program educational objective relates to working in interdisciplinary teams and working effectively with others. The seminar, project management and senior project courses encourage students to rise to that level.

Students in the Computer Engineering program are urged to continue their learning inside and outside the classroom while in school and particularly after graduation. This aligns well with the fourth objective relating to lifelong learning and professional growth.

Students are represented by at least one Electrical or Computer Engineering senior on the Industrial Advisory Board.

Engineering Employers

Addressing the needs of local engineering employers for computer engineers is the primary reason that the WSU Computer Engineering Program was established. Local engineering employers, particularly aerospace companies, have an acute need for engineering graduates who can design and develop state-of-the-art computer systems. Employers often remind us that the most important “soft skills” are communication and the ability to work in a team environment. Employers also demand engineering graduates who are willing to further their knowledge and skills in their areas of expertise. Furthermore, employers require employees who act professionally and ethically.

Engineering employers are represented by engineering managers on the Industrial Advisory Board. Table 2-1 gives the current composition of the IAB, which meets annually each spring semester.

Table 2-1. WSU ECE Industrial Advisory Board Composition

Company	Business Sector	Members
BAE	Aerospace	1
Kihomac	Aerospace	3
Lockheed Martin	Aerospace	3
Hill AFB	US Air Force	3
L-3 Harris	Communications	1
Boeing	Aerospace	1
Design Criteria	Power Electronics	1
Select Engineering Services	Engineering Services	2
Northrop Grumman	Aerospace	3
Mitre Corp	R&D Center	1
WSU (Faculty, Staff, Student)	Education	10

E. Process for Review of the Program Educational Objectives

The program educational objectives were defined by the faculty and approved by the Industrial Advisory Board (IAB) prior to the initial accreditation visit in 2012. The approach used for the review of the program educational objectives is described below.

The Industrial Advisory Board, which consists of program faculty, engineering managers from local engineering companies, and at least one senior Electrical Engineering or Computer Engineering student, is tasked with reviewing and potentially revising the educational objectives of the program. This board convenes once per year in the spring semester. Topics and issues discussed by this board include, but are not necessarily limited to, the following:

1. Review of program educational objectives
2. Program structure
3. Content of courses
4. Declared majors and course enrollments
5. Graduate projections
6. Internship opportunities
7. Full-time hiring projections

Since the creation of the Computer Engineering (CE) program in 2016, the IAB meetings have been joint meetings in which both the EE and CE programs are discussed.

While the EE program educational objectives have been periodically reviewed by the IAB, the IAB has initiated a change in the program educational objectives only once as a result of the 2018 ABET program review. The program educational objectives were revised by the faculty members of the IAB to address a program weakness. The new program educational objectives were then ratified by the entire IAB in Spring of 2019 and implemented.

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The student outcomes for Computer Engineering students can be found at https://weber.edu/ece/abet.html. The outcomes match the ABET student outcomes and describe what students are expected to know and be able to do by the time of graduation. Graduates of the WSU Electrical and Computer Engineering Programs will have:

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

B. Relationship of Student Outcomes to Program Educational Objectives

The Objectives of the ECE undergraduate programs in Electrical and Computer Engineering are to educate graduates to become productive, accountable, and responsible professionals in engineering who will:

1. Apply their engineering skills, through theory and application, in industry, government, society, or in graduate school.
2. Practice high technical and ethical standards and communicate their work to colleagues, industry, and professional organizations.
3. Work effectively and contribute in interdisciplinary fields while encouraging expression and valuing diversity.
4. Understand the importance of lifelong learning and continuous professional growth in a changing world as shown through self-directed learning, specialized trainings, certifications, licensing, and graduate programs.

Figure 3-1 illustrates the relationship of student outcomes to program educational objectives. Program educational objectives are assessed using instruments at the program level, whereas student outcomes are assessed using instruments at both the program and course levels. These assessment instruments are fully described in Criterion 4 Continuous Improvement. By virtue of the relationships shown in Fig. 3-1, the degree to which program educational objectives are achieved is a reflection, to a great extent, of the degree to which student outcomes are achieved.

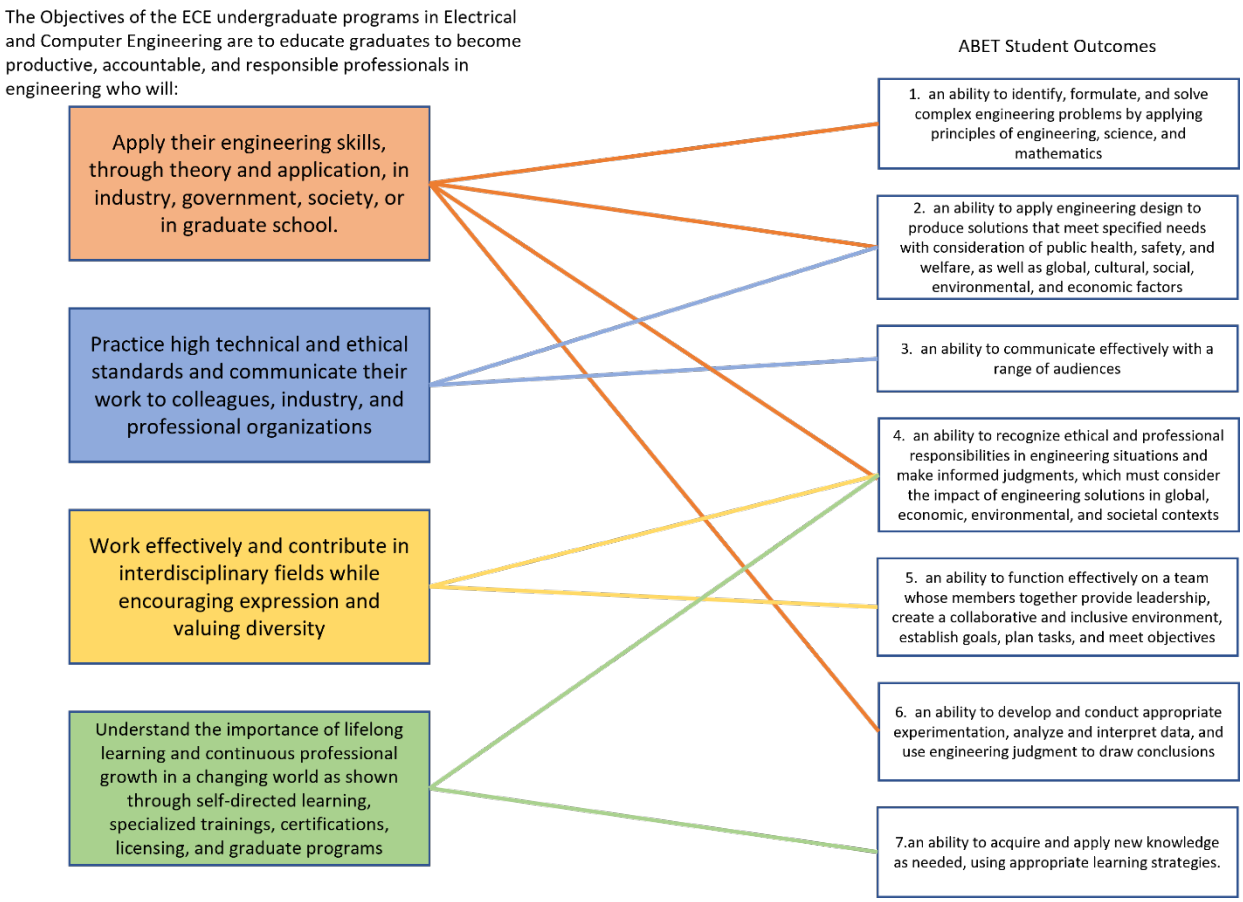

Figure 3-1 Relationship of Educational Objectives to Student Outcomes

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

Student learning outcomes are listed in “CRITERION 3. STUDENT OUTCOMES.” Table 4-1 provides a summary of the assessment processes that is used to gather data upon which the evaluation of student outcomes are based. For each assessment instrument, the table gives the frequency with which the process is carried out, the expected level of attainment for each of the student outcomes, a summary of the results of the evaluation process, and the manner in which the results are documented and maintained. Detailed explanations of the assessment instruments and how the data is used for continuous improvement are given in Section B.

Table 4-1 Assessment of Student Outcomes

Assessment Instrument.	Frequency of Application	Expected Level of Attainment	Summary of Results	How the results are (1) documented (2) maintained
Course Assessment Rubrics	Each time a course is taught	*S ≥ 3*[1] *X ≥ 2.85*[2]	*Triggered 43 times at course level* *Triggered 5 times at program level* *See Section B.1*	*(1) Spreadsheet* *(2) Department Chair*
Graduate Survey	At the graduation of each cohort	*X ≥ 3.5*[3]	*Not triggered* *See Section B.2*	*(1) Spreadsheet* *(2) Department Chair*
Internship Employer Survey	Annually	*X ≥ 3.5*[3]	*Not triggered* *See Section B.3*	*(1) Spreadsheet* *(2) Department Chair*
Industrial Advisory Board Recommendations	Annually	*N/A*	*3 Recommendations* *See Section B.4*	*(1) minutes of IAB meetings* *(2) department administrative assistant*
Senior Assessment Exam	During ECE 4010 and ECE 4020	*Subjective*	*Triggered 1 time* *See Section B.5*	*(1) CANVAS* *(2) department chair*

1. S = Performance Indicator (PI) score for a given student outcome (1 = unsatisfactory, 4 = exemplary).
2. X = mean PI score for a given course. Prior to spring 2023 the threshold was 2.67. Currently the threshold is 2.85.
3. X = mean PI score on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

B. Continuous Improvement

Impetus to change the program comes from five main sources as shown in Table 4-1. Whatever the impetus for a program change, the process for tracking the change and assessing its efficacy is essentially the same. Each time a problem is indicated from one of the sources, a TPS (Traceable Progress System) report is issued to track the proposed remedy and make sure it is effective. The open TPS reports are reviewed by the faculty each year. If the change has been effective, the report is closed. If the change has not had enough time to take effect, the report remains open. If the change has had time but has not been effective, it may be incumbent upon the faculty to devise a new remedy.

There are subtle differences in the process that are described in each of the subsections, below, each of which corresponds to a row in Table 4-1. The TPS reports (whether open or closed) that pertain to the computer engineering program and were issued during the review period (2018-2024) are available upon request.

B.1. Course Assessment Rubrics

For each course in the curriculum, a level of applicability for each student outcome was assigned. The levels of applicability are low, medium and high, designated by a blank, M and H, respectively, in the matrix. Only the student outcomes that ranked high in the matrix were assigned a performance indicator (PI) in the corresponding course rubric. Table 4-2 is the matrix of courses with at least one student outcome ranked high. Levels of applicability were assigned to other courses in the program, but without an outcome that ranks high, those courses are not connected to a PI and therefore have no course assessment rubric.

Table 4-2 Matrix of ECE Courses and Student Outcomes

	Student Outcome						
Course	1	2	3	4	5	6	7
ECE 1270 - Introduction to Electrical Circuits	H		M			H	M
ECE 1400 - Fundamentals of Engineering Computing	H					H	
ECE 2260 - Fundamentals of Electrical Circuits	H		M			H	M
ECE 2700 - Digital Circuits	H			M	M	M	
ECE 3000 - Engineering Seminar		H	H	H			H
ECE 3090 - Project Management		H	H	H	H		H
ECE 3110 - Microelectronics I	H		M			M	M
ECE 3210 - Signals & Systems	H					M	
ECE 3430 - Engineering Probability and Statistics	H					H	
ECE 3610 - Digital Systems	H	M			M	M	
ECE 3710 - Embedded Systems	H	M	H		M	M	
ECE 3890 - Internship		H	H	H	H	H	H
ECE 4010 - Senior Project I	H	H	H	H	H	H	H
ECE 4020 - Senior Project II	H	H	H	H	H	H	H

At the conclusion of each semester, faculty prepare a rubric for each ECE course they taught by assigning a level of achievement (for the class as a whole) to each PI for the student outcomes in the rubric. The levels of achievement are (1) unsatisfactory, (2) developing, (3) satisfactory and (4) exemplary. A recent example of a course rubric is shown in Table 4-3.

Table 4-3 Course Assessment Rubric Example for ECE 3710 Embedded Systems

ECE COURSE RUBRIC	Electrical Engineering Majors							
COURSE	ECE 3710 Embedded Systems (4)							
SEMESTER	Spring							
YEAR	2024						S = 1 or 2: action initiated by instructor	
INSTRUCTOR	Brown						S = 3 or 4: no action initiated by instructor	
NUMBER OF EE STUDENTS	31							
Performance Indicator (PI)	Student Outcomes	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Exemplary	Score (S)	Initiate action by instructor ?	Action to be initiated
Write a computer program in assembly language.	1	Cannot write a program that assembles.	Writes a program that assembles but does not work.	Writes a program that assembles and works but is poorly organized and	Writes a program that assembles, works and is well organized and documented.	4	N	
Write code to handle interrupts.	1	Cannot write interrupt handlers, or interrupt handlers cause the system to crash.	Writes interrupt handlers that do not cause the system to crash.	Writes interrupt handlers that work.	Writes interrupt handlers that work and are well documented.	4	N	
Debug a computer program using both hardware and software tools.	1	Debugs computer programs using trial and error.	Debugs computer programs using an interactive debugger only.	Debugs computer programs using an interactive debugger and basic laboratory equipment.	Debugs computer programs using an interactive debugger and a logic analyzer.	3	N	
Interface peripherals to a microcontroller or microprocessor using a bus.	1	Cannot interface peripherals to a microcontroller or microprocessor.	Interfaces peripherals using I/O ports only.	Interfaces one peripheral using a bus.	Interfaces multiple peripherals using a bus.	3	N	
Document the hardware and software of an embedded systems design.	2,3	Cannot document a design using an acceptable format.	Uses an acceptable format to document a design but leaves out important aspects.	Uses an acceptable format to document all the important aspects of a design.	Uses an acceptable format to document a design completely, clearly and concisely.	3	N	
Design a test plan and use it to verify that a system satisfies its requirements and costraints.	6	Can only perform tests on an ad hoc basis.	Designs a test plan but fails to verify the system satisfies the requirements or constraints.	Designs a suitable test plan and verifies that the requirements and constraints are satisfied.	Designs a suitable test plan and documents the requirements and constraints verified by each test.	2	Y	Add a more detailed rubric for grading the test plan in the design document.
					Average Score for Course =	3.2		
					(Transfer this number to course continuous improvement record)			

The continuous improvement process for courses occurs on two levels--the instructor level and the program level as shown in Figure 4-1. At the instructor level, the instructor makes independent improvements to the course. When the score, S, for a given PI is 3 or greater, no action is taken by the instructor to improve the course. When S falls below 3, the instructor identifies corrective actions to implement the next time that he/she teaches the course. Table 4-4 lists the 43 instructor-level course improvements that have been made during the review period 2018-2024.

At the program level, the instructor, with input from department faculty, makes improvements to the course (See Figure 4-1). If the mean score for a given course is greater than or equal to 2.85 (2.67 for semesters prior to spring 2023), no action is taken to improve the course, but a mean score of less than 2.85 requires a faculty discussion at the program level. For the course assessment rubric shown in Table 4-3, action is to be initiated by the instructor for one PI, but no program level action is required.

Sometimes, a low score is the result of a statistical anomaly (typically one poor student and very few or no other students from the same major). If the faculty finds that this is the case, no corrective action is required, otherwise the program faculty must propose and implement a remedy. This process has been triggered five times during the review period 2018-2024, however three of the triggers were statistical anomalies associated with the Computer Engineering program and are therefore not applicable. Table 4-5 lists the program level triggers from course assessment rubrics.

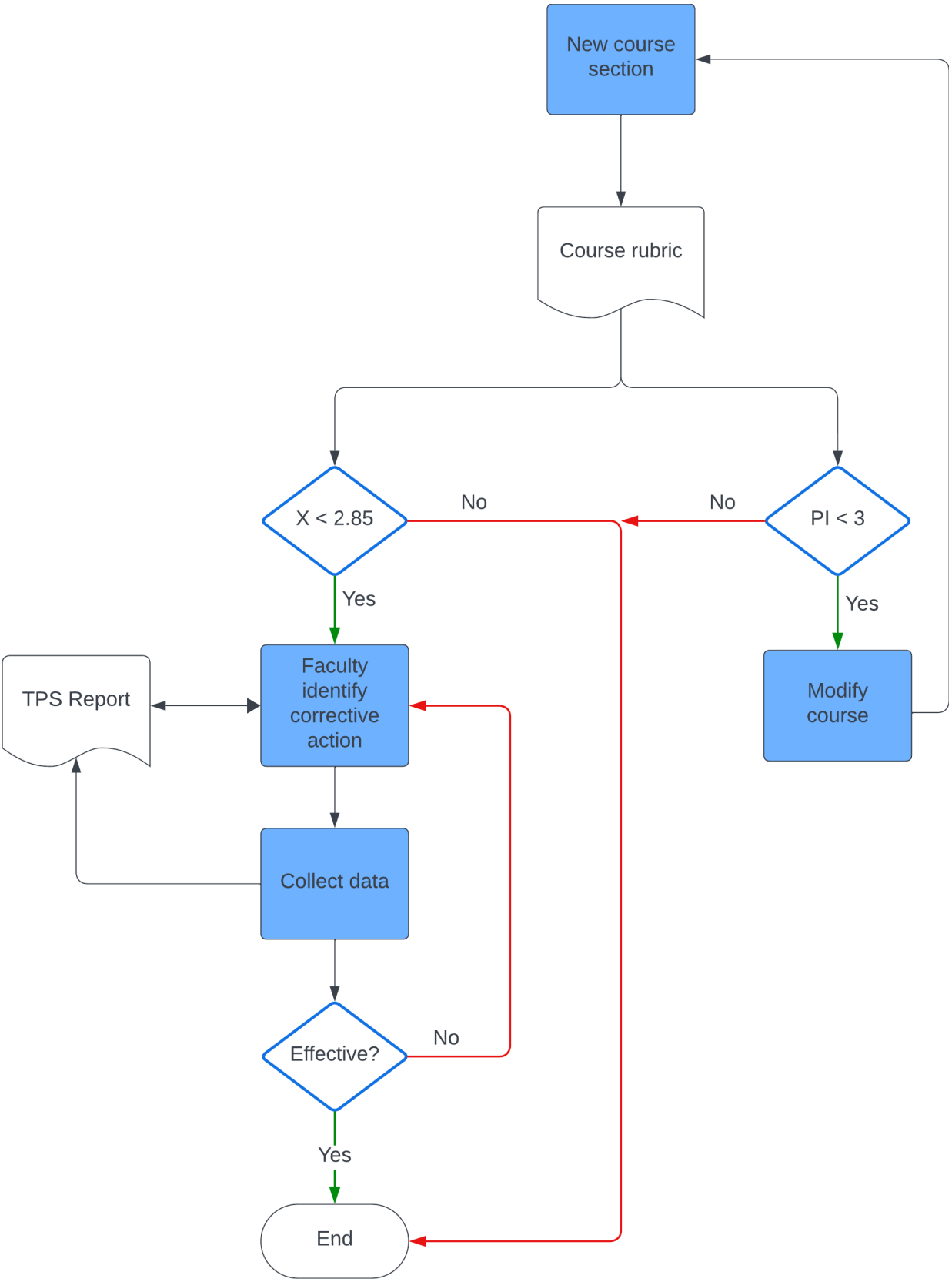

Figure 4-1. Continuous Improvement Process for Course Assessment Rubrics

Table 4-4. Course Rubric Triggers and Resulting Corrective Actions at the Instructor Level.

Semester	Course	Performance Indicator (PI)	Outcomes	Corrective Action
F 2018	ECE 2260	Apply Fourier transforms to signals	1	Faster transition from Fourier Series to Fourier Transforms
F 2018	ECE 3110	All (4)	1	The data is based on just 2 students - one of them did well in the assignments and scored a B in the course, while the other had to miss several classes and did not take the final and ended up with an E in the course. Since the 2 student's performance was so different and hence the evidence is not concrete, the instructor will monitor the performance of future CE students in this course to determine if there is a consistent pattern in their performance.
F 2018	ECE 3610	Write a test bench using a hardware description language.	1	The revamp of lab exercises resulted in many test benches being provided by the instructor. Next time this set of labs are used, Project 1 should be given more time and require students to write test benches for each component.
S 2019				
F 2019	ECE 3210	Program simple scripts and functions in MATLAB.	1	Rewrite the labs. Migrate to Python.
F 2019	ECE 2260	All (4)	1	Small sample size - will monitor
S 2020				
F 2020	ECE 1270	Utilize Phasors to determine sinusoidal steady-state waveforms response.	1	Spend more class time on phasor analysis next time I teach 1270
F 2020	ECE 1400	Understand C memory management	1	Allocate more lectures on this topic in subsequent offerings
F 2020	ECE 2700	Compute propagation delays and maximum clock frequency.	1	Changing allocation of time, introducing timing diagrams earlier
F 2020	ECE 2260	Apply Fourier transforms to signals	1	Revamp 2260 schedule for Spring 2021. Replace two class periods spent on Laplace and 1st and 2nd order circuits with Fourier transforms.

F 2020	ECE 4010	Manage a budget	4	Emphasize the need for proper budgeting in the first and second class periods. Follow up on first meeting.
S 2021	ECE 2700	Compute propagation delays and maximum clock frequency.	1	Re-worked timing diagram homeworks. Introduced earlier, but did not spend sufficient time.
F 2021	ECE 1270	Derive Thevenin and Norton equivalent circuits.	1	more examples of Thevenin and Norton, plus more homework on the topic
F 2021	ECE 2700	Compute propagation delays and maximum clock frequency.	1	Introducing delays much earlier in the course (week 2 vs 12), allowing time to throughly develop understanding
F 2021	ECE 4010	Maintain an engineering logbook	4	emphasize documentation for 4020
S 2022	ECE 2700	Compute propagation delays and maximum clock frequency.	1	Continuing to redesign and add additional relevant homeworks. Will also be integrating clock speed calculations into prpjects
S 2022	ECE 4010	Conduct a design review.	2,3	Require students to give practice presentation to instructor to better prepare them for questions.
S 2022	ECE 4010	Fulfill assigned duties as a team member.	5	Several students struggled with the work load when combined with their other classes. Advise students to reduce course loads when possible.
S 2022	ECE 4020	Write a design document.	2,3	focus on technical writing skills
S 2022	ECE 4020	Write a test plan.	6	add'l focus on writing skills
S 2022	ECE 4020	Maintain an engineering logbook	4	discuss updating logbook requirement next department meeting
F 2022	ECE 1400	Understand C memory management	1	Separate C and Python by covering Python in the first half of the semester and C in the second half.
F 2022	ECE 2700	Compute propagation delays and maximum clock frequency.	1	Small sample size with abnormally poor group of students. High sample size of EE students showed improvement in the topic since last semester.
		Analyze circuits that use medium scale integrated devices.	1	Small sample size with abnormally poor group of students. Has not previously been an issue and is not expected to need ongoing corrective action.
F 2022	ECE 3890	Students shall participate in team problem-solving activities	5	too small class (3 ces), size-limited projects

F 2022	ECE 3090	Write a feasibility study and business case	2,4,7	Emphasize the business case portion of the class.
S 2023	ECE 1270	Analyze a basic circuit using node and mesh techniques.	1	All of the CE students struggled here. Such a small number of students, hard to determine why. Of the 4 only 1 attended and participated in class, including turning in homework.
S 2023	ECE 1270	Derive Thevenin and Norton equivalent circuits.	1	All of the CE students struggled here. Such a small number of students, hard to determine why. Of the 4 only 1 attended and participated in class, including turning in homework.
S 2023	ECE 1270	Utilize Phasors to determine sinusoidal steady-state waveforms response.	1	I had 4 CE students in the class. Of the 4 only 1attempted this section of the course. Other 3 had "dropped" UW from the course.
S 2023	ECE 3710	Debug a computer program using both hardware and software tools.	1	Require oscilloscope output from DAC to be recorded in lab book.
F 2023	ECE 2700	Design and build sequential circuits using gates, inverters and flip flops.	1	This data point represents one student. More students are needed to indicate an actual problem
		Analyze circuits that use medium scale integrated devices.	1	This data point represents one student. More students are needed to indicate an actual problem
F 2023	ECE 3210	Design, build and analyze linear time-invariant systems.	1	Should be a 4, but we use Python. PI needs to be changed to Python, not MATLAB.
F 2023	ECE 3210	Program simple scripts and functions in MATLAB.	1	We don't use Matlab. These students can write sophisticated C programs and compile them as Python modules.
F 2023	ECE 3890	Students shall demonstrate ethics in the workplace	4	Discuss with faculty that teach ECE 3000 to spend more time covering ethics.
S 2024	ECE 1270	Analyze a basic circuit using node and mesh techniques.	1	will implement dependent source exs in mesh/node analysis material
S 2024	ECE 3710	Document the hardware and software of an embedded systems design.	2,3	Add a more detailed rubric for grading the design document. Also, the problem may resolve with ECE 3090 changes.

S 2024	ECE 3710	Design a test plan and use it to verify that a system satisfies its requirements and costraints.	6	Add a more detailed rubric for grading the test plan in the design document. Also, the problem may resolve with ECE 3090 changes.

Table 4-5. Course Rubric Triggers and Resulting Corrective Actions at the Program Level.

Semester	Course	Major/Score	Adjudicated	Corrective Action
F 2018	ECE 3110	EE/3.3 CE/2.1	13 Feb 2019	Statistical Anomaly – Only two CE students in the class one of whom was a poor student.
F 2018	ECE 3210	EE/3.0 CE/2.0	13 Feb 2019	Statistical Anomaly – Only one CE student in the class
S 2022	ECE 4020	EE/2.8 CE/2.8	21 Sep 2022	Change senior project proposal procedure to a live presentation to the faculty. See Figure 4-2, below.
S 2023	ECE 1270	EE/3.6 CE/2.4	25 Aug 2023	Statistical Anomaly – Only one CE student in the class.
F 2023	ECE 3210	EE/2.3 CE/2.3	25 Apr 2024	Hold an annual meeting to review/update course performance indicators and open TPS reports. See Figure 4-3, below.

Weber State University Department of Engineering

DEPARTMENT-INITIATED COURSE IMPROVEMENT RECORD

This form is used to document course improvements initiated by the department faculty. It is required for all improvements triggered by an average performance indicator (PI) score of 2.67 or less, but it may also be used to document course improvements regardless of motivation or PI score. The form should be completed by the department chair or delegate after the course has been offered with the improvement(s) in place.

PART I – ACTION PLAN

Course Number ECE 3090 Course Name Project Management

What was the motivation for the improvement(s)? (If the improvement was motivated by an assessment instrument, name the instrument, semester of assessment, performance indicator, and/or score.)

This change was motivated by the course assessment rubrics for ECE 4020 in Spring 2022. The mean score was 2.8 for EE students in one section and CE students in two sections of ECE 4020.

Describe the improvement(s) planned or made to the course.

After deliberation 9/21/2022, the faculty postulated that the root cause of the low scores was the vetting process of projects in ECE 3090, project management. The remedy was to require students to make a live presentation of their project proposal to the faculty at large and then have the faculty deliberate before approving the project.

PART II - IMPLEMENTATION

Year and semester course improvement(s) were implemented Spring , 2023

Comment on the efficacy of the improvement.

Students in ECE 3090 Spring Semester of 2023 should have completed ECE 4020 in spring 2024. Course assessments for ECE 4020 in spring 2024 were 3.5 (EE) and 3.6 (CE), so it would appear that the improvement was effective. Recommend continuing to monitor ECE 4020 and closing this case after spring 2025 if all looks good.

Figure 4-2. TPS Report for Spring 2022 Program Level Trigger

Weber State University Department of Engineering

ASSESSMENT PROCESS IMPROVEMENT RECORD

This form is used to document improvements in the assessment and feedback process. The form should be completed by the department chair or delegate after the improvement(s) are implemented.

PART I – ACTION PLAN

Program(s) Affected Electrical Engineering, Computer Engineering

What was the motivation for the improvement(s)?

The Fall 2023 Course Assessment Rubric for ECE 3210 had a score of 2.3 for both EE and CE programs. The cause of the low score was not the course material per se, but the outdated performance indicators.

Describe the improvement(s) planned or made to the assessment or feedback process.

Performance indicators must be changed by program faculty as a whole, and there has never been a formal meeting to review and update performance indicators, some of which have been untouched since 2012. The faculty decided (4/25/24) to establish an annual meeting to review/update performance indicators and to review open TPS reports.

PART II - IMPLEMENTATION

Year and semester program improvement(s) were implemented Fall, 2024

Comment on the efficacy of the improvement.

No evidence of efficacy as of yet. Edit this line when evidence is available.

Figure 4-3. TPS Report for Fall 2023 Program Level Trigger

B.2. Graduate Survey

Students taking the senior design project course, ECE 4020 as asked to complete a graduating student survey. The graduate survey is an eleven-question survey asking graduates to indicate the degree to which the student learning outcome was achieved in their program. This instrument has been administered to graduating seniors since fall semester 2014 when student outcomes were (a) through (k) and the survey questions have remained the same to maintain data continuity, but the survey questions have been mapped to the new student learning outcomes, 1 through 7, using weighted expressions relating how the survey questions correlate to the new learning outcomes. The weights for the questions are shown in table 4-6, such that survey questions 1, 5 and eleven each account for 1/3rd of student learning outcome 1's evaluation. This mapping is used only for the purposes of the graduate survey evaluation.

The responses are given on the following five-point Likert scale: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 =strongly agree. The trigger point was set by faculty at 3.5. Table 4-7 is a summary of the graduate survey results. Numbers in the table are the calculated mean values for the graduating cohort for each of the 7 outcomes using the weights in Table 4-6. The survey also asks the graduate to provide feedback on the strengths and weaknesses of the ECE programs. The survey in its entirety is given in Appendix F.

The continuous improvement process is shown in figure 4-4 (which includes the Graduate Survey and FE Exam results as they are both linked to ECE 4010/4020). Faculty review the results of the graduate survey to identify if there is a concern. One concern was the previous mentioned trigger of a score below 3.5, but other triggers could include consistent feedback from students regarding a program weakness.

All student outcomes scored about the thresholds each year. Outcome 4 was the lowest score over this time period, but it is likely explained by COVID-19 as those graduating students would have experienced remote courses and social distancing, which likely had a negative impact on students learning to work in teams and supported by the most recent year reaching pre-COVID levels.

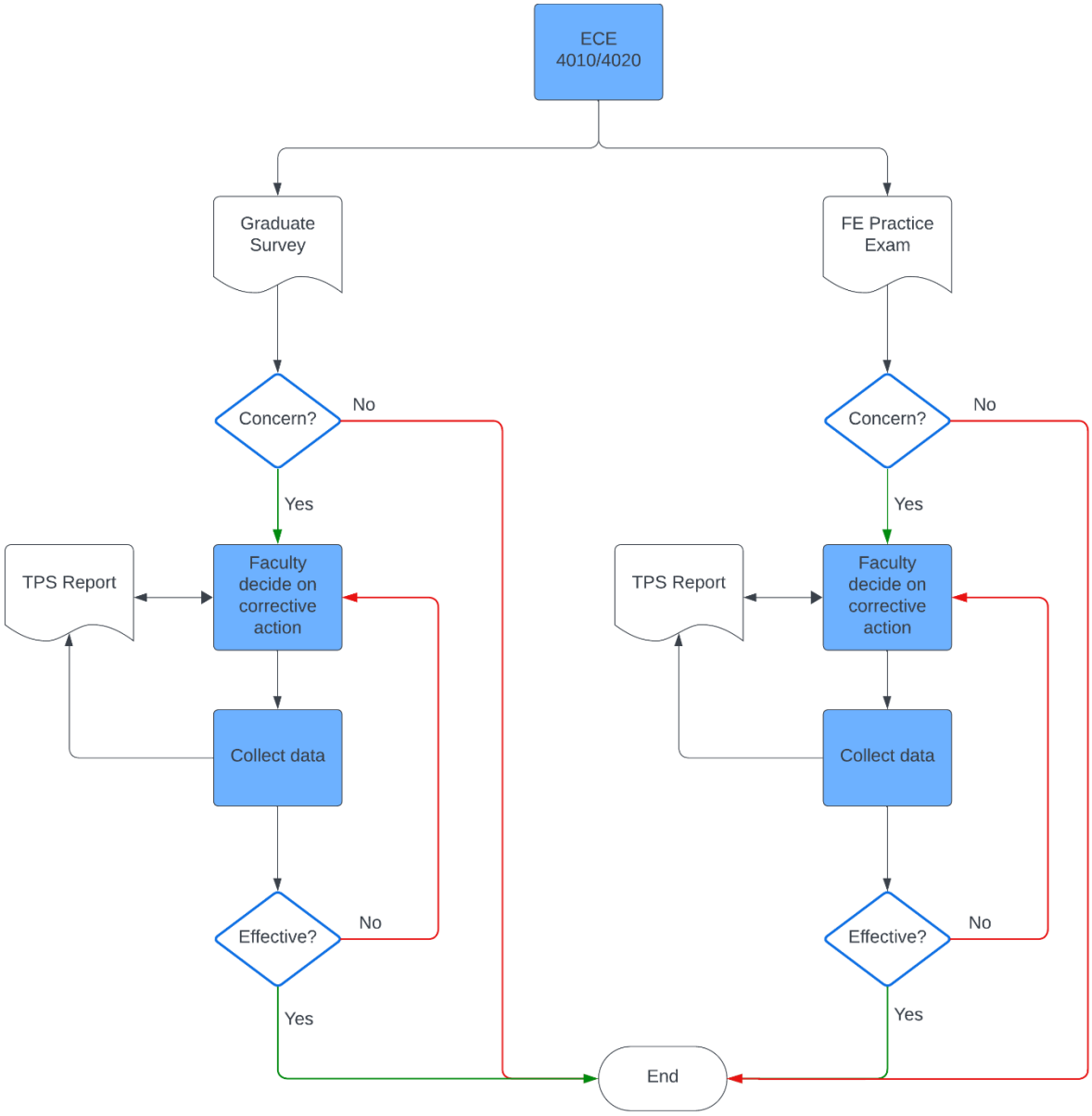

Figure 4-4. Continuous Improvement Process for Graduate Survey and FE Practice Exam

Table 4-6. Map of Graduate Survey Questions to Student Outcomes.

Survey Question	Outcome Weight						
	1	2	3	4	5	6	7
1	0.33						
2						0.80	
3		0.80					
4					1.00		
5	0.33						
6				0.33			
7			1.00				
8				0.33			
9							1.00
10				0.33			
11	0.33	0.20				0.20	

Table 4-7. Computer Engineering Graduate Survey Results.

Academic Year	Outcome						
	1	2	3	4	5	6	7
2018-19	4.87	4.60	5.00	4.22	5.00	4.87	5.00
2019-20	-	-	-	-	-	-	-
2020-21	4.60	4.60	4.50	4.50	5.00	4.60	4.50
2021-22	4.48	4.40	4.20	4.13	4.60	4.72	4.60
2022-23	4.85	4.75	4.75	4.50	4.75	4.95	4.75
2023-24	4.87	4.73	5.00	4.89	4.33	5.00	5.00

B.3. Internship Employer Survey

The internship employer survey is a ten-question survey instrument administered on behalf of students who are enrolled in ECE 3890 Internship, a required course in the ECE programs. The survey is completed by the employer, not the intern. Seven of the ten questions ask the employer to supply a response using the same five-point Likert scale that is used for the graduate survey. These questions are:

1. The intern performed his/her duties on schedule.
2. The intern reported to work on time.
3. The intern demonstrated professionalism and ethical behavior.
4. The intern demonstrated an ability to learn new concepts, skills, procedures, policies, etc. that are pertinent to the job.
5. The intern was an effective communicator.
6. Overall, I am satisfied with the performance of the intern.
7. If there was a full-time engineering position open at my company, I would hire this intern.

Responses to the other three questions require a yes/no answer, multiple choice answer or brief comments. This instrument has been administered to students since the 2013-2014 academic year. Table 4-7 is a summary of the internship employer survey results during the review period 2018-2024 for the seven five-point scale questions. Numbers in the table are mean values for computer engineering students enrolled in ECE 3890 during the year indicated. Like the graduate survey, the trigger point is set by faculty at 3.5, which is halfway between “neutral” and “agree”. The continuous improvement process is similar to that of the graduate surveys and is illustrated in Figure 4-5. The survey in its entirety is given in Appendix G.

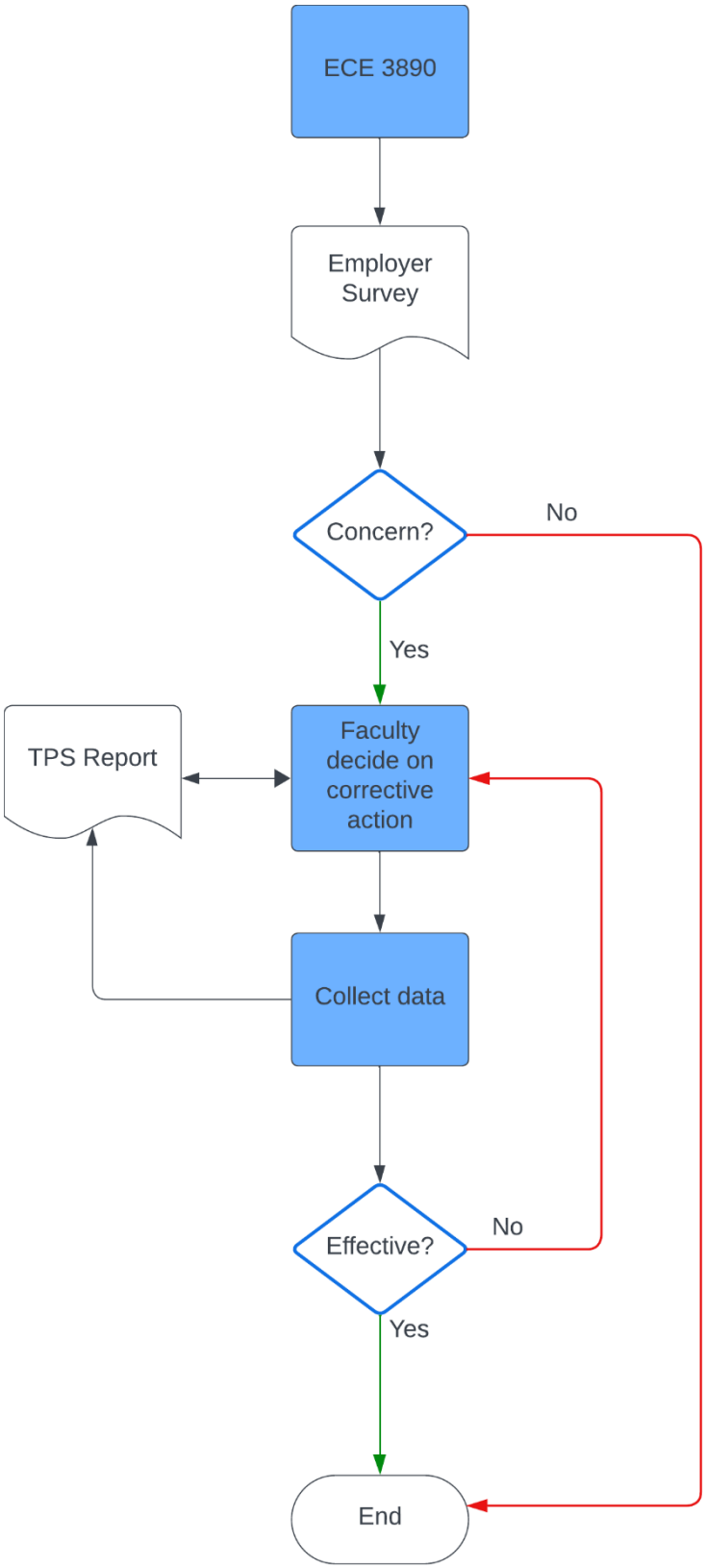

Figure 4-5. Continuous Improvement Process for Internship Employer Survey

Table 4-8. Internship Employer Survey Results for CE Students.

Academic Year	Question						
	1	2	3	4	5	6	7
2018-19	4.63	4.50	4.50	4.50	4.38	4.63	4.50
2019-20	4.50	5.00	5.00	5.00	4.50	4.50	4.50
2020-21	4.86	4.86	5.00	4.57	4.43	4.71	4.86
2021-22	-	-	-	-	-	-	-
2022-23	4.50	5.00	5.00	5.00	4.50	4.50	4.50
2023-24	4.73	4.60	4.80	4.73	4.27	4.80	4.67

The data in Table 4-8 show that employers of our computer engineering interns are largely satisfied with students' performance. All results exceed the trigger point, which implies that there is no compelling reason to modify the program or the ECE 3890 Internship course based on this data.

B.4. Industrial Advisory Board Recommendations

The Industrial Advisor Board (IAB) consists of program faculty and staff members, engineering managers and engineers from local engineering companies and at least one senior ECE student. The primary role of the IAB is to periodically evaluate the ECE programs and make recommendations for improvement. Board members sometimes represent the companies with whom our graduates are employed, so they have a unique and direct impact on the direction and educational objectives of the program.

The IAB typically convenes once per year in the spring semester. Topics and issues discussed by this board include, but are not necessarily limited to, the following:

1. Review of program educational objectives
2. Program structure
3. Content of courses
4. Declared majors and course enrollments
5. Graduate projections
6. Internship opportunities
7. Full-time hiring projections

The procedure for making program or course changes is illustrated in Figure 4-6. The IAB is free to make recommendations any time of year but typically recommendations come only at the annual IAB meeting when such recommendations are solicited.

Once a recommendation is made, the faculty deliberate to see how best to implement it. If the implementation involves a program assessment, curriculum or course change, a TPS is issued to ensure the change is tracked to completion.

During the review period 2018-2024, the IAB has made several recommendations that have resulted in program or course changes. These recommendations and the corresponding actions taken are summarized in Table 4-8.

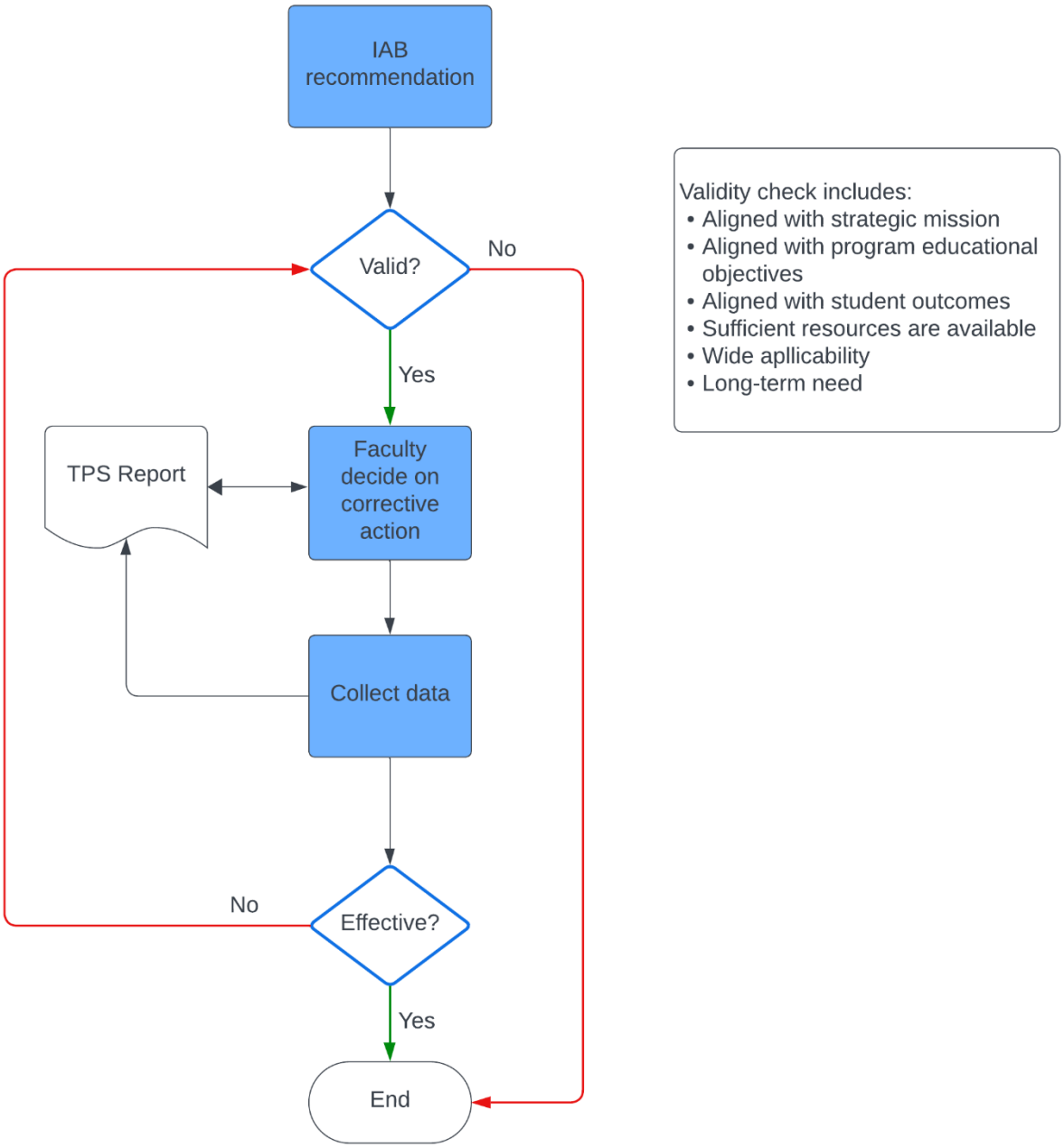

Figure 4-6. Continuous Improvement Process for IAB Recommendations

Table 4-8. IAB Recommendations.

Year	Recommendation	Action Taken
2020	Students should be better trained in the field of instrumentation	The course name and content of ECE 6140 was modified to focus less on the design of sensors and more on instrumentation.
2020	Students doing Digital Design should be trained on the newest Xilinx development tools	ECE 2700 and ECE 3610 were changed to use Vivado instead of ISE Webpack to develop digital designs.
2021	Students need to be familiar with model-based engineering	A new elective, ECE 6640 – Model Based Systems Engineering, was created to satisfy the IAB request.

B.5. Senior Assessment Exam

In 2017, ECE faculty decided that an instrument to directly and globally assess the technical knowledge of our senior students would be helpful. We discussed using the Fundamentals of Engineering (FE) examination administered by the National Council of Examiners for Engineering and Surveying (NCEES). However, we did not want to be constrained by the lack of detailed score reporting, cost, and timing of the FE examination, so we designed an internal exam that resembles the FE exam. Questions similar or identical to those in old FE review manuals were chosen to build the exam.

The exam covers the following 15 topics that map to student outcomes as shown in Table 4-9:

Table 4-9. Senior Assessment Exam Topics and Student Outcomes.

Topic	Outcome
Circuits	1, 6
Computers	1, 6
Controls	1, 6
Digital	1, 6
Economics	2, 4

Topic	Outcome
Electromagnetics	1, 6
Electronics	1, 6
Ethics	4, 5
Mathematics	1
Mechanics	1, 6

Topic	Outcome
Power	1, 6
Probability	1
Properties	1, 2
Signals	1, 6
Software	3, 6

The exam consists of six questions for each topic for a total of 90 questions. To avoid giving a single long exam, we split the exam into two equal parts by giving students 45 questions in ECE 4010 Senior Project I and 45 questions in ECE 4020 Senior Project II.

The exam was administered to students for the first time during the 2017-2018 academic year. Table 4-10 is a summary of the mean scores over the last 7 years with the exception of 2021. In response to COVID, students were allowed to take the exam from home and scores jumped remarkably in Fall of 2020. As a result, the exam was put on hiatus until it could be administered in the testing center again.

Table 4-10. Senior Assessment Exam Scores – Computer Engineering Students.

Topic	Fall 2017	Spring 2018	Fall 2018	Spring 2019	Fall 2019	Spring 2020	Fall 2020	Spring 2021	Fall 2021	Spring 2022	Fall 2022	Spring 2023	Fall 2023
Circuits	41.7%	40.4%	37.9%	36.2%	36.5%	42.3%	64.3%			51.4%	66.6%	55.00%	50.1%
Computers	61.9%	62.6%	65.5%	53.3%	54.2%	76.9%	69.0%			54.0%	73.3%	47.62%	56.9%
Controls	53.0%	44.4%	47.1%	38.1%	47.9%	53.8%	54.8%			39.8%	80.0%	23.81%	43.1%
Digital	56.0%	52.5%	55.2%	47.1%	55.2%	51.9%	76.2%			75.5%	53.3%	57.14%	56.9%
Economics	54.8%	48.5%	44.8%	47.6%	40.6%	72.0%	76.2%			46.9%	46.6%	38.10%	37.3%
Electromagnetics	57.1%	54.5%	60.9%	58.7%	47.9%	53.8%	47.6%			64.3%	66.6%	45.00%	59.7%
Electronics	42.9%	53.5%	51.7%	37.1%	43.8%	51.9%	64.3%			45.0%	53.3%	40.00%	47.8%
Ethics	61.9%	60.6%	66.7%	62.9%	58.3%	74.1%	76.2%			50.7%	60.0%	57.14%	68.6%
Mathematics	82.1%	76.8%	72.4%	72.4%	71.9%	81.5%	88.1%			78.1%	53.3%	80.00%	78.0%
Mechanics	41.7%	34.3%	40.2%	40.4%	31.3%	38.5%	61.9%			31.0%	33.3%	42.11%	38.9%
Power	36.9%	34.3%	27.6%	34.6%	33.3%	42.3%	35.7%			26.2%	6.6%	44.44%	35.9%
Probability	47.6%	50.5%	44.8%	44.8%	43.8%	40.0%	47.6%			28.1%	33.3%	36.84%	36.7%
Properties	41.7%	46.5%	41.4%	43.8%	36.5%	42.3%	57.1%			41.0%	46.6%	52.38%	39.2%
Signals	25.0%	34.3%	26.4%	29.5%	26.0%	33.3%	50.0%			23.1%	26.6%	36.84%	36.7%
Software	60.7%	62.6%	56.3%	55.2%	53.1%	48.1%	69.0%			83.6%	60.0%	76.19%	56.9%
Average	51.0%	50.4%	49.3%	46.8%	45.3%	53.5%	62.5%			49.2%	50.6%	48.8%	49.5%

After a meeting to establish threshold for action on this data, the faculty determined that the large deviation in this data make it unsuitable for an absolute threshold. Instead, a subjective trigger was chosen wherein faculty would look at trends in the data and address topics where the scores were consistently low.

Based on this approach, one program change was initiated during the review period triggered by the senior assessment exam data. The faculty noted Exam Scores through Spring 2022 (excluding the pandemic anomaly) were weaker in the area of signals (27.3%) than in any other topic assessed by the exam. In response, the faculty approved (8/26/22) a curriculum change (and issued a TPS) wherein students may take ECE 5210 (Digital Signal Processing) in lieu of ECE 4100 (Controls). The two courses are offered in alternate semesters.

This curriculum change was made in connection to a course change that adds a laboratory component to ECE 5210. The anticipated result was that (a) more students will take signals courses and (b) those students will receive more instruction on the subject.

The change was implemented in the 2022-2023 academic year and ECE 5210 was offered for the first time under that paradigm Spring 2023. Initial indications are that the change was effective; the exam scores that semester rose from about 27% to about 36%.

C. Additional Information

Copies of any of the assessment instruments or materials referenced in 4.A and 4.B will be available for review at the time of the visit as will other information, such as minutes from meetings where the assessment results were evaluated and where recommendations for action were made.

CRITERION 5. CURRICULUM

A. Program Curriculum

1. Curriculum Description

Table 5-1 describes the plan of study for students. This table lists required and selected elective courses in the order recommended to students for timely graduation. The table also lists the number and type of credit hours, the semester(s) the courses were last offered and the maximum enrollments. Weber State University is on the semester system and credits reported are semester credit hours.

The Computer Engineering Program has no special curricular options.

Elective courses that have not been offered in the previous four semesters have been omitted.

Table 5-1 Curriculum

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)*			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]
		Math & Basic Sciences	Engineering Topics; Check if Contains Significant Design (√)	Other		
Semester 1						
ECE 1000 – Introduction to Electrical Engineering *or*	SE		*2* (√)		*F23, S24*	*48*
ENGR 1000 – Introduction to Engineering	SE		*2*		*F23, S24*	*140*
MATH 1210 – Calculus I	R	4			*F23, S24*	*475*
PHYS 2210 – Physics for Scientists and Engineers I	R	5			*F23, S24*	*270*
LIBS 1701 – Information Literacy	R			*1*	*F23, s24*	*N/A*
General Education – American Institutions	R			*3*	*F23, S24*	*N/A*
Semester 2						
ECE 2700 – Digital Circuits	R		*4* (√)		*F23, S24*	*72*
MATH 1220 – Calculus II	R	4			*F23, S24*	*380*
PHYS 2220 - Physics for Scientists and Engineers II	R	5			*F23, S24*	*185*
ECE 1400 – Fundamentals of Engineering Computing	R		*4*		*F23, S24*	*74*
Semester 3						
ECE 1270 – Introduction to Electric Circuits	R		*4*		*F23, S24*	*72*
CS 1410 – Object Oriented Programming					*F23, S24*	*260*
ECON 2010 – Principles of Microeconomics	R			*3*	*F23, S24*	*600*
COMM 2110 – Interpersonal and Small Group Communication	R			*3*	*F23, S24*	*>1000*
ENGL 2010 – Intermediate Writing	R			*3*	*F23, S24*	*>1000*
Semester 4						
ECE 2260 – Fundamentals of Electric Circuits	R		*4*		*Su23, F23*	*72*
ENGR 2240 – Dynamic Systems Engineering *or both*	SE	4			*S23, S24*	*24*

MATH 2270 – Linear Algebra *and*	SE	3			*F23, S24*	*103*
MATH 2280 – Ordinary Differential Equations	SE	3			*F23, S24*	*112*
CS 2130 – Computational Structures	R		*4*		*F23, S24*	*210*
CS 2420 – Introduction to Data Structures and Algorithms	R		*4*		*F23,S24*	*195*
General Education – Creative Arts / Diversity	R			*3*	*F23, S24*	*N/A*
Semester 5						
ECE 3000 – Seminar	R		*1*		*F22, F23*	*72*
ECE 3110 – Microelectronics I	R		*4*		*F22, F23*	*74*
ECE 3210 – Signals & Systems	R		*4*		*F22, F23*	*72*
ECE 3610 – Digital Systems	SE		*4* (√)		*F22, F23*	*72*
ENGL 3100 – Professional and Technical Writing *or*	SE			*3*	*F23, S24*	*193*
PS 3250 – Business Communication	SE			*3*	*F23, S24*	*533*
Semester 6						
ECE 3090 – Project Management	R		*1*(√)		*F23, S24*	*48*
ECE 3430 – Engineering Probability & Statistics *or*	SE	3			*S23, S24*	*48*
MATH 3410 – Probability & Statistics	SE	3			*F23, S24*	*138*
ECE 3710 – Embedded Systems	R		*4* (√)		*S23, S24*	*72*
ECE 3890 – Internship	R		*1*		*F23, S24*	*48*
CS 3100 – Operating Systems	R		*4*		*F23, S24*	*205*
Semester 7						
ECE 4010 – Senior Project I	R		*2* (√)		*F23, S24*	*48*
General Education – Life Science	R	4			*F23, S24*	*N/A*
Electives (choose 2)						
ECE 3510 – Power Systems *or*	SE		*4*		*F22, F23*	*44*
ECE 4100 – Control Systems or	SE		*4*		*F22, F23*	*48*
ECE 5140 – Sensors and Instrumentation	SE		*3*		*F21, F23*	*36*
ECE 5410 – Communication Circuits & Systems	SE		*3*		*F21, F23*	*36*
ECE 5440 – Optical Communication	SE		*3*		*F21*	*18*
ECE 5220 – Image Processing	SE		*3*		*F21*	*18*
ECE 5710 – Real-Time Systems	SE		*4*		*F21, F23*	*36*
ECE 5730 – Robotics	SE		*4*		*F21, F23*	*36*
ECE 5420 – Digital Communication	SE		*3*		*F20, F22*	*36*

ECE 5640 – Model-based Systems Engineering	SE		*3*		*F22*	*18*
CS 4280 – Computer Graphics	SE		*4*		*F22, S24*	*60*
CS 5200 – The Internet of Things	SE		*3*		*F23*	*7*
CS 5600 – Machine Learning	SE		*3*		*F22, F23*	*9*
CS 5740 – Computer Systems Security	SE		*3*		*F22*	*3*
CS 5820 – Compiler Design	SE		*3*		*F22, F23*	*6*
Semester 8						
ECE 4020 – Senior Project II	R		*2* (√)		*F23, S24*	*48*
General Education – Social Science	R			*3*	*F23, S24*	*N/A*
General Education – Humanities	R			*3*	*F23, S24*	*N/A*
Electives (choose 2)						
ECE 3120 – Microelectronics II	R		*4*		*S23, S24*	*48*
ECE 3310 – Electromagnetics	R		*4*		*S23, S24*	*48*
ECE 3730 – Fundamentals of Robotics	SE		*4*		*S22, S24*	*36*
ECE 5110 – Digital VLSI	SE		*3*		*S21, S23*	*36*
ECE 5130 – Advanced Semiconductor Devices	SE		*3*		*S22, S24*	*36*
ECE 5210 – Digital Signal Processing	SE		*4*		*S23, S24*	*48*
ECE 5750 – Quantum Computer Engineering	SE		*3*		*S22, S24*	*36*
ECE 5800 – Individual Studies	SE		*1-4*		*N/A*	*N/A*
ECE 5900 – Special Topics	SE		*1-4*		*N/A*	*N/A*
CS 4110 – Formal Languages & Algorithms	SE		*4*		*F23, S24*	*165*
CS 5420 – Advanced Algorithms	SE		*3*		*S23, S24*	*7*
CS 5610 – Computer Architecture	SE		*3*		*S23, S24*	*12*
CS 5850 – Parallel Programming & Architecture	SE		*3*		*Su22, Su23*	*6*
TOTALS (in terms of semester credit hours)		51	*114*			
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.

2. Alignment of Curriculum to Program Educational Objectives

The program educational objectives are to produce graduates that are able to:

- Apply their engineering skills, through theory and application, in industry, government, society, or in graduate school;
- Practice high technical and ethical standards and communicate their work to colleagues, industry, and professional organizations;
- Work effectively and contribute in interdisciplinary fields while encouraging expression and valuing diversity;
- Understand the importance of lifelong learning and continuous professional growth in a changing world as shown through self-directed learning, specialized trainings, certifications, licensing, and graduate programs.

The alignment of the curriculum with the program educational objectives can be inferred from Figure 3-1 (Criterion 3) and Table 4-2 (Criterion 4) via the student outcomes. A more direct representation of the alignment is shown in Table 5-2 for convenience.

Because acquisition and application of engineering skills are the primary focus of the technical part of the program curriculum, the first educational objective encompasses most of the courses. The other three program educational objectives encompass the so-called “soft” skills and knowledge areas contained primarily in the seminar, internship, project management and senior project courses.

Table 5-2 Curriculum Alignment

Program Educational Objective	Computer Engineering Course
Apply their engineering skills, through theory and application, in industry, government, society, or in graduate school	ECE 1270 Introduction to Electrical Circuits ECE 1400 Fundamentals of Engr Computing ECE 2260 Fundamentals of Electrical Circuits ECE 2700 Digital Circuits ECE 3000 Engineering Seminar ECE 3090 Project Management ECE 3110 Microelectronics I ECE 3210 Signals & Systems ECE 3430 Engineering Probability and Statistics ECE 3610 Digital Systems ECE 3710 Embedded Systems ECE 3890 Internship ECE 4010 Senior Project I ECE 4020 Senior Project II
Practice high technical and ethical standards and communicate their work to colleagues, industry, and professional organizations	ECE 3000 Engineering Seminar ECE 3090 Project Management ECE 3710 Embedded Systems ECE 3890 Internship ECE 4010 Senior Project I ECE 4020 Senior Project II
Work effectively and contribute in interdisciplinary fields while encouraging expression and valuing diversity	ECE 3000 Engineering Seminar ECE 3090 Project Management ECE 3890 Internship ECE 4010 Senior Project I ECE 4020 Senior Project II
Understand the importance of lifelong learning and continuous professional growth in a changing world as shown through self-directed learning, specialized trainings, certifications, licensing, and graduate programs	ECE 3000 Engineering Seminar ECE 3090 Project Management ECE 3890 Internship ECE 4010 Senior Project I ECE 4020 Senior Project II

3. Curriculum Prerequisite Structure and Student Outcomes

The curriculum supports the attainment of student outcomes delineated in Table 4-2 of Criterion 4. By carefully considering the curricular content of each Computer Engineering course, the faculty ascertained that specific student outcomes are supported by the courses designated "highly applicable" in Table 4-2.

For example, Outcome 1 is the ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

One of the courses that the faculty has designated "Highly applicable" to this outcome is *ECE 3210 – Systems and Signals*. This course teaches students to solve complex problems by applying, e.g. Laplace and Fourier transforms to solve differential equations applicable to signals. This course has the prerequisite "*ECE 2260 and either ENGR 2240, MATH 2250 or both MATH 2270 and MATH 2280*". This prerequisite structure ensures that students understand differential equations (ENGR 2240, etc.) and that students are familiar with electrical circuits and signals (ECE 2260). ECE 2260 in turn has a prerequisite of "*MATH 1220 and either*

ECE 1270 or ECE 2210" which ensures that students have mastered basic circuits and integral calculus before moving on to electrical signals.

For every course that is highly applicable to one or more student outcomes, a course assessment rubric is used to ensure each outcome associated with that course is being attained. For example, *ECE 3710 – Embedded Systems* is highly applicable to outcomes (1) and (3) so it has a course assessment rubric that measures, semester by semester, its attainment of outcomes (1) and (3). ECE 3090 Project Management on the other hand is highly applicable to outcomes (2), (3), (4), (5) and (7) so its course assessment rubric scores its attainment of those outcomes.

The prerequisite structure of the required courses in this program is given in Table 5-4.

4. Prerequisite Structure Worksheet

The prerequisite structure for required courses is shown in Table 5-4. General Education Courses (except physics and chemistry) are not listed nor are co-requisite lab courses. For courses that have multiple pre-requisite options, only the option typically taken by Computer Engineering Students may be listed.

Table 5-4 Prerequisite Structure of Required Courses

Course	Prerequisite(s) – Items marked with (*) may be taken concurrently
MATH 1210 – Calculus I	MATH 1080 – Pre-calculus
MATH 1220 – Calculus II	MATH 1210 – Calculus I
MATH 2270 – Linear Algebra	MATH 1220 – Calculus II
MATH 2280 – Ordinary Differential Equations	MATH 1220 – Calculus II
MATH 3410 – Probability & Statistics	MATH 1220 – Calculus II
PHYS 2210 – Physics for Scientists and Engineers I	MATH 1210 – Calculus I*
PHYS 2220 - Physics for Scientists and Engineers II	PHYS 2220 - Physics for Scientists and Engineers II MATH 1220 – Calculus II*
ENGL 3100 – Professional and Technical Writing	ENGL 2010 – Intermediate College Writing
ENGR 1000 – Introduction to Engineering	MATH 1080 – Pre-calculus
ENGR 2240 – Dynamic Systems Engineering	MATH 1210 – Calculus I ECE 1400 – Fundamentals of Engineering Computing ECE 1270 – Introduction to Electric Circuits
ECE 1000 – Introduction to Electrical Engineering	MATH 1210 – Calculus I*
ECE 1270 – Introduction to Electric Circuits	MATH 1220 – Calculus II* *and either* ECE 1000 – Introduction to Electrical Engineering* *or* ENGR 1000 – Introduction to Engineering*
ECE 1400 – Fundamentals of Engineering Computing	MATH 1210 – Calculus I *and either* ECE 1000 – Introduction to Electrical Engineering *or* ENGR 1000 – Introduction to Engineering
ECE 2260 – Fundamentals of Electric Circuits	MATH 1220 – Calculus II ECE 1270 – Introduction to Electric Circuits
ECE 2700 – Digital Circuits	ECE 1000 – Introduction to Electrical Engineering *or* ENGR 1000 – Introduction to Engineering
ECE 3000 – Seminar	ECE 1270 – Introduction to Electric Circuits
ECE 3090 – Project Management	Departmental Permission
ECE 3110 – Microelectronics I	MATH 1220 – Calculus II ECE 1270 – Introduction to Electric Circuits
ECE 3210 – Signals & Systems	ECE 2260 – Fundamentals of Electric Circuits and either ENGR 2240 – Dynamic Systems Engineering *or*

	MATH 2270 – Linear Algebra *and* MATH 2280 – Ordinary Differential Equations
ECE 3430 – Engineering Probability & Statistics	MATH 1220 – Calculus II ECE 1400 – Fundamentals of Engineering Computing
ECE 3610 – Digital Systems	ECE 2700 – Digital Circuits ECE 1400 – Fundamentals of Engineering Computing
ECE 3710 – Embedded Systems	ECE 2700 – Digital Circuits ECE 1400 – Fundamentals of Engineering Computing ENGL 3100 – Professional and Technical Writing*
ECE 3730 – Fundamentals of Robotics	ECE 1400 – Fundamentals of Engineering Computing
ECE 3890 – Internship	Departmental Permission
ECE 4010 – Senior Project I	Departmental Permission
ECE 4020 – Senior Project II	ECE 4010 – Senior Project I
ECE 4100 – Control Systems	ECE 3110 – Microelectronics I ECE 3210 – Signals & Systems
ECE 5110 – Digital VLSI	ECE 3110 – Microelectronics I ECE 3610 – Digital Systems
ECE 5210 – Digital Signal Processing	ECE 3210 – Signals & Systems
ECE 5220 – Image Processing	ECE 3210 – Signals & Systems
ECE 5130 – Advanced Semiconductor Devices	PHYS 2220 - Physics for Scientists and Engineers II ECE 3110 – Microelectronics I
ECE 5140 – Sensors and Instrumentation	PHYS 2220 - Physics for Scientists and Engineers II ECE 3110 – Microelectronics I
ECE 5410 – Communication Circuits	ECE 3210 – Signals & Systems *and either* ECE 3430 – Engineering Probability & Statistics *or* MATH 3410 – Probability & Statistics
ECE 5420 – Digital Communication	ECE 3210 – Signals & Systems *and either* ECE 3430 – Engineering Probability & Statistics *or* MATH 3410 – Probability & Statistics
ECE 5440 – Optical Communication	ECE 3310 – Electromagnetics
ECE 5640 – Model-based Systems Engineering	ECE 3610 – Digital Systems
ECE 5710 – Real-Time Systems	ECE 3710 – Embedded Systems
ECE 5730 – Robotics	ECE 3730 – Fundamentals of Robotics
ECE 5750 – Quantum Computer Engineering	ECE 2700 – Digital Circuits PHYS 2220 - Physics for Scientists and Engineers II

	MATH 3410 – Probability & Statistics ENGR 2240 – Dynamic Systems Engineering *or* MATH 2270 – Linear Algebra *and* MATH 2280 – Ordinary Differential Equations
ECE 5800 – Individual Studies	Permission
ECE 5900 – Special Topics	Permission
CS 1410 – Object Oriented Programming	ECE 1400 – Fundamentals of Engineering Computing, *or* CS 1400 – Programming I
CS 2130 – Computational Structures	ECE 1400 - Fundamentals of Engineering Computing, *or* CS 1400 – Programming I
CS 2420 – Introduction to Data Structures and Algorithms	CS 1410 – Object Oriented Programming MATH 1220 – Calculus I
CS 3100 – Operating Systems	CS 2420 – Introduction to Data Structures and Algorithms CS 2810 - Computer Architecture/Organization, *or* ECE 3620 – Microprocessor Architecture
CS 4110 – Formal Languages & Algorithms	CS 2130 – Computational Structures CS 2420 – Introduction to Data Structures and Algorithms
CS 4280 – Computer Graphics	CS 2420 – Introduction to Data Structures and Algorithms
CS 5200 – The Internet of Things	CS 2810 – Computer Architecture/Organization, *or* ECE 3710 – Embedded Systems
CS 5420 – Advanced Algorithms	CS 2420 – Introduction to Data Structures and Algorithms
CS 5600 – Machine Learning	CS 2420 – Introduction to Data Structures and Algorithms
CS 5610 – Computer Architecture	CS 2810 – Computer Architecture/Organization, *or* ECE 3710 – Embedded Systems
CS 5740 – Computer Systems Security	CS 2420 – Introduction to Data Structures and Algorithms CS 3100 – Operating Systems
CS 5820 – Compiler Design	CS 2130 – Computational Structures CS 2420 – Introduction to Data Structures and Algorithms
CS 5850 – Parallel Programming & Architecture	CS 3100 – Operating Systems

5. Conformance to General and Program Specific Requirements

This section addresses how the program meets the requirements in terms of hours and depth of study for each subject area (Math and Basic Sciences, Engineering Topics, Broad Education and Design Experience) specifically addressed by either the general criteria or the program criteria.

Subject Area: Math and Basic Sciences

General Criteria: a minimum of 30 semester credit hours (or equivalent) of a combination of college-level mathematics and basic sciences with experimental experience appropriate to the program.

Program-Specific Criteria: must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus, discrete mathematics; sciences (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software.

The curriculum requires 10 credits of physics, 5 credits of chemistry and 19 credits of mathematics (8 Calculus, 3 Probability, 4 Linear Algebra/Differential Equations, 4 Discrete Mathematics). This sums to 34 semester credit hours.

Students may select MATH 3410 or ECE 3430 to satisfy the probability and statistics requirement. The mathematics department has agreed to teach engineering applications appropriate to the all engineering programs established at Weber State University.

Students may select MATH 2250, ENGR 2240 or both MATH 2270 and MATH 2280 to satisfy the linear algebra/differential equations requirement.

Students take CS 2130 (Computational Structures) to satisfy the discrete mathematics requirement.

Students design, analyze and experiment with complex hardware systems in ECE 3610 and complex software/hardware systems in ECE 3710. These topics are then reinforced in ECE 4010 and ECE 4020 (Senior Projects). Analysis is also taught in ECE 1270, ECE 2260, ECE 3110, ECE 3210, ECE 3310, ECE 3510, ECE 4100, and ECE 5210.

Subject Area: Engineering Topics

General Criteria: a minimum of 45 semester credit hours (or equivalent) of engineering topics appropriate to the program, consisting of engineering and computer sciences and engineering design, and utilizing modern engineering tools.

Program-Specific Criteria: must include engineering topics necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components.

The curriculum requires 60 credits of engineering topics (ECE 1270, ECE 1400, ECE 2260, ECE 2700, ECE 3110, ECE 3210, ECE 3610, ECE 3710, ECE 4010, ECE 4020, CS 1410, CS 2420, CS 3100 and 12 credits of electives).

Modern engineering tools are employed in many of the courses. In terms of hardware tools, for example, the oscilloscopes, digital multimeters, function generators and power supplies in the teaching labs are the late models from Keysight and have all been purchased since 2022. Other hardware tools a potentiostat is used in ECE 5140, and a high-speed camera is used in ENGR 2240. Students working on their senior projects have access to several modern engineering tools as listed in Table 7-1.

In terms of modern software tools, Vivado is used in ECE 2700 and ECE 3610, Python and Git are used in ECE 1400, Multisim/LTSpice is used in ECE 3110, Enterprise-Architect SysML is used in ECE 5640, and MAGIC is used in ECE 5110 and ECE 5120.

Students design, analyze and experiment with complex hardware systems in ECE 3610 and complex software/hardware systems in ECE 3710. These topics are then reinforced in ECE 4010 and ECE 4020 (Senior Projects). Analysis is also taught in ECE 1270, ECE 2260, ECE 3110, ECE 3210, ECE 4100.and ECE 5210.

Subject Area: Broad Education

General Criteria: a broad education component that complements the technical content of the curriculum and is consistent with the program educational objectives

In addition to general education courses in English and quantitative literacy, Weber State requires Social Science (6 credits), Humanities (3 credits) Creative Arts (3 credits), Physical Science (3 credits) Life Science (3 credits) and American Institutions (3 credits). There are an additional 6 credits required, but students cannot take more than one general education course from any one department. This provides students with a broad educational background that helps them attain program educational objective 3, "*Work effectively and contribute in interdisciplinary fields while encouraging expression and valuing diversity*." See also Subsection 6, below.

Subject Area: Design Experience

General Criteria: 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.

The required design experience is provided by ECE 3090, ECE 4010 and ECE 4020. (See Subsection 7, below). Briefly, in ECE 3090, students develop business cases, write project proposals and often apply for funding for their senior projects. Students are required to list requirements, constraints and applicable standards (if any) in their proposals. Depending on the complexity of the project, design teams consist of one to three students plus an advisor (who is usually not a member of the faculty). In ECE 4010 teams develop the design for the project and in ECE 4020 they implement it. At the end of ECE 4010 and ECE 4020 teams must present a critical design review and a final design review, respectively.

To ensure students use the knowledge and skills acquired in earlier courses, students who have not registered for their 3000-level core courses are not allowed to enroll in ECE 3090*.

* In practice, students are allowed to register for ECE 3090 if no more than one core-level course is missing so long as it is not probability and statistics.

6. Broad Education Component

Students at Weber State are required to take 24 credits in various subject areas, which gives students a broad understanding of societal, cultural, economic and contemporary issues. This can provide an engineer with a better understanding of the requirements and constraints he or she may encounter in engineering practice. There are, however, specific general education courses that directly relate to the program educational objectives and are required by the Computer Engineering program. Students are required to take the general education courses COMM 2110 (small group communication) and ECON 2010 (Microeconomics) to help students achieve program objectives 2 (communicate their work to colleagues) and 3 (Work effectively and contribute in interdisciplinary fields).

7. Design Projects

ECE 3090, ECE 4010 and ECE 4020 constitute required capstone courses that not only prepare students for engineering practice but integrate as much of the curriculum as possible into a dedicated design experience. Each project, overseen by a faculty member, requires students to plan, budget, design, analyze, build, test and document a device or system that performs an engineering or scientific function. The project typically originates from industry or a research project of the faculty. The academic requirements and guidelines for the computer engineering capstone project are given in Appendix E, Senior Project Workbook.

Design projects typically require a great deal of circuit analysis, a topic that is extensively covered in several courses. Depending on the nature of the project, writing code may also be required. Because projects are carried out by two or more people working together, students learn how to function on teams, a critical skill for successful engineering practice. Communication, individual responsibility and professionalism are attributes that a team-based project begin to foster in students as they make the transition from the university to industry.

Engineering codes and standards are an integral part of engineering practice. Depending on the nature and scope of the senior project, students are introduced to some of the codes and standards used in the electrical and electronics industry. The Institute of Electrical and Electronics Engineers (IEEE) has developed standards for a variety of systems and processes. For example, IEEE 488 (Standard digital interface for programmable instrumentation) and IEEE 1076 (VHDL - VHSIC hardware description language) are two well-known IEEE standards to which students may be introduced.

Because engineering design is a decision making process in which resources are optimally converted to meet desired needs, design is inherently subject to constraints. Generally speaking, the constraints that are emphasized in senior projects are the functional, economic, timing and safety constraints. These four constraints are emphasized because the students must obviously design and build devices and systems that work within limiting electrical and mechanical parameters. The projects must also be completed within budget and on schedule. Economic constraints are driven by the allocated budget for the project, and timing constraints are driven by project related schedules as well as academic calendar deadlines. Also, the device or system must not pose a safety hazard of any kind to the user or the public. Other constraints (environmental, life-cycle, legal, etc.) may apply, depending on the nature and scope of the project.

Design constraints are addressed in Section 8 of the senior project workbook (Appendix E). Students must document both design constraints and applicable standards as specified in Section 9 of the senior project workbook (see excerpt of documentation requirements, below):

> 3.2. Constraints
> This section enumerates the design constraints (i.e. what limitations are imposed on the design). Constraints include cost, physical, scheduling and safety constraints. Often, constraints are not tested, per se. Instead, analysis of the design is used to verify that the constraints are satisfied.
>
> 3.3. Applicable Standards
> This section lists the engineering standards applicable to the design (if any). Engineering standards are part of many designs, particularly those that communicate electronically (e.g. use USB, I2C, SPI, CAN, RS-232, Ethernet, etc.).

The use and documentation of multiple design constraints is measured by a performance indicator in the course assessment rubrics for ECE 4010 and ECE 4020.

During the 2023-2024 academic year, the following capstone projects were completed (at least one student on each team was an computer engineering student):

- Autonomous Drone and Base Station
- Artificial Reverberation
- Optical Frequency Domain Reflectometry

8. Cooperative Education

Cooperative education, referred to as “Internship” in the program, is addressed by the general criteria. As shown in Table 4-2 of Criterion 4, student outcomes (2), (3), (4), (5), (6) and (7) are highly applicable to ECE 3890 Internship, a required one-credit hour course. ECE 3890 Internship is a course in which the student works part time for a local engineering company in order to receive industrial experience while attending school.

Faculty evaluate internships using two assessment instruments. The first instrument is a course assessment rubric that faculty use to rate student performance for each of the applicable outcomes. Details of course rubric content and their use are discussed in Criterion 4, Section B. The second instrument is a survey for the employer of the intern. Faculty administer the survey to the employer at the conclusion of the internship. The employer internship survey asks ten questions relating to the responsibilities, timeliness, professionalism, communication, ethics and overall performance. Seven of the ten questions are assigned a numerical rating that is used to quantify results..

9. Materials Available During On-site Visit

The following materials will be available for review during the on-site visit:

• textbooks used in Computer Engineering courses

• course syllabi

• samples of student work that pertain to the achievement of student outcomes (1) through (7):
  - examinations and quizzes
  - homework
  - laboratory reports
  - class reports
  - senior project log books
  - senior project design documentation
  - other student work as appropriate

B. Course Syllabi

Syllabi for each course used to satisfy the general and discipline-specific requirements of Criterion 5 are included in Appendix A.

CRITERION 6. FACULTY

A. Faculty Qualifications

There are eight full-time faculty associated with the Computer Engineering program, each of whom have doctorates in Electrical Engineering, Computer Engineering or a closely related field (See Table 6-2 and Appendix B). The combined years of industrial experience of the faculty is 87 years and the combined years of teaching experience of the faculty is 84 years. During the most recent review period the department has employed two Adjunct Professors, each of whom has a MS degree in Electrical Engineering.

All the faculty are qualified and capable of teaching all lower division courses, and while all the faculty could teach any of the Junior-level courses, it has been policy to have faculty teach the courses that align to their strengths. The elective courses, on the other hand, are taught by faculty who specialize in the particular subject area. Some of the areas of expertise of the faculty are listed in Table 6-1.

Table 6-1. Full-time Faculty Areas of Expertise

Faculty Member	Areas of Expertise
Fon Brown	Embedded Systems Real-time Systems Digital Communication
Shellee Dyer	Quantum Computing Optics
A. Tye Gardner	Sensors and Instrumentation Digital Systems Model Based Engineering
Eric Gibbons	Signal Processing Image Processing Stochastic Systems
Christian Hearn	Electromagnetics Antennas Analog Communication
Justin B. Jackson	Microelectronics Semiconductor Physics VLSI
Alyssa Mock	Electromagnetics Material Science Probability
Jonathan West	Power and Power Electronics Robotics VLSI

Faculty resumes are provided in Appendix B.

B. Faculty Workload

Table 6-3 summarizes the workload of the Engineering faculty. Weber State University full-time faculty are assigned a teaching load of 24 credit hours per academic year, which means that faculty teach approximately 12 credit hours per semester. The program coordinator receives three credit hours per semester of equivalent load for that duty as does the director of the graduate program. The department chair receives six credit hours per semester of equivalent load for that duty. The “Other” category in Table 6-3 includes time devoted to these advising and administrative responsibilities.

C. Faculty Size

The department is currently shorthanded by approximately two tenure track faculty as evidenced by the ubiquitous nature of teaching overload. One additional faculty member has been hired and will start Fall 2024. A recent grant award has provided a 2nd faculty line but the recent search to fill that line failed. A new search will begin at the start of Fall 2024.

A growing number of biomedical engineering students will require additional faculty resource allocation with four new courses being offered in the next 2 years and will need a 3 credit hour course release for a BME program coordinator. Combined, these two will reduce available faculty for ECE courses and it is expected that we will need another faculty member in the coming years.

As a teaching-focused institution, the faculty’s primary responsibilities are teaching related, and we pride ourselves on our high-quality teacher-student relationships. Faculty are required to have 5 office hours per week, teach all the laboratory courses, and supervise senior projects. The department program coordinator has a course release and is, in part, responsible for advising students. The department receives generally positive feedback on faculty availability.

Department faculty are involved in a wide range of service positions that includes faculty senate, executive committee, funding committees (Research & Professional Growth (RSPG), Academic Resources & Computing (ARCC)), graduate council, and in the Office of Undergraduate Research. Faculty are able to find satisfactory service positions.

Faculty members in the department are required to have industry or national laboratory experience, enabling strong connections to industry. Industry professionals interact with faculty in the following ways: 1) The industrial advisory board, 2) internships, 3) external senior project supervisors, 4) industry/faculty research collaborations and 5) consulting.

D. Professional Development

Provide detailed descriptions of professional development activities for each faculty member.

All engineering faculty are expected to stay current in their discipline through activities such as research, conferences, trainings, and other professional and scholarly activities. Professional development opportunities are adequate, perhaps even very good for a university like WSU. The college provides resources for faculty looking to grow, internal funding resources from the RSPG and ARCC committees provide small research grants, travel funds, and stipends for other professional development activities. The department provides funds for conference travel, matching funds for internal grant applications, and pays for professional membership registration (IEEE, ASEE, etc).

Professional development activity examples

Faculty at Weber State University may pursue professional development activities through many different avenues. For example, Dr. Gardner took short courses on Model-based systems engineering from MIT and from the Israeli Institute of Technology in response to needs expressed by the industrial advisory board. He is also currently pursuing an MBA funded by the University to strengthen project management, technical writing, and other soft-skills within the curriculum. The college also paid for a Council for Advancement and Support of Education-Development for Deans conference to support Dr. Gardner's ambitions in academic leadership.

In contrast, Dr. Hearn exemplifies professional development through research and industry collaboration. His professional objective is to develop and maintain a student-focused applied electromagnetics (EM) program. The initial effort began in 2018 with a near-term goal to improve EM measurement capabilities. The Utah NASA Space Grant Consortium (UNSGC) has twice awarded support for undergraduates to develop a low-cost, software-radio based open-source antenna radiation pattern measurement system. In addition to creating realistic EM laboratory exercises and one of the department's few MS theses, program outcomes include collaborations with industry (KIHOMAC), DoD (NSWC-DNA) and academia (VT). Current thesis-level research is supported with two UNSGC fellowships.

Similarly, faculty may choose to pursue an industry position for their sabbatical, such as done by Dr. Jackson. Dr. Mock has a continuing collaboration with an industry partner who manufactures materials science related instrumentation. Dr. Dyer primarily pursues research suitable for Engineering Education venues such as ASEE. Further examples of professional development can be found in each faculty members CV.

E. Authority and Responsibility of Faculty

Faculty are responsible for the content and creation of courses within their area of expertise and have wide latitude in implementation so long as the course content meets the established rubric. Changes to the rubric must be proposed to the department and the department chair facilitates a vote. Each faculty member is responsible for filling out course rubrics for each section taught, identifying shortcomings and proposing solutions. Lower division courses taught by multiple faculty members still allow faculty wide latitude in implementation, but in instances where teaching preferences conflict, the issue must be raised in a faculty meeting and the department chair facilitates a vote. In virtually all cases, the faculty have been able to come to agreements about lower-division course content.

Any ECE faculty member may propose a change to the PEO's, at which point the department chair would facilitate a vote. Student outcomes are tied directly to the ABET student outcomes. The dean and provost have little-to-no input on course or curriculum matters, but rather seek to facilitate cooperation between departments, maximize resource usage efficiency across the college and university, and are part of approving (but not proposing or modifying) proposals. All course proposals and program changes must be submitted through the university system, and the proposals are reviewed by the college curriculum committee, the Dean, the university curriculum committee, the Faculty Senate, and finally the President's Council.

Table 6-2. Faculty Qualifications

Bachelor of Science in 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
Fon Brown	Ph. D. Electrical Engineering, 1998	P	T	FT	26	17	14		M	L	H
Shellee Dyer	Ph. D. Electrical Engineering,	AST	TT	FT	22	8	5		H	M	L
A. Tye Gardner	Ph. D. Electrical Engineering, 2020	AST	TT	FT	7	5	4		H	H	L
Eric Gibbons	Ph. D. BioEngineering, 2017	AST	TT	FT	2	8	6		M	L	L
Christian Hearn	Ph. D. Electrical Engineering, 2012	ASC	T	FT	8	16	13	PE (VA)	M	M	H
Justin B. Jackson	Ph. D. Electrical Engineering, 2008	P	T	FT	3	17	17		M	M	L
Alyssa Mock	Ph. D. Electrical Engineering, 2017	AST	TT	FT	3	3	3	FE	H	L	M
Jonathan West	Ph. D. Engineering, 2017	AST	TT	FT	16	10	4		L	L	L
Trent Tholen	MS Electrical Engineering, 2019	A	NTT	PT	31	4	4	PE	H	L	M
Eric Widdison	MS Electrical Engineering	A	NTT	PT							

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other
2. Code: T = Tenured TT = Tenure Track NTT = Non-Tenure Track
3. FT = Full-Time Faculty or PT = Part-Time Faculty
4. The level of activity (high, medium or low) should reflect an average over the three years prior to the visit.

Table 6-3. Faculty Workload Summary

Bachelor of Science in Computer Engineering

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2] (Academic Year 2023-24)	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research or Scholarship	Other[4]	
Fon Brown	FT	ECE 2700/4, F23 ECE 3710/4, S24x2 ECE 5710/4, F23	40	10	50	100
Shellee Dyer	FT	ECE 1270/4, F23x2 ECE 2260/4, S24x2 ECE 4020/2, F23 ECE 5750/3, S24 ECE 5800/2, F23	70	15	15	100
A. Tye Gardner	FT	ECE 2700/4, S24x2 ECE 3090/1, F23, S24 ECE 3610/4, F23x2 ECE 4010/2, S24 ECE 5140/3, F23	70	15	15	100
Eric Gibbons	FT	ECE 1400/4, F23 ECE 3000/1, F23 ECE 3210/4, F23x2 ECE 3430/3, S24 ECE 5210/4, S24	60	10	30	100
Christian Hearn	FT	ECE 1270/4, S24 ECE 3000/1, F23 ECE 3310/4, S24 ECE 4100/4, F23 ECE 5320/3, S24 ECE 5410/4, F23	70	15	15	70

Justin B. Jackson	FT	ECE 3110/4, F23x2 ECE 3120/4, S24 ECE 4020/2, S24 ECE 3890/1, Su23, F23, S24 ECE 5130/3, S24	60	10	30	100
Alyssa Mock	FT	ECE 1000/2, F23, S24 ENGR 2240, S24	60	25	15	30
Jonathan West	FT	ECE 1400/4, S24x2 ECE 3510/4, F23x1.5 ECE 3730/4, S24 ECE 4010/2, F23 ECE 5730/4, F23	70	10	20	100
Eric Widdison	PT	ECE 2260/4, Su23	100	0	0	100

1. FT = Full-Time Faculty or PT = Part-Time Faculty, at the institution
2. For the academic year for which the Self-Study Report is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. Out of the total time employed at the institution.

CRITERION 7. FACILITIES[1]

A. Offices, Classrooms and Laboratories

This section summarizes the program's facilities in terms of their ability to support the attainment of the student outcomes and to provide an atmosphere conducive to learning.

1. Offices

The Department of Electrical and Computer Engineering occupies the southwest corner of the second floor of the Noorda Engineering Building (NB). NB is a four-story building located in the north-central part of the WSU Ogden campus that was completed in 2022. This ECE office area houses faculty offices, the department reception area, a conference room and a workroom. A total of thirteen offices have been assigned to the ECE department of which eight are occupied by full-time faculty and one is shared by the adjunct professors. Each office contains a desk, three chairs, a book case and file drawers. Occupied offices are furnished with either a desktop or laptop computer.

Three of the thirteen offices are disjoint from the other ten and have an antechamber containing desks suitable for tutoring.

The department administrative assistant works in the reception area. She has a large work surface and raised counter, file cabinets, storage cabinets, computer, and a networked color copier/printer/scanner. Adjacent to the reception area is a secure workroom with faculty mail boxes, office supplies, storage and a small refrigerator. Department meetings and other gatherings are held in the conference room which is also adjacent to the reception area. The conference room has storage cabinets, a bookshelf and a small refrigerator.

2. Classrooms

Four classrooms are dedicated to the ECE department, however if more classrooms are needed, they can be scheduled using a centralized scheduling service. The classrooms (NB-101, NB-236, NB-325 and NB-326) are located throughout the Noorda building. Each is equipped with a computer, projector, speakers, microphone, document scanner and an HDMI port for laptop projection. Each room has a three-layer whiteboard that allows faculty to slide one layer toward the ceiling or floor and continue to write on the next layer.

The maximum number of seats in each room is 24 with the exception of NB 101, which has a capacity of 28.

3. Laboratories

Table 7-1 lists the basic laboratory equipment and engineering related software packages installed on the laboratory computers. A detailed list of equipment is given in Appendix C.

Laboratories are available to the students from about 8:30 am to 10:00 pm, Monday through Friday, during the fall and spring semesters, including final examination periods.

[1]Include information concerning facilities at all sites where program courses are delivered.

Table 7-1 Laboratory Facilities

Room	Description	Equipment	Software
NB-102	Open Lab	10 computers, power supplies, multimeters, oscilloscopes, and function generators	MS Office, Adobe, Vivado, LT Spice, Labview, MATLAB, Python, VS Code, NI Multisim, Keil
NB-103	Teaching Lab	12 computers, power supplies, multimeters, oscilloscopes, and function generators	MS Office, Adobe, Vivado, LT Spice, Labview, MATLAB, Python, VS Code, NI Multisim, Keil
NB-104	Teaching Lab	12 computers, power supplies, multimeters, oscilloscopes, and function generators	MS Office, Adobe, Vivado, LT Spice, Labview, MATLAB, Python, VS Code, NI Multisim, Keil
NB-112	Teaching Lab	12 computers, power supplies, multimeters, oscilloscopes, and function generators	MS Office, Adobe, Vivado, LT Spice, Labview, MATLAB, Python, VS Code, NI Multisim, Keil
NB-136	Power/Robotics Lab	6 Power analyzers, power supplies (3φ), DC motors, Induction Motors (3φ), Synchronous machines, Dynamometers, Prony Brakes, Multi-function machines, VFDs, Resistive loads, reactive loads, tachometers. Also 18 transformers. 36 multi-meters, 3 Robot Arms, and 5 robotic vehicles..	Ubuntu, Python, ROS, Gazebo
NB-203	Linux Lab	26 Linux Computers, 2 monitors each.	Ubuntu, Python, Magic (VLSI), Xschem, GnuSpice, ROS, Gazebo, GNU Radio Companion
NB 116	Electromagnetics Lab	Spectrum analyzer, Vector network analyzer, RF signal generator, function generator, phased array beamformer, far field antenna pattern measurement system	Ubuntu, Python, GNU Radio Companion
NB 118	Optics Lab	Optical Spectrum Analyzer, Tunable Laser/attenuator, Fiber Femtosecond Laser, Fiber Fusion Splicer	CompleteEase, Wvase

NB 120	Microscopy Lab	Optical Microscope, SEM, Ellipsometers	
NB 126	Senior Projects Lab	3D-Printer, PCB Router, Stereo Microscope, Pick & Place Machine, Drill Press, Hand tools, Eyewash station, 15 stations each with power supplies, multimeters, oscilloscopes, and function generators	MS Office, Adobe, Vivado, LT Spice, Labview, MATLAB, Python, VS Code, NI Multisim, Keil

4. Other Facilities

In addition to classrooms and laboratories, there are other rooms in the Engineering Technology Building that support the program. These rooms are described in Table 7-2.

Table 7-2 Other Rooms

Room	Description	Equipment
NB-202	Graduate and Undergraduate Research Room	Conference Room, Computer, Kitchenette, 12 Student desks
NB-115	Storage	Desk, Chair and Computer for Lab Aide. Scope probes, Backup scopes, meters, function generators and power supplies, other inventory to support various courses
NB-117	Clubs and Organizations (used for IEEE but shared with other organizations in the college)	Kitchenette, tables, chairs

B. Computing Resources

Weber State University has a well-developed computing and IT infrastructure at the Ogden campus. Central computing facilities for students, faculty and staff are closely monitored to ensure that capacity planning meets expected bandwidth needs. Decentralized computing facilities have continued to grow in recent years to the point where over 90 percent of the university's classrooms and laboratories are equipped with a computer connection to the network and various instructional hardware.

Due to the growing use of laptops with mobile devices, the demand for open student computer laboratories has decreased recently, but WSU still maintains over hundreds of desktop computers in nine locations with a mix of Windows and Apple computers. The Stewart Library provides additional computers in a reference laboratory, a commons area and circulation desk with laptops for checkout. A virtual laboratory environment allows students to access software from anywhere at any time. This virtual laboratory, consisting of over 70 software applications, is available to all enrolled students and employees at WSU.

Professional technical support staff provide instruction to faculty on the use of technology in the classroom. This instruction often involves the use of software applications that students will learn in their course work. Training Tracker is an online training program developed to schedule and approve training for faculty and staff in a variety of personal, financial and professional development topics as well as computing related subjects.

A laboratory is available to faculty and staff to scan photos and slides and to prepare multimedia materials for their courses, publications and department web sites. This laboratory is supported by designers and development experts that can assist faculty and staff in the use of high-end software applications to efficiently complete their projects.

C. Guidance

Students in the program are guided in the use of laboratory equipment and computer software by the engineering faculty, who have many years of experience in the use of electrical test equipment and engineering software applications. The majority of Computer Engineering courses are combined lecture/laboratory courses in which basic test equipment is used. As indicated in Table 7-1, the primary equipment in the laboratories are power supplies, oscilloscopes, multi-meters and signal generators.

Faculty guide students in the use of engineering and computing software as it is introduced in the curriculum. As majors progress in the program, they use this equipment on a more frequent basis and progressively learn how to use more functions. By the time students are taking upper division courses, particularly senior project, they have become proficient in using all the basic test equipment. Faculty teach students how to operate the equipment properly such that their measurements are meaningful. Faculty also teach students how to handle the equipment so that they do not harm themselves or others or damage the equipment or surroundings.

D. Maintenance and Upgrading of Facilities

The program has a course fee system for the periodic replacement of expendable and non-expendable items. Expendable items include electrical parts and supplies that require replacement on a relatively short timeline due to continuous consumption by students. Non-expendable items include test equipment such as oscilloscopes, multi-meters, power supplies and signal generators. Course fees are assessed to students when they register for courses, and the funds generated go into an account that the program uses to replace the equipment. The cost structure of the system accommodates a one-year replacement timeline for expendable items and a five-year replacement time line for non-expendable items. Course fees also include costs for the maintenance of annual software licenses.

Computers in faculty offices and student laboratories are typically replaced/upgraded every three to four years by the college IT staff. These computers are normally funded by a combination of internal and external grants. Each summer when our facilities experience little or no utilization by students, our IT staff conducts an assessment of the software requirements of faculty and laboratory computers. If upgrades are needed, the IT staff installs them at this time. Summers are also an opportune time to organize and clean laboratories and other areas in the department in preparation for a new academic year. Depending on staffing, this duty may fall on work-study students under the direction of the ECE faculty. Equipment, supplies and office furniture that have outlived their usefulness are sent to Property Control where they are offered to other departments on campus or sold to the public.

E. Library Services

The Stewart Library at WSU provides students and faculty with the full range of services expected of any university library, including expert reference assistance and information literacy instruction. Collections include print, electronic, and audio-visual resources as well as access to an increasingly large number of electronic databases, books and journals. The library contains 296,531 physical book titles, 592,742 electronic book titles, 397 databases, 133,478 print and

electronic periodicals, 37,656 physical media titles, and 1,874,952 electronic media titles. The library has online access to IEEE transactions through IEEE Xplore, and many of the print periodicals and bound volumes are electrical engineering or technology related. The library also has access to ACM journals and conference proceedings through the ACM Digital Library.

An equivalent full-time faculty of 16.98 plus 42.02 FTE staff provide library services to the WSU community. The library is open 91 hours per week during fall and spring semesters; reduced hours are in effect during the summer semester and semester breaks. Computers are located throughout the library to facilitate access to resources, and a wireless system affords connectivity for patrons with laptops. Off-campus access to resources and services is available 24/7 through the library's web site. During the 2022-2023 academic year, around 11,000 in-person circulation transactions occurred.

The Department of Engineering is supported by a subject librarian that provides expert assistance to students and faculty. The subject librarian is responsible for periodically consulting with faculty to assess instructional and research needs and to develop the collection. The library allocates an annual budget to the department for the purchase of these items.

The electronic catalog is the main tool for finding materials held by the library. Academic Search Premier is the library's primary search tool for finding materials that are not held by the library. The Inter-Library Loan (ILL) system can then be utilized to obtain the materials in a timely manner. Numerous databases are available through the Stewart Library, including technical databases such as IEEE All-Society Periodical Package and NASA Technical Reports Server. An Electronic Reserve system permits faculty to place course materials and other documents on reserve such that students can access them online at any time.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

A. Leadership

The WSU Computer Engineering Program is led by the chair of the Department of Electrical and Computer Engineering, Dr. Fon Brown, and the Computer Engineering program coordinator, Dr. Eric Gibbons. The leadership responsibilities of the chair include, but are not limited to, the following:

- Manage and oversee the programs in the Department of Electrical and Computer Engineering
- Represent the department to outside entities
- Guide the accreditation efforts of the Electrical, Computer and Biomedical Engineering Programs
- Manage personnel issues in the department
- Oversee the recruitment, hiring and evaluation of faculty, adjunct faculty and staff
- Manage and approve department budgets and expenditures
- Schedule and run regular department meetings
- Schedule regular Industrial Advisory Board meetings
- Attend department chair meetings in the college
- Oversee and approve teaching assignments
- Oversee the curricula in the department
- Consult with and report to the dean of the college on matters pertaining to the department
- Sit on the department promotion and tenure committee
- Foster excellent teaching, scholarship and service among faculty
- Approve faculty leaves of absence
- Supervise the department administrative assistant
- Oversee scholarships offered by the department

The leadership responsibilities of the program coordinator include, but are not limited to, the following:

- Advise new and current students in Computer Engineering
- Schedule ECE courses
- Assign instructors for ECE courses
- Assist the chair with various duties as required

The department chair and ECE program coordinator receive six credit hours and three credit hours, respectively, of equivalent teaching load per semester for their leadership duties.

The Dean of the College of Engineering, Applied Science & Technology, Dr. David Ferro, has upper-level administrative oversight of the program. The department chair and program coordinator have direct leadership responsibility and decision-making authority for the Computer Engineering program, but all faculty participate to some extent in program leadership. Faculty opinions and suggestions are freely and openly discussed in department meetings. Faculty have input to department curriculum, policies and practices and are responsible for and participate in the continuous improvement of the program. Faculty fulfill their teaching, scholarship and service obligations as part of their academic appointments at the university.

B. Program Budget and Financial Support

1. Process used to establish the program's budget and evidence for continuity of institutional support.

   The program budget consists of two main components---salaries and benefits of faculty and staff and operations. Salaries are determined at the time of hire and are allocated by the institution to the various academic divisions. Depending upon state and institutional economic conditions, salaries increase over time with across-the-board cost of living increases, promotions, special bonuses allocated by the administration, performance-based pay raises and equity adjustments. Benefits include retirement, medical and dental insurance, life insurance, unemployment insurance, workers compensation insurance and long-term disability.

   Operations include the maintenance and upgrading of equipment and supplies, faculty development, disbursement of financial aid and routine office functions and materials. Maintenance and upgrading of equipment and supplies is funded by course fees as well as grants and special allocations. Faculty development is funded by the department, college or outside entities. The department typically funds registration fees for conferences, seminars and professional courses, whereas the college funds travel expenses for these activities. Faculty may pursue external funding for research or projects through the WSU Office of Sponsored Projects. Internal funding is available for faculty development through the Research, Scholarship and Professional Growth (RS&PG) and Hemingway committees. Routine office functions and materials such as telephones, copy machine, printers, office supplies, advising literature, etc. are covered by the operating budget of the department.

2. How teaching is supported by the institution in terms of graders, teaching assistants, teaching workshops, etc.

   Weber State University is primarily an undergraduate institution and, as such, has limited access to students who can serve as graders and TAs in the Computer Engineering Program. In 2016 and 2018 graduate programs were added to the department, but the graduate students have not widely been used for grading because either (a) they are employed by HAFB and are not allowed supplemental employment, (b) they are employed full-time and have no time available to grade or act as TAs. Consequently, grading and teaching are done by the program faculty.

   Faculty are encouraged to participate in the Teaching & Learning Forum, an organization founded by a group of WSU faculty in 1992. The Forum offers retreats, book groups, workshops, collaborative projects, and other initiatives in support of faculty teaching and development. Activities are directed by the Teaching, Learning, and Assessment (TLA) Committee, a standing committee of the WSU Faculty Senate. The Teaching and Learning Forum office is staffed year-round and has a library of books and other materials on teaching and learning. The Forum consists of several learning groups, two of which are particularly applicable to the program: "Technology and Education" and "Issues in Science Education." Program faculty are also encouraged to attend and participate in conferences sponsored by national societies and groups such as the American Society for Engineering Education (ASEE) and The Teaching Professor.

3. To the extent not described above, how resources are provided to acquire, maintain and upgrade the infrastructures, facilities and equipment used in the program.

   Resources for maintaining and upgrading laboratory equipment are described in Criterion 7, Section D. WSU Facilities Management provides the resources for the broader infrastructures and facilities such as building safety, lighting, power, heating and air-conditioning, water, furnishings and cleaning.

4. Adequacy of the resources described in this section with respect to the students in the program being able to attain the student outcomes

   The budgets of the institution, college and department are adequate to facilitate the achievement of student outcomes. The qualifications and number of faculty as well as faculty development in support of teaching are likewise sufficient for the attainment of student outcomes. Finally, student outcomes are appropriately and adequately supported by the infrastructure, facilities and equipment used by the program.

C. Staffing

The Computer Engineering Program is supported by administrative, instructional and technical staff. Administrative personnel who have control of the program are the dean of the college, the provost and the president. The dean has academic and budgetary oversight of six academic units in the college, including the Department of Electrical and Computer Engineering. As discussed in Criterion 6, Sections A and C, the qualifications and number of the instructional staff are adequate to meet the needs of the program.

The IT manager for the college contributes approximately 10 percent of his total workload to the Computer Engineering Program (See Table D-2, Appendix D). He is responsible for upgrading and maintaining faculty, staff, and laboratory computers in the program. He is assisted by IT staff and hourly student employees. His responsibilities do not include the setup, maintenance and monitoring of laboratory equipment, supplies and parts.

D. Faculty Hiring and Retention

1. Process for hiring new faculty

Hiring new faculty at WSU is a three-step process:

Position approval and advertisement

- Identify a significant instructional need in the program
- Obtain the verbal approval of the dean and provost to hire a new faculty member
- Hiring/screening committee is organized
- Committee prepares the selection criteria and prepares an advertisement
- Requisition, advertisement and other forms are submitted to Human Resources (HR)
- HR submits the forms to the dean and provost for signatures
- Position is advertised for the appropriate time period
- Committee receives applications and resumes from HR

Screening and interviewing applicants (1)

- Preferences (veteran, diversity and/or internal) are applied
- Committee makes first cut, eliminating applicants who do not meet minimum qualifications
- First cut is approved by the AA/EO Director

- Committee narrows applicant list using numerical ratings of their selection criteria
- Committee conducts telephone interviews of remaining applicants (around 6 to 8)
- Based on telephone interviews, committee narrows list to 3 or 4 final applicants
- Committee notifies HR of foreign nationals among final applicants
- Final applicants are invited for campus interviews
- Interviews are completed
- Reference checks are completed
- Finalist is selected by the committee with the dean's approval

Selection Approval and Offer

- Name of finalist and ARS rating sheets are submitted to HR
- Finalist is approved by HR and the AA/EO Director
- Background check is conducted
- Employment offer is extended to the finalist by HR or the dean
- HR sends letters to the finalists not selected

(1) WSU uses an online Applicant Rating System (ARS) that quantifies the screening process. The starting salary of a new faculty member is open to negotiation between the finalist and the Dean, who considers such factors as the ratings of the screening committee, academic credentials and industrial experience of the finalist, salaries of current faculty in the program and the college budget.

2. Strategies to retain current qualified faculty

Strategies to retain current qualified faculty are, to a great extent, woven into the fabric of the university working environment. The direct and indirect benefits of working at a university are difficult, if not impossible, to match elsewhere. Engineering courses are not typically offered during the summer, so faculty may consult or work in their disciplines on a full-time basis if they wish. Furthermore, WSU has a liberal sabbatical leave policy that provides faculty opportunities to conduct research or pursue other professional endeavors.

The program strives to assign faculty courses that are within their areas of technical expertise. This strategy is not only more satisfying to the faculty member, but students likewise benefit by learning from professors with in-depth knowledge and experience in the subject matter of the course.

Another strategy for retaining current qualified faculty is to abide by institutional policies with respect to academic freedom. From the WSU Policies and Procedures Manual (PPM) 9-1: "Weber State University seeks to provide and sustain an environment conducive to sharing, extending and critically examining knowledge and values and to furthering the search for wisdom. Effective performance of these central functions requires that faculty members be free to pursue and teach the truth in accord with appropriate standards of scholarly inquiry."

Also from PPM 9-1: "Academic freedom in the pursuit and dissemination of knowledge through all media shall be maintained at Weber State University. Such freedom shall be recognized as a right of all members of the faculty whether of tenure or non-tenure status, of all administrative officers and of all students."

Other strategies are reflected in the employment benefits and working environment of WSU. Full time faculty enjoy a wide range of benefits and privileges including a generous employer retirement contribution, tuition waivers for themselves, spouses and children, on-campus services and activities such as recreation, sporting events and performing arts. Nestled against the western slope of the Wasatch Mountains, the WSU community enjoys numerous outdoor recreational activities such as hiking, biking, skiing, fishing and hunting.

To incentivize tenured professors who hold the rank of full professor, a program called Performance Compensation Plan (PCP) provides a monetary award for maintaining a level of accomplishment in teaching, scholarship and service equivalent to promotion to full professor. Tenured faculty are eligible to apply for the PCP every five years after being promoted to full professor up to two times.

E. Support of Faculty Professional Development

Support of faculty professional development is integral to the support of faculty scholarship, one of the key expectations of faculty academic duties and responsibilities. Thus, professional development of faculty is supported at the department, college and university levels. The department funds registration fees for seminars, conferences and short courses, while the college funds travel expenses. If the faculty member is awarded a grant or contract in support of professional development, funding is provided centrally through the university from the funding agency.

As discussed in Criterion 6, Section D, the institution provides a liberal sabbatical leave program in which faculty can engage in professional development for an extended period of time without having regular teaching and other faculty responsibilities. After achieving tenure, faculty are eligible for a two-semester sabbatical leave at 75 percent of their base salary. After taking that sabbatical leave, faculty accrue a one-semester sabbatical leave after three years of service and a two-semester sabbatical leave after six years of service. For the one-semester and two-semester leaves, faculty are paid 100 percent and 75 percent, respectively, of their base salary. Granting of a sabbatical leave is contingent on the approval of the chair and dean and is subject to existing instructional needs and funding constraints.

PROGRAM CRITERIA

ABET specifies program criteria for Electrical, Computer, Communications, Telecommunication(s) and Similarly Named Engineering Programs. The applicable criteria for computer engineering programs are:

1. The structure of the curriculum must provide both breadth and depth across the range of engineering topics implied by the title of the program.
2. The curriculum must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science); and engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components.
3. The curriculum for programs containing the modifier “computer” in the title must include discrete mathematics.

1. Breadth and Depth across the Range of Engineering Topics

The Weber State Computer Engineering Curriculum provides significant breadth by offering courses in the curriculum covering a wide range of engineering topics, including but not limited to.

- Circuit Analysis
- Microelectronics

- Signals and Signal Processing
- Communication
- Digital Systems
- Computer Systems
- Data Structures

Moreover, depth is provided by course sequences that delve further into a particular subject. For example, a student interested in Digital may take ECE 2700 (Digital Circuits), ECE 3610 (Digital Systems) and ECE 5110 (Digital VLSI Design). Another student interested in communication might take ECE 5410 (Communication Systems), ECE 5420 (Digital Communication) and ECE 5440 (Optical communication). A third student interested in software algorithms might take CS 2420 (Introduction to Data Structures and Algorithms), CS 4110 (Formal Languages & Algorithms) and CS 5420 (Advanced Algorithms).

2. Probability, Mathematics, Science and Engineering Topics

There are four primary elements of this program criteria defined above:

(1) probability and statistics, including applications
(2) mathematics through differential and integral calculus
(3) sciences
(4) engineering topics, including computing science

Probability and statistics, including applications

Probability and statistics are two separate but related branches of mathematics that deal with random phenomena and the analysis and interpretation of data. A required course in the Computer Engineering curriculum is either Math 3410 Probability and Statistics or ECE 3430 Engineering Probability and Statistics. Either course is three credit hours and is typically taken in the fall or spring semester of the junior year.

The mathematics department has agreed to teach applications appropriate to engineering, including computer engineering, in MATH 3410. ECE 3430 specifically teaches electrical and computer engineering applications.

Mathematics through differential and integral calculus

The Computer Engineering curriculum contains a two-semester calculus sequence: Math 1210 Calculus I and Math 1220 Calculus II. These two courses provide students with a good foundation in differential and integral calculus.

Sciences

Three science courses are required in the program. A two-semester physics sequence consisting of Phys 2210 Physics for Scientists and Engineers I and Phys 2220 Physics for Scientists and Engineers II is typically taken in the freshman year. Each physics course is five credit hours and includes a three-hour laboratory each week. As part of the general education component of the program, a Life Science (LS) course is also required. Any course that has an LS prefix is acceptable. The Life Science groups from which students may select a course are Anthropology, Botany, Health Sciences, Honors, Microbiology, Nutrition and Zoology.

Engineering topics

Engineering courses are the backbone of the curriculum. The primary engineering topical areas are:

- analog circuits
- digital circuits
- computer programming
- microelectronics
- embedded systems
- signal processing
- seminar
- internship
- senior project

To ensure that the curriculum is sufficient for students to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components, all students are required to take ECE 3710 in which they analyze and design hardware and software systems. Most students reuse these hardware and software skills as part of their senior projects.

Course descriptions of all required engineering, mathematics and science courses in the curriculum are given in Appendix A.

3. Discrete Mathematics

Computer Engineering students are also required to take CS 2130 – Computational structures, which is basically a discrete mathematics course with a non-intuitive name. To highlight this point, the description of CS 2130 from the catalog is given below:

> An overview of the fundamentals of algorithmic, discrete mathematics applied to computation using a contemporary programming language. Topics include sets, functions, logic, matrices, relations, graphs, trees, regular expressions, grammars, finite state machines, and data encoding.

ACCREDITATION POLICIES AND PROCEDURES MANUAL

APPM I.E.5.b requires that instructional and learning environments are adequate and are safe for the intended purposes. Adequacy of the learning environment is addressed in Criterion 7, Section A.

The safety of the learning environment is ensured by the policies outlined below.

Safety Briefings.

It is the policy of the Department of Electrical and Computer Engineering that each instructor of a course that utilizes a laboratory brief the students on proper use of the equipment, safety precautions and proper clean-up procedures.

Power Laboratory

In contrast to the computer or electronic laboratories where is simple safety briefing is sufficient, the power laboratory involves higher voltages (up to 150VAC) where the current limit is 10A or more. This environment presents both a shock and fire hazard, so an entire lecture in the power

courses that use the laboratory are devoted to safety. Further, even if students have attended the lecture, they are not allowed in the laboratory without a responsible member of the faculty present to supervise. Finally, in case a student is inadvertently admitted into the lab, the 3-phase power supplies are clearly marked “ELECTRICAL SHOCK HAZARD – DO NOT USE WITHOUT PROPER SUPERVISION”.

Optical Laboratory

Lasers are sometimes used in the optical laboratory, and any student using a laser must be briefed on safety procedures by one of the faculty. Eye protection is provided by the department, and both students and faculty are required to wear eye protection when the laser is in use. (Signs to this effect are posted inside the laboratory as a reminder.) In order to avoid someone inadvertently opening the door to the laboratory when the laser is in use, students and faculty must, before energizing the laser, (a) post a sign on the door stating that the laser is in use and (b) lock the door.

Senior Projects Laboratory

The senior projects laboratory contains some power tools (drill press, sander, band saw, etc.) Students who wish to use those tools must demonstrate that they have experience with such tools or receive a safety briefing from one of the faculty. The power tools are located in a workspace adjoining the main lab, and anyone in that workspace is required to wear eye protection while any power tool is in use. (Signs to this effect are posted as a reminder.) In the event of an accident, the laboratory is equipped with an eyewash station.

One other hazard in the Senior Projects Laboratory is an electronic hot-plate that is used to flow-solder single-side surface-mount circuit boards. When students are trained on the use of the hot-plate they are warned not to touch it or let it come in contact with combustible material. A sign to this effect is posted near the hot plate as a reminder.

Students who do not follow these procedures may be denied admittance into the power, optics or senior project laboratories, particularly if they are repeat offenders.

APPENDICES

APPENDIX A – COURSE SYLLABI

ECE 1000 Introduction to Electrical Engineering

2 Credits, 2 Contact hours

Instructors: Alyssa Mock, Shellee Dyer

Text: Control Systems Engineering, 6e, Norman Nise, John Wiley & Sons, 2010

Description: An introductory course to Electrical & Computer Engineering topics including electronic terms, numbering systems, software tools, and documentation practices.

Pre-requisite/Co-requisite: MATH 1060 or MATH 1080 or MATH 1210 or equivalent.

Educational Objectives:

- Demonstrate an understanding of basic electronics terms.
- Build and Analyze simple electronic circuits.
- Draw Schematic Diagrams.
- Understand component labeling and tolerances
- Use scientific notation and the binary numbering system.
- Become familiar with technical writing

Topics:

- Electrical Terminology
- Lab Safety and Equipment
- Drawing Circuits
- Ohms and Kirchhoff's laws
- Basic Analysis
- Alternating Current
- Capacitors and Inductors
- Simple Electronic Devices
- Digital Logic
- Python Coding

ECE 1270 Introduction to Electrical Circuits

4 Credits, 6 Contact hours

Instructors: Christian Hearn, Justin Jackson or Shellee Dyer

Text: Electric Circuits, 10e, James W. Nilsson and Susan A. Riedel, Pearson, 2015.

Description: The basics of analog circuits as an introduction to Electrical Engineering. Concepts of voltage, current, power, resistance capacitance and inductance. Circuit analysis techniques such as Kirchhoff's Laws, node voltages, and mesh currents. Thevenin's and Norton's equivalent circuits, sinusoidal steady state and phasors. Lecture and lab combination.

Pre-requisite(s): MATH 1210
Pre-requisite/Co-requisite: MATH 1220 and either ECE 1000 or ENGR 1000.

Educational Objectives:

- Analyze a basic circuit using node and mesh techniques.
- Derive Thevenin and Norton equivalent circuits.
- Explain the function of passive circuit elements.
- Utilize phasors to determine sinusoidal steady-state waveforms response. Conduct tests on basic circuits.

Topics:

- Circuit variables
- Kirchhoff's Laws
- Resister combinations
- Measuring techniques
- Node analysis
- Mesh analysis
- Thevenin and Norton equivalents
- Operational amplifiers
- Capacitors
- Inductors
- Sinusoidal steady-state
- Phasors
- Transformers
- Complex power calculations
- Three phase circuits

ECE 1400 Fundamentals of Engineering Computing

4 Credits, 6 Contact hours

Instructors: Nathan West or Eric Gibbons

Texts:
An Introduction to Python for Scientists and Engineers, Johnny Wei-Bing Lin, et. al, 2022.
The C Programming Language, 2nd Edition, Kernighan & Ritchie, Prentice Hall, 1988

Description: Computer programming and computational tools applied to electrical and computer engineering problems. Topics include coding fundamentals, numeric libraries and debugging techniques. Lecture and lab combination.

Pre-requisite(s): MATH 1210 and either ECE 1000 or ENGR 1000.

Educational Objectives:

- Solve engineering problems in Python.
- Solve engineering problems in C
- Understand C memory management.
- Be a Productive UNIX environment user.

Topics:

- Python as a Calculator
- Plotting
- Looping and Conditionals
- Reading and Writing Text Files
- Python Memory Management
- Introduction to C
- Conditionals and Functions
- Arrays and Looping
- Pointers
- Dynamic Memory
- Data Structures

ECE 2260 Fundamentals of Electrical Circuits

4 Credits, 6 Contact hours

Instructors: Christian Hearn, Nathan West, Justin Jackson or Shellee Dyer

Text: Electric Circuits, 10e, James W. Nilsson and Susan A. Riedel, Pearson, 2015.

Description: Fundamental electric-circuit techniques including: time domain transient responses for 1st and 2nd order circuits, Laplace transforms, Fourier series, and filters. Lecture and lab combination.

Pre-requisite(s): MATH 1220 and either ECE 1270 or ECE 2210.
Pre-requisite/Co-requisite: ECE 1400 and either ENGR 2240, MATH 2250 or MATH 2280.

Educational Objectives:

- Analyze transient responses for 1st and 2nd order circuits.
- Apply Laplace transforms to circuits.
- Apply Fourier transforms to signals.
- Construct simple passive filters.

Topics:

- 1st order circuit response
- 2nd order circuit response
- Review phasors
- Laplace transforms
- Inverse Laplace transform
- S-domain circuit analysis
- Fourier series
- Fourier transform
- Passive filters

ECE 2700 Digital Circuits

4 Credits, 6 Contact hours

Instructors: Tye Gardner or Fon Brown

Text: Introduction to Digital Circuits with VHDL, 3e, Fon Brown, Linus Learning, 2022

Other materials: Vivado Software

Description: An introduction to digital electronics, integrated circuits, numbering systems, Boolean algebra, gates, flip-flops, multiplexers, sequential circuits, combinational circuits, and computer architecture. Introduction to hardware description language and programmable logic devices.
Lecture and lab combination. Laboratory activities to include the design, construction, analysis, and measurement of basic digital systems. Lecture and lab combination.

Pre-requisite/Co-requisite: ECE 1000 or ENGR 1000.

Educational Objectives:

- Design and build combinational circuits using gates and inverters.
- Design and build sequential circuits using gates, inverters and flip-flops.
- Compute propagation delays and maximum clock frequency.
- Analyze circuits that use medium scale integrated devices.
- Convert numbers from/to binary, decimal, and hexadecimal.
- Design logic circuits that use binary numbers..

Topics:

- Digital signals
- Numbering systems and arithmetic
- Boolean algebra
- Combinational logic design
- Karnaugh maps and VEMs
- Modeling and simulation
- Integrated logic circuits
- Introduction to VHDL
- Synthesis, programmable devices
- Sequential logic design
- Memory devices
- State machine design
- Addressable Memory
- Microprocessor architecture

ECE 3000 Engineering Seminar

1 Credits, 1 Contact hour

Instructors: Tye Gardner, Eric Gibbons, Christian Hearn, Justin Jackson or Fon Brown

Text: none

Description: An engineering seminar course designed to prepare the student for professional engineering employment. Topics to include resumes, hiring criteria, interviewing techniques, engineering ethics, professional and societal responsibilities, lifelong learning, diversity, creative problem solving, goals, quality, timeliness, and continuous improvement. The students will research related topics and write a paper.

Pre-requisite(s): ECE 1270.

Educational Objectives:

- Explain ethical responsibilities in engineering
- Define engineering professionalism
- Write a resume and cover letter
- Understand interviewing techniques
- Summarize a major engineering failure
- Explain the role of their general education as it pertains to engineering
- Attend technical presentations, short courses, or seminars
- Understand the role of professional societies and publications

Topics:

- Resumes and cover pages
- Hiring criteria
- Finding a professional position
- Interviewing techniques
- Honesty, ethics, and integrity
- Engineering ethics
- Professional and societal responsibilities
- Lifelong learning
- Diversity
- Assertiveness and motivation
- Creative problem solving
- Goals
- Quality
- Timeliness
- Continuous improvement

ECE 3090 Project Management

1 Credit, 1 Contact hour

Instructors: Tye Gardner, Nathan West

Text: none

Description: Project Management course is designed to prepare students for the senior capstone project. The course will include development of a contract, goal setting, time management, budgeting, project funding, project leadership and team building principles. Engineering economics, team work, quality statistics and continuous improvement will also be discussed. Other topics include project life cycles, organization and risk management. Students should take this course the semester before taking ECE 4010.

Pre-requisite(s): Permission from the department.

Educational Objectives:

- Write a feasibility study and business case
- Form teams and together propose and plan a project
- Present a business case
- Write a project proposal
- Write a project plan

Topics:

- Overview of Project Management
- Systems Design
- Project Life Cycle
- Project Inception
- Project Definition
- Project Planning
- Cost Estimation
- Quality Management
- Risk Management
- Project Execution and Monitoring
- Agile and Lean
- Project Roles and Leadership
- Team building and conflicts

ECE 3110 Microelectronics I

4 Credits, 6 Contact hours

Instructors: Justin Jackson or Nathan West

Text: Microelectronic Circuits, Adel S. Sedra and Kenneth C. Smith, Oxford, 2009

Description: Fundamental semiconductor device characteristics including diodes, MOSFETs and bipolar transistors; small and large signal characteristics and design of linear circuits. Lecture and lab combination. Laboratory activities to include the design, construction, computer simulation, and analysis of semiconductor circuits, amplifiers and power supplies. Lecture and lab combination.

Pre-requisite(s): MATH 1220 and ECE 1400 and either ECE 1270 or ECE 2210.

Educational Objectives:

- Model semiconductor devices such as diodes, BJT transistors, and field effect devices.
- Design and model semiconductor circuits.
- Explain the difference between the BJT and MOSFET amplifier configurations.
- Design, build, and evaluate BJT and MOSFET amplifiers..

Topics:

- Signals and amplifiers
- Semiconductors
- Diodes
- MOS field effect transistors
- Bipolar junction transistors
- Operational amplifiers

ECE 3120 Microelectronics II

4 Credits, 6 Contact hours

Instructors: Justin Jackson or Nathan West

Text: Microelectronic Circuits, Adel S. Sedra and Kenneth C. Smith, Oxford, 2009

Description: Intermediate topics related to microelectronics including differential and multistage amplifiers, frequency response, feedback systems, power amplifiers, filters, and signal generation.
Lecture and lab combination. Laboratory activities to include the design, construction, computer simulation, and analysis of filters and advanced circuits. Lecture and lab combination.

Pre-requisite(s): ECE 2260 and ECE 3110.

Educational Objectives:

- Model semiconductor devices such as diodes, BJT transistors, and field effect devices.
- Design and model semiconductor circuits.
- Explain the difference between the BJT and MOSFET amplifier configurations.
- Design, build, and evaluate BJT and MOSFET amplifiers..

Topics:

- Building blocks of integrated circuit amplifiers
- Differential and multistage amplifiers
- Frequency response
- Feedback
- Output stages and power amplifiers

ECE 3210 Signals and Systems

4 Credits, 6 Contact hours

Instructors: Eric Gibbons, Alyssa Mock or Christian Hearn

Text: Signal Processing and Linear Systems, 2e, B.P. Lathi and Roger Green, Oxford, 2021

Description: Topics related to the analysis of linear time invariant continuous and discrete systems and signal transformations, convolution, frequency spectra, Laplace transforms, Z transforms, and fast Fourier transforms. Lecture and lab combination. Laboratory activities to include the computer simulation, analysis, and numerical modeling of signals and systems.

ECE 2260 and either ENGR 2240, MATH 2250 or both MATH 2270 and MATH 2280.

Educational Objectives:

- Represent signals in time, frequency, Laplace and Z domains
- Perform discrete and continuous time convolution
- Design, build and analyze linear time-invariant systems.
- Program simple scripts and functions in MATLAB or Python.

Topics:

- Continuous-time and discrete-time signals
- Linear time invariant systems
- Time domain analysis
- Convolution (continuous)
- Stability
- Fourier series
- Fourier transformation
- Sampling
- Discrete (and fast) Fourier transforms
- Circular convolution (discrete)
- Laplace transform
- Analog filters
- Z transform

ECE 3310 Electromagnetics I

4 Credits, 6 Contact hours

Instructors: Christian Hearn, Alyssa Mock or Shellee Dyer

Text: Fundamentals of Applied Electromagnetics, 6e, Fawwaz Ullaby et. al, Prentice Hall, 2010

Description: An introduction to electrostatics, magnetostatics and Maxwell's equations with specific applications to wave propagation and transmission line theory. Lecture and lab combination. Laboratory activities to include the design, construction, and analysis of RF radar subsystems.

MATH 2210, PHYS 2220, and either ECE 1270 or ECE 2210..

Educational Objectives:

- Apply Coulomb's and Gauss's equations to electrostatics problems
- Apply Biot-Savart's and Ampere's equations to magnetostatics problems
- Apply Maxwell's equations to time-varying fields
- Describe wave propagation in free space
- Describe transmission line theory.

Topics:

- Coulomb's equation
- Gauss's equation
- Capacitance
- Biot-Savart's equations
- Ampere's equation
- Inductance
- Maxwell's equations
- Wave equation
- Plane-wave propagation
- Transmission line theory
- Smith Chart
- Impedance matching
- Radiation

ECE 3430 Engineering Probability and Statistics

3 Credits, 3 Contact hours

Instructors: Eric Gibbons, Alyssa Mock

Text: Probability, Statistics, and Random Processes for Electrical Engineering, 3e, Leon-Garcia

Description: This course covers basic concepts and techniques of probability theory with applications to statistics, machine learning, and signal processing. Topics include probabilistic modeling and analysis, confidence intervals, and statistical inference. Example problems are drawn from engineering applications and include both analytic and computational solutions.

Pre-requisite(s): ECE 1400 and MATH 1220

Educational Objectives:

- Solve engineering problems using basic concepts in probability including combinatorics, independence, conditional probability, and Bayes rule
- Solve basic problems arising in engineering that involve discrete and continuous probability distributions
- Use concepts such as means, variances, and various types of graphs to analyze datasets using computational software such as Python in engineering applications
- Apply basic random processes theory to electrical engineering applications

Topics:

- Set theory, sample space
- Conditional probability, Bayes rule
- Expected value, variance
- Continuous and discrete random variables
- PDFs, CDFs
- Multiple random variables
- Central limit theorem
- Parameter estimation
- Maximum Likelihood
- Confidence intervals
- Hypothesis testing

ECE 3510 Power Systems

4 Credits, 6 Contact hours

Instructors: Nathan West or Trent Tholen

Text: Electric Machinery and Power System Fundamentals, Stephen Chapman, McGraw-Hill

Description: A study of AC and DC power systems and machines, including single and 3-phase power, power factor and correction, transformers, synchronous and induction machines, DC motors, power transmission lines, and analysis of power flow and faults. Lecture and Lab combination.

Pre-requisite(s): ECE 1270 or ECE 2210.

Educational Objectives:

- Safely work with up to 300V circuits according to NFPA 70E
- Design a system in compliance to the NEC, current version
- Solve single and three phase power problems with or without the per-unit system
- Correct for poor power factor
- Analyze static and rotating magnetic fields
- Analyze and configure DC, Induction and Synchronous machines

Topics:

- Safety and NEC
- Magnetic Principles and DC Machines
- AC Real and Reactive Power
- Transformers
- Per Unit System
- Auto and Three phase transformers
- MMF and flux distribution
- AC machines
- Synchronous Generators
- Synchronous Motors
- Induction Motors
- Three phase systems
- Transmission lines

ECE 3610 Digital Systems

4 Credits, 6 Contact hours

Instructors: Tye Gardner or Fon Brown

Text: Digital Systems Design Using VHDL, 2e, Charles Roth Jr. and Lizy John, Cengage, 2008

Other materials: Vivado Software

Description: Introduction to microprocessor architecture, arithmetic logic units, memory systems, input/output interfaces, peripheral devices, and communication. Lecture and lab combination. Laboratory activities to include the programming and operation of microprocessor circuits.

Pre-requisite(s): ECE 2700 and (CS 2250 or CS 1410 or ECE 1400).

Educational Objectives:

- Analyze microprocessor architecture
- Design a digital system using a hardware description language
- Write a test bench using a hardware description language
- Simulate and debug a digital system using software design tools

Topics:

- Review of digital circuit design
- Introduction to hardware description language
- Designing with programmable logic devices
- Design of networks for arithmetic operations
- Digital design with SM charts
- Designing with programmable gate arrays
- Floating point arithmetic
- VHDL models for memories and busses
- Hardware testing and design for testability

ECE 3710 Embedded Systems

4 Credits, 6 Contact hours

Instructors: Fon Brown or Justin Jackson

Text: The 8051 Microcontroller and Embedded Systems, Mazidi et. al., Prentice Hall, 2006

Other materials: Silicon Labs IDE software

Description: Design and implementation of a microcontroller or microprocessor embedded system including assembly language programming, interfacing to peripherals, interrupt handling and debugging techniques. Lecture and Lab combination. Laboratory exercises build toward a final embedded systems project.

Pre-requisite(s): (ECE 2700 or CS 2810) and (ECE 1400 or CS 2250 or CS 1410).
Pre-requisite/Co-requisite: ENGL 3100 or PS 3250.

Educational Objectives:

- Write a computer program in assembly language
- Write code to handle interrupts
- Debug a computer program using both hardware and software tools
- Interface peripherals to a microcontroller or microprocessor using a bus
- Document the hardware and software of an embedded system design
- Design a test plan and use it to verify that a system satisfies its requirements and constraints

Topics:

- Microprocessor/microcontroller architecture
- Machine and assembly language
- Instruction set architecture
- I/O ports
- Timers
- Serial communications
- Interrupts
- Busses
- Semiconductor memory
- A/D and D/A conversions
- Miscellaneous peripherals

ECE 3730

4 Credits, 6 Contact hours

Instructors: Nathan West

Text: Learning Robotics using Python, Joseph Lentin, Packt Publishing

Other materials: ros.org

Description: Fundamentals of robotic systems. Introduction to the Robot Operating System and the Gazebo simulator. Topics include reading data from sensors, localization, mapping, navigation and task planning. Students will demonstrate the ability to program a provided robotic system to navigate to a position and perform a task in both simulated and real environments.

Pre-requisite(s): ECE 1400 or CS 1410.

Educational Objectives:

- Demonstrate knowledge of the operation, interface and data processing of various sensors such as accelerometers, gyroscopes, GPS, compass and encoders.
- Demonstrate working knowledge of the Robot Operating System to collect and process sensor data and communicate with mechanical systems.
- Demonstrate the use of the Gazebo system to visualize and simulate robotic systems

Topics:

- Robot Operating System and Gazebo
- Nodes, Topics, Subscribers, Publishers
- Services, Actions
- Sensor collection, processing
- Cameras
- System integration and launching
- Localization, navigation
- Sensor fusion
- Path planning, obstacle avoidance
- Visual navigation and feedback
- Executive control and state machines

ECE 3890 Internship

1 Credits, 0.5 Contact hours

Instructors: Justin Jackson or Fon Brown

Text: none

Description: This is a core course that is required for the BS Engineering degree. The student will need department approval before being allowed to register.

Pre-requisite(s): Permission from the department.

Educational Objectives:

- Participate in team problem-solving activities
- Demonstrate ethics in the workplace
- Demonstrate professionalism in the workplace
- Communicate (presentations, memos, meetings, reports, etc.) in the workplace
- Discuss how the company provides engineering solutions in a global, economic, environmental and social context
- Learn industrial procedures and practices of the company
- Explain how the company stays abreast of contemporary issues
- Demonstrate techniques, skills and modern engineering tools used within the industry

Topics:

- Career objectives
- Technical skills
- Human relations skills
- Communication (oral and writing) skills
- Personal skills
- Dependability
- Productivity
- Appropriate attire
- Team building skills
- Attention to detail
- Attitude

ECE 4010 Senior Project I

2 Credits, 2 Contact hours

Instructors: Fon Brown, Justin Jackson, Nathan West, Shellee Dyer or Christian Hearn

Text: none

Other materials: Senior Project Workbook (Brown & Gardner, Weber State)

Description: Students will be required to complete a 300-hour engineering project (over two semesters) in a team environment. Project management and problem solving techniques will be emphasized. Topics to include goal setting, developing milestone charts, writing contracts, conducting research, project design and construction, testing and analysis, project documentation, and design review presentations. Before seeking departmental approval, students should be currently enrolled in ECE 3090 and should have taken at least four 3000-level core ECE courses, MATH 3410, and either ENGL 3100 or PS 3250. Exceptions to this rule are made only if a student's graduation would otherwise be delayed.

Pre-requisite(s): Permission from the department.

Educational Objectives:

- Define the requirements of a design
- Develop a project plan
- Conduct a design review
- Share the workload
- Fulfill assigned duties as a team member
- Contribute individual expertise to the group
- Demonstrate collegiality and congeniality with teammates
- Maintain an engineering logbook
- Manage a budget
- Write a project proposal
- Describe the concepts and knowledge areas required for a senior project that are not covered in other engineering courses
- Describe how the student's senior project addresses contemporary issues

Topics:

- Project plan and milestone chart
- Goal setting
- Conducting research
- Project design and construction
- Testing and analysis
- Design review presentation
- Miscellaneous peripherals

ECE 4020 Senior Project II

2 Credits, 2 Contact hours

Instructors: Fon Brown, Justin Jackson, Nathan West, Shellee Dyer or Christian Hearn

Text: none

Other materials: Senior Project Workbook (Brown & Gardner, Weber State)

Description: A continuation of Senior Project I. Students will be required to complete a significant engineering project in a team environment. Project management and problem solving techniques will be emphasized. Topics to include goal setting, developing milestone charts, writing contracts, conducting research, project design and construction, testing and analysis, project documentation, and design review presentations.

Pre-requisite(s): ECE 4010.

Educational Objectives:

- Develop a project plan
- Write a design document
- Write a test plan
- Conduct a design review
- Share the workload
- Fulfill assigned duties as a team member
- Contribute individual expertise to the group
- Demonstrate collegiality and congeniality with teammates
- Maintain an engineering logbook
- Manage a budget
-
- Describe the concepts and knowledge areas required for a senior project that are not covered in other engineering courses
- Describe how the student's senior project addresses contemporary issues
- Enumerate design requirements and constraints, then create a design that conforms to them.

Topics:

- Project plan and milestone chart
- Goal setting
- Conducting research
- Project design and construction
- Testing and analysis
- Design review presentation
- Miscellaneous peripherals

ECE 4100 Control Systems

4 Credits, 6 Contact hours

Instructors: Christian Hearn or Nathan West

Text: Control Systems Engineering, 6e, Norman Nise, John Wiley & Sons, 2010

Description: Topics related to control theory, analysis, and testing of systems in the time domain, frequency domain and state space. Lecture and lab combination.

Pre-requisite(s): ECE 3110 and ECE 3210.

Educational Objectives:

- Apply block and signal flow diagrams to circuits
- Describe steady and transient behavior
- Construct a signal flow diagram
- Describe state space
- Design a stable electromechanical system
- Utilize root locus concepts to estimate system response
- Determine transfer functions characteristics from experiment data sets

Topics:

- Modeling in the frequency domain
- Modeling in the time domain
- State space
- Signal flow diagrams
- Mason's Rule
- Stability/Routh-Hurwitz criterion
- Steady-state errors
- Root locus
- Nyquist diagram
- Bode plots
- Controllability
- Observability

ECE 5110 Digital VLSI Design

3 Credits, 3 Contact hours

Instructors: Justin Jackson

Text: CMOS VLSI Design 4e, Weste and Harris

Description: Introduction to Digital VLSI design. Includes the development of standard cell library of common CMOS circuits. Use of hardware description language and CAD tools for the design and simulation of custom large-scale digital systems. Students will understand the impacts and tradeoffs from speed, power consumption, and thermal properties of large-scale custom ICs.

Pre-requisite(s): ECE 3110 and ECE 3610.

Educational Objectives:

- knowledge of the VLSI fabrication process.
- knowledge of standard cell libraries.
- ability to design, build, and analyze very large scale integrated (VLSI) circuits

Topics:

- CMOS Logic and Fabrication
- MOS Transistor Theory
- CMOS Processing Technology
- Delay
- Power
- Interconnects
- Robustness
- Circuit Simulation
- Combinational Circuit Design
- Sequential Circuit Design

ECE 5120 Analog VLSI Design

3 Credits, 3 Contact hours

Instructors: Jonathan West

Texts:
Cadence Online Learning Courses (support.cadence.com) Accounts set up first week of class
Analog VLSI: Circuits and Principles, Shih-Chi Liu, Available through the Weber library

Other materials: Cadence Virtuoso, LtSPICE.

Description: Design of analog VLSI systems. Course includes design, modeling, and verification of analog circuits in large-scale systems. Students will develop custom analog system designs utilizing CAD programs.

Pre-requisite(s): ECE 3120.

Educational Objectives:

- Understand the physics and construction of diodes and transistors.
- Design and layout analog VLSI MOS, BJT and Diode circuits
- Simulate analog VLSI circuits
- Use Cadence Virtuoso software suite to produce fabrication data for VLSI devices

Topics:

- Schematic Editor
- Layout Design Basics
- Visualization and Analysis
- Analog Design Environment
- Modeling with Verilog-A
- Modeling with Verilog-AMS

ECE 5130 Advanced Semiconductor Devices

3 Credits, 3 Contact hours

Instructors: Justin Jackson or Alyssa Mock

Text: Semiconductor Devices, Physics and Technology, 3e, S.M. Sze, M.K. Lee

Description: Introduction to advanced semiconductor physics and devices. Topics include carrier transport theory, energy band diagrams, PN junctions, metal-semiconductor junctions, BJTs and MOSFETs. Study of current semiconductor process technologies and discussion of off-roadmap technologies.

Pre-requisite(s): PHYS 2220 and ECE 3110.

Educational Objectives:

- knowledge of band energy diagrams and carrier transport phenomena.
- knowledge of pn junctions, bipolar transistors, MOS capacitors, and MOSFETs.
- knowledge of advanced semiconductor devices such as LEDs and solar cells.
- knowledge of semiconductor technology processes

Topics:

- Energy Bands and Carrier Concentrations
- Carrier Transport Phenomena
- P-n Junctions
- Bipolar Transistors
- MOS Capacitors and MOSFETs
- LEDs and Lasers
- Photodetectors and Solar Cells
- Semiconductor Technologies

ECE 5140 Sensors and Instrumentation

3 Credits, 3 Contact hours

Instructors: Tye Gardner

Text: Handbook of Modern Sensors, 5e, Fraden

Description: This course introduces a host of sensor technologies from both theoretical and practical perspectives. A study of the electronics for sensor signal conditioning will be complemented by lectures on the principles and operation of various sensor modalities including pressure, thermal, strain, displacement, inertial, magnetic field, optical, acoustic, and/or bio-medical. Students will be introduced to precision analog circuit architectures, noise analysis, and signal processing algorithms commonly used in data acquisition systems.

Pre-requisite(s): ECE 3110 and PHYS 2220.

Educational Objectives:

- knowledge of various sensor modalities.
- knowledge of signal conditioning circuits that interface with various sensors.
- ability to construct a sensor system

Topics:

- Instrumentation and Bridge circuits
- Sensor types and technologies
- Signal conditioning
- System noise
- Calibration and error correction
- ADCs and data acquisition
- Precision PCB design and layout
- Smart Sensors

ECE 5210 Digital Signal Processing

4 Credits, 6 Contact hours

Instructors: Eric Gibbons or Christian Hearn

Text: Discrete-Time Signal Processing 3rd edition by Alan Oppenheim and Ronald W. Schafer

Description: Theory, application, and implementation of digital signal processing (DSP) concepts, from the design and implementation perspective. Topics include: Fast Fourier transforms, adaptive filters, state-space algorithms, random signals, and spectral estimation. Lecture and Lab combination.

Pre-requisite(s): ECE 3210.

Educational Objectives:

- Design and implement digital signal processing systems
- Understand discrete-time transform methods
- Design digital filters
- Become familiar with DSP on ARM processors

Topics:

- Discrete-time signals and systems
- Z-Transform
- Sampling and reconstruction
- Downsampling, upsampling
- Interpolation
- Noise shaping
- Minimum phase decomposition
- linear phase filters
- Filter design
- Discrete Fourier Transform
- Fast Fourier Transform

ECE 5220 Image Processing

3 Credits, 3 Contact hours

Instructors: Eric Gibbons

Text: Digital Image Processing, 4e, Rafael Gonzalez and Richard Woods

Description: Advanced image processing theory and methods. Topics include digital image formation, transformation, filtering, enhancements, segmentation and morphological processing. Lectures, computer assignments and project (including term paper).

Pre-requisite(s): ECE 3210.

Educational Objectives:

- Use low level analytical tools for image processing such as spatial and frequency filtering
- Perform image sharpening, noise reduction, and image restoration
- Perform Image compression
- Use basic computer vision techniques such as image segmentation and classification

Topics:

- Elements of Digital Image Processing and the Image Model
- Sampling, Quantization and Pixel Relationships
- The Discrete Fourier and Cosine Transforms
- The Haar and Hadamard Transforms
- Spatial Filtering and Enhancement by Point Processing
- Enhancement in the frequency domain
- Color Image Processing
- Image Segmentation, Discontinuity Detection
- Thresholding, Edge Linking and Boundary Detection
- Region oriented segmentation, use of Motion for Segmentation
- Boundary and Regional Description
- Morphological Dilation, Erosion, Opening and Closing.
- Morphological Algorithms and Gray Scale Images

ECE 5320 Antennas and Wave Propagation

3 Credits, 3 Contact hours

Instructors: Christian Hearn

Text: Antennas and Wave Propagation, 5e, J.D. Kraus and R.J. Marhefka

Other materials:

Description: Behavior of radiated electromagnetic waves in atmosphere, space, urban and indoor environments; path, frequency and antenna selection for practical communication systems; propagation prediction.

Pre-requisite(s): ECE 3310.

Educational Objectives:

- Understand antenna fundamentals and definitions
- Apply Biot-Savart's and Ampere's equations to magnetostatic problems
- Apply Maxwell's equations to time-varying fields
- Apply plane-wave reflection and transmission principles.
- Apply transmission line theory
- Apply the Smith chart

Topics:

- Antenna Fundamentals and Definitions
- Radiating Systems and Antenna Practice
- Array Theory
- Resonant Antennas: Wires and Patches
- Broadband Antennas
- Aperture Antennas
- Antennas in Systems
- Antenna Measurements

ECE 5410 Communication Circuits and Systems

3 Credits, 3 Contact hours

Instructor: Christian Hearn

Text: Fundamentals of Communication Systems, 2e, J.G. Proakis, M. Salehi, Pearson

Description: A study of communication circuits, modulation and decoding theory, spectrum usage, networks, and protocols.

Pre-requisite(s): ECE 3210 and either ECE 3430 or MATH 3410.

Educational Objectives:

- Perform Communication Link Analysis
- Analyze Transmission Lines + Antennas in practice
- Describe Overview of Analog modulation
- Analyze Noise in Communication Systems
- Use Probability+Random Processes in Communication Systems
- Describe Binary and multi-level (M-ary) modulated signal transmission
- Explain Digital Transmission in Bandlimited AWGN channels

Topics:

- Communication System Model
- Signals and Linear Systems
- Amplitude Modulation, Frequency Modulation
- Probability + Random Processes
- Noise
- Digital Modulation Methods
- M-ary Systems

ECE 5420 Digital Communication

3 Credits, 3 Contact hours

Instructor: Fon Brown

Text: Digital Communications: A Discrete-Time Approach, Michael Rice

Description: This course provides in-depth coverage of the theory, analysis, and design of digital communications systems with an emphasis on advanced topics related to wired and wireless data communication. Students will develop computer models to emulate the concepts. The course is particularly beneficial to students interested in doing work/research in fields related to communications and networking.

Pre-requisite(s): ECE 3210 and either ECE 3430 or MATH 3410.

Educational Objectives:

- Use modulation/demodulation techniques for transmitting digital data over a noisy, bandwidth-limited channel.
- Synchronize carrier phase
- Synchronize symbol timing
- Design various components of a digital communication system.

Topics:

- Signal Space
- Pulse Amplitude Modulation
- Phase Shift Keying and QAM
- OQPSK and MSK
- Multicarrier Modulation
- Noise, Error Rate
- Phase Locked Loops
- Carrier Phase Synchronization
- Symbol Timing Synchronization

ECE 5440 Optical Communication Systems

3 Credits, 3 Contact hours

Instructors: Shellee Dyer

Text: Fiber-Optic Communication Systems, 5e, Govind Agrawal, John Wiley & Sons, 2021

Description: This course covers the fundamentals of optical communication. Topics include wave propagation in fiber optics, optical transmitters and receivers, system design and performance, multichannel light wave systems, optical losses and loss management, fiber dispersion and dispersion management.

Pre-requisite(s): ECE 3310.

Educational Objectives:

- Demonstrate knowledge of the basic building blocks of optical communication systems: transmitters, receivers, waveguides
- Evaluate optical losses and design optical amplifiers to compensate for losses
- Evaluate dispersion effects and describe compensation techniques
- Design multichannel optical communication systems and evaluate their performance

Topics:

- Optical Fibers and Wave Propagation
- Dispersion and Fiber Losses
- Optical Transmitters
- Optical Receivers
- Receiver Noise and Sensitivity
- System Architectures
- System Design Guidelines
- Wavelength-Division Multiplexing
- Time-Division Multiplexing and Code-Division Multiplexing
- Optical Amplifiers: Gain, Noise, and Applications
- Raman and Brillouin Amplifiers
- Doped-Fiber Amplifiers
- Dispersion Pre-compensation
- Fiber Bragg Gratings for Dispersion Compensation

ECE 5510 Advanced Power Systems

3 Credits, 3 Contact hours

Instructors: Trent Tholen, Jonathan West

Text: Electric Machinery and Power System Fundamentals, Stephen Chapman, McGraw-Hill

Other materials:

Description: This course will explore advanced power systems concepts.

Pre-requisite(s): ECE 3510.

Educational Objectives:

- Become familiar with synchronous reluctance machines.
- Analyze, short, medium, and long transmission lines.
- Design, represent, and analyze power systems.
- Analyze power studies.
- Correct for poor power factor.
- Analyze magnetic circuits.
- Analyze symmetrical faults.
- Analyze unsymmetrical faults.
- Design and analyze circuits using simulation software

Topics:

- Short, medium, and long transmission lines
- Power System Representation and Equations
- Power Flow Studies
- Power System modeling using software
- Symmetrical faults
- Asymmetrical Faults
- Synchronous reluctance machines

ECE 5640 Model-based Systems Engineering

3 Credits, 3 Contact hours

Instructors: Tye Gardner

Text: A Practical Guide to SysML, 3e, Sanford Friedenthal, Alan Moore and Rick Steiner, 2020

Description: This course is an introduction to the use of formal models to describe complex electrical systems. Topics include modeling tools, design, verification and testing of model-based systems, model validation and verification, and the use of state-machines in models.

Pre-requisite(s): ECE 3610.

Educational Objectives:

- Demonstrate proficiency in an industry-standard modeling language.
- Demonstrate a knowledge of prominent model-based engineering standards and approaches.
- Apply model-based engineering methods and tools to design and verify a complex electrical system

Topics:

- Model-based engineering processes and approaches
- Review of digital systems
- Defining requirements and specifications
- OPL, states, and animated simulation
- Procedural and structural links
- Case, block and state-machine diagrams
- Dynamic systems and control
- Object-oriented modeling
- SysML diagrams
- Structural relationships
- Exhibition-Characterization
- Instantiation, refinement and abstraction
- Other modeling tools

ECE 5710 Real-Time Systems

4 Credits, 6 Contact hours

Instructor: Fon Brown

Text: Real Time Systems, Liu, Prentice Hall

Other materials: EFM32GG-STK3700A Cortex 3 development board

Description: An advanced course on real-time system design. Topics include task concurrency, scheduling paradigms, synchronization, resource access control, and inter-process communication. Lecture and Lab combination.

Pre-requisite(s): ECE 3710.

Educational Objectives:

- Describe the characteristics of a real-time system.
- Write multi-threaded real-time applications.
- Use synchronization primitives.
- Control access to resources shared by multiple threads.
- Design applications with cooperative threads.
- Determine whether a set of tasks is schedulable.

Topics:

- Timing constraints
- Types of real-time tasks
- Preemption
- Loop schedules
- Clock driven schedules
- Earliest deadline first
- Rate and deadline monotonic
- Schedulable utilization
- Time demand analysis
- Resource contention
- Priority ceiling protocols
- Multiprocessor approaches

ECE 5730 Robotics

3 Credits, 3 Contact hours

Instructors: Jonathan West

Text: Learning Robotics using Python, Joseph Lentin, Packt Publishing, 2017

Description: Robotic hardware design and control principles. Topics include selection and design of sensors, motor and actuator types and control, computer vision for navigation and tasks and hardware interfaces to sensors. Use of the Robot Operating System to interface and fuse data from various sensors such as LIDAR, Inertial measurement units, compass and physical and visual odometry for navigation and control. Use of the Gazebo simulation environment to validate designs before implementation.

Pre-requisite(s): ECE 3730 and ECE 4100.

Educational Objectives:

- Demonstrate knowledge of the operation and design of electro-mechanical systems such as drive motors, servos and manipulators
- Demonstrate knowledge of the operation, interface and data processing of various sensors such as accelerometers, gyroscopes, GPS, compass and encoders.
- Demonstrate working knowledge of the Robot Operating System to collect and process sensor data and control mechanical systems.
- Demonstrate the use of the Gazebo system to visualize and simulate robotic systems
- Demonstrate understanding of control systems as it applies to robot navigation and manipulation.

Topics:

- Selection of robotic hardware and sensors
- Robot Operating System and Gazebo
- Design and integration
- Sensor collection, processing and fusion
- System integration
- Localization, navigation, path planning
- Visual navigation and feedback
- System control and state machines

ECE 5750 Quantum Computer Engineering

3 Credits, 3 Contact hours

Instructors: Shellee Dyer

Text: Dancing with Qubits, by Robert S. Sutor

Description: Overview of quantum computer engineering. How quantum computers are fundamentally different from classical computers. Key applications of quantum computers. Topics include qubits, entanglement, EPR paradox, Bell's theorem, Bloch sphere, single-qubit gates, multi-qubit gates, Shor's algorithm, Simon's algorithm. Also covers physical realizations of a quantum computer: photons, polarization, and decoherence.

Pre-requisite(s): ECE 2700, PHYS 2220, either ECE 3430 or MATH 3410, and either ENGR 2240 or MATH 2250 or MATH 2270.

Educational Objectives:

- Design measurements for single and multi- qubit systems and calculate the probabilities of possible measurement outcomes
- Design quantum circuits that will yield a desired quantum state output
- Describe the physical realization of a modern quantum computer and the scalability challenges involved in large-scale multi-qubit systems

Topics:

- Quantum Mechanics and Single Quantum Bits
- Single-Qubit Measurement
- Quantum Key Distribution
- Quantum State Space
- Entangled States
- Multi-Qubit Measurements
- Dirac Notation
- EPR Paradox and Bell's Theorem
- Quantum Gates
- Unitary Transforms as Quantum Circuits
- Quantum Algorithms
- Physical Realization of Quantum Computers

ECE 5800 Individual Studies

1-4 Credits, 1-4 Contact hours

Instructor: Various

Text: N/A

Description: The students will receive credit for approved studies in the Electrical & Computer Engineering programs. A maximum of four credits can count as an elective course in the Electrical & Computer Engineering programs.

Pre-requisite(s): Departmental Permission.

Educational Objectives – Depends on field of study

Topic Outline – Depends on field of study.

ECE 5900 Special Topics

1-4 Credits, 1-4 Contact hours

Instructor: Various

Text: N/A

Description: A one-time special study course designed to introduce a new relevant topic that is not covered in the Electrical & Computer Engineering curriculum. Lecture and lab combination. Laboratory activities support the selected course topic. May be repeated four times for a maximum of four credit hours..

Pre-requisite(s): Departmental Permission.

Educational Objectives – Depends on field of study

Topic Outline – Depends on field of study.

CS 1410 Object-Oriented Programming

4 Credits, 4 Contact hours

Instructor: Various

Text: zyBooks: CS 1410: Object-Oriented Programming

Description: An introduction to the C++ language. Topics will include data types, control structures, functions, pointers, arrays, I/O streams, classes, objects, encapsulation, overloading, inheritance and use of these concepts in problem solving

Pre-requisite(s): (CS 1400 or ECE 1400 or CS 2250) and (ENGL 1010 or ENGL 2010)

Educational Objectives:

- Understand and be able to use the fundamental concepts of the ANSI C++language, including variables, expressions, statements, flow-of-control statements, functions, structures, pointers, references, i/o streams, and templates
- Understand the Object-Oriented model and its relationship to and implementation in the C++ programming language; specifically, classes, objects, static and dynamic instantiation, relationships: inheritance, association, aggregation, composition, encapsulation, abstraction, polymorphism
- Express the solutions to problems as computer programs

Topics:

- Introduction to C++,
- Variables/Assignments
- Branches & Loops
- Arrays/Vectors
- User-Defined Functions In-class Quiz
- Recursion
- Pointers
- Classes and Objects
- Constructors, Destructors
- Structures
- Copy Constructors
- Overloaded Operators,
- Classes, objects, and instantiation
- Inheritance
- Virtual and abstract classes
- Polymorphism
- Class Relationships
- Templates
- Streams (File IO)

CS 2130 Computational Structures

4 Credits, 4 Contact hours

Instructor: Various

Text: Discrete Mathematical Structures, 6e, Kolman, Busby, Ross

Description: An overview of the fundamentals of algorithmic, discrete mathematics applied to computation using a contemporary programming language. Topics include sets, functions, logic, matrices, relations, graphs, trees, regular expressions, grammars, finite state machines, and data encoding.

Pre-requisite(s): CS 1400 or ECE 1400.

Educational Objectives:

- Apply mathematical reasoning in order to read, comprehend, and construct mathematical arguments.
- Apply combinatorial analysis to solve counting problems.
- Manipulate discrete structures, including sets, permutations, relations, trees, and finite state
- machines.
- Select and validate computing algorithms and construct computer programs implementing those
- algorithms.
- Develop and construct mathematical models for application to other fields of study.
- Develop improved thinking habits to prepare to be a better problem solver.
- Solve problems using mathematical concepts that would otherwise be difficult to solve.

Topics:

- Sets and functions
- Sequences and Recursive Functions
- Integers and Number Bases
- Propositional Logic and Truth Tables
- Boolean Functions and Digital Logic
- Advanced Counting
- Relations, Digraphs and Matrices
- Graphs and Trees
- Algorithms, Languages and Grammars

CS 2420 Introduction to Data Structures and Algorithms

4 Credits, 4 Contact hours

Instructor: Various

Text: Data Structures Using C++, 2nd Edition by D. S. Malik.

Description: General principles of common data structures and design of efficient algorithms. Topics include: arrays, linked-lists, stacks, queues, trees, graphs, tables, storage and retrieval structures, searching, sorting, hashing, and algorithmic analysis. Emphasis will be on abstraction, efficiency, re-usable code, and object-oriented implementation.

Pre-requisite(s): CS 1410.
Pre-requisite/Co-requisite: MATH 1050 or MATH 1080 or MATH 1210.

Educational Objectives:

- Reinforce good scheduling and working habits
- Learn adaptable skills in a software development workplace environment
- Understand object-oriented program design
- Understand algorithm development techniques
- Understand the conceptual idea behind as well as the implementation of the data structures including static and dynamic arrays, vectors, linked lists, stacks, queues, and binary trees
- Compare and contrast efficiency both in time and space for these data structures
- Understand common search and sort algorithms

Topics:

- Linked lists
- Doubly linked lists
- Linked list iterators
- Hash tables, algorithmic analysis
- Sort algorithms
- Multi-threaded sort algorithms
- Binary trees, AVL trees, B trees
- Graphs

CS 3100 Operating Systems

4 Credits, 4 Contact hours

Instructor: Various

Text: Operating Systems: Three Easy Pieces by Dusseau & Dusseau

Description: An overview of computer operating system from the programmer's point of view. Input-output hardware, interrupt handling, properties of external storage devices, associative memories and virtual address translation techniques, optimizing programs for performance, concurrent programming with threads, and network programming.

Pre-requisite(s): CS 2420 and (CS 2810 or ECE 3620).

Educational Objectives:

- Identify the components of operating systems process management
- Recognize issues related to concurrent processes and synchronization techniques
- Construct software which uses multiple threads
- Discuss and illustrate several scheduling algorithms
- Describe I/O handling in operating systems
- Illustrate file system interfaces and implementation
- Perform independent lab experiments on a focused OS internal topic
- Document research results in a technical paper

Topics:

- Introduction to Operating Systems
- Process and Process APIs
- CPU Scheduling
- Computer Address Space, and the memory APIs
- Memory Management
- Introduction to paging, translation look aside buffers, and virtual memory
- Concurrency and threads
- Locks and locked data structures
- Condition Variables and Semaphores
- I/O and storage devices
- Files and Directories
- File System Implementation
- FSCK and Journaling
- Distributed and network file systems
- Introduction to OS security

CS 4110 Formal Languages and Algorithms

4 Credits, 4 Contact hours

Instructor: Various

Text: Introduction to Computer Theory, 2e, Daniel I. A. Cohen, Wiley

Description: Concepts of formal language definition, automata theory, Turing theory, and solvability, with an introduction of algorithms and computational methods used in advanced computer science courses.

Pre-requisite(s): CS 2420 and either MATH 1630 or CS 2130.:

Educational Objectives:

- Know what formal languages are and how they are defined
- Read and write various representations of finite automata
- Understand different types of theoretical machines
- Model computing related processes using mathematical logic
- Understand the concepts of decidability, the Halting Problem, Church's Thesis and computability.

Topics:

- Languages
- Recursive Definitions
- Regular Expression
- Finite Automata
- Transition Graphs
- Kleene's Theorem
- Regular and Non-regular Languages
- Decidability
- Context Free Grammar
- Regular Grammar
- Chomsky Normal Form
- Pushdown Automata
- Context Free and Non-context Free Languages
- Decidability
- Turning Machine
- Minsky's Theorem
- The Chomsky Hierarchy

CS 4280 Computer Graphics

4 Credits, 4 Contact hours

Instructor: Various

Text: Interactive Computer Graphics, 8e, Edward Angel and Dave Shreiner

Description: This course introduces and investigates the mathematical and programming basis for generating pictures and images using a computer. Fields impacted by visual rendering technologies include filmmaking, publishing, banking, engineering, and education. Students are introduced to the theory and practice of computer graphics, with an emphasis on designing and developing working applications using currently available graphics libraries. The course focuses on strategies for rendering geometric data (points, lines, and polygons), and the analysis of the processing stages and components of the graphics pipeline, including transformations, viewing volumes, and projections. Programming and mathematical techniques related to modeling, viewing, coordinate frames, and perspective will be primary topics for discussion and code development. The course covers the key processing steps and structures needed to appropriately map 3D geometric primitives to 2D screen positions while maintaining a realistic look, which involves hidden surface removal, proper lighting, and simulated material properties.

Pre-requisite(s): CS 2420.

Educational Objectives:

- Use matrix operations to perform transformations, viewing, and projections
- Differentiate between modeling and rendering; fixed-function and shade based graphics pipelines;
- Successfully create interactive shader-based WebGL and Three.js programs;
- Load external geometric 3D models and use them to create scenes and generate computer pictures;
- Use I/O devises to interactively manipulate the graphics functions performed by their WebGL/Three.js programs.

Topics:

- 2D graphics
- The graphics rendering pipeline
- Interaction and animation
- Transformations
- Viewing
- Curves and surfaces
- Lighting and shading
- Textures and materials
- Picking and collision detection
- Hierarchical models
- Physics engines

CS 5200 The Internet of Things

3 Credits, 3 Contact hours

Instructor: Various

Text: none

Description: The growth of the Internet of Things (IoT) is changing the way we interact with the world by saving time and resources and opening new opportunities for growth and innovation. This course explores the fundamentals of the world of IoT, including design considerations and constraints. It provides an overview of the networks and security issues related to IoT devices. Course participants will get hands-on experience using Arduino and/or Raspberry Pi hardware and software platforms, learn different communication protocols, how to harness the data from IoT devices, and review capabilities of cloud-based IoT platforms.

Pre-requisite(s): CS 2810 or ECE 3710.

Educational Objectives:

- Describe IoT systems including different technologies, platforms, and applications
- Learn to build IoT devices
- Program Raspberry-Pi, Arduino, or other boards to interact with the Internet
- Learn how to build IoT networks
- Understand security vulnerabilities in IoT systems
- Analyze and visualize data from IoT devices
- Understand the business opportunities of IoT

Topics:

- Introduction to Internet of Things
- What are intelligence systems
- IoT Architectures
- Sensors and Actuators
- Programming Microcontrollers: Arduino, Raspberry Pi, etc.
- IoT Programming Basics
- Electronics and Circuits
- Sketches and IO pins
- Connecting IoT Devices over Wireless with IEEE 801.15.4
- Low Power Wide Area Networks (LPWANs)
- IoT Connectivity for the Home Network
- IPV6 Fundamentals for IoT
- Management Protocols for IoT
- IoT Security
- Fog and Edge Computing
- Data Analytics, Architectures
- Issues related to IoT/Utilities and the Smart Grid
- IoT for Transportation, Smart Cities, Public Safety, etc.

CS 5420 Advanced Algorithms

3 Credits, 3 Contact hours

Instructor: Various

Text: Introduction to Algorithms, 3e, T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein

Description: Introduction to fundamental principles of advanced algorithm design, including asymptotic analysis; divide-and-conquer algorithms and recurrences; greedy algorithms; practical data structures (heaps, hash tables, search trees, graphs); dynamic programming; graph algorithms; and randomized algorithms.

Pre-requisite(s): CS 2420.

Educational Objectives:

- explain the divide-and-conquer algorithm design paradigm and its applications;
- explain the greedy algorithm design paradigm and its applications;
- explain the dynamic programming algorithm design paradigm and its applications;
- explain the graph algorithm design paradigm and its applications;
- explain the randomized algorithm design paradigm and its applications;
- implement and operate practical data structures and their applications, including heaps, hash tables, search trees, graphs, storage structures, etc.;
- describe the NP-completeness and P vs. NP problem.

Topics:

- Asymptotic notation and Analyzing Algorithms
- Divide-and-Conquer Algorithm
- Randomized Algorithms
- Heap and Heapsort
- Elementary Data Structures
- Hash Tables
- Binary Search Trees
- Dynamic Programming
- Greedy Algorithms
- Elementary Graph Algorithms
- NP-Completeness

CS 5600 Machine Learning

3 Credits, 3 Contact hours

Instructor: Various

Text: Machine Learning: An Algorithmic Perspective, 2e, Stephen Marsland

Description: Introduction to fundamental principles and practical techniques of machine learning and its applications, including parametric and non-parametric algorithms, support vector machines, kernels, neural networks, clustering algorithms, dimensionality reduction, recommender systems, and deep learning. This course focuses on understanding and implementing the machine learning algorithms.

Pre-requisite(s): CS 2420.

Educational Objectives:

- Describe and implement the supervised learning techniques, including parametric and non-parametric algorithms, support vector machines, kernels, and neural networks
- Describe and implement the unsupervised learning techniques, including clustering algorithms, dimensionality reduction, recommender systems, and deep learning.
- Employ the best practices in machine learning and implement learning techniques in solving real world problems

Topics:

- Linear Discriminants
- Multi-Layer Perception
- Radial Basis Functions and Splines
- Support Vector Machines
- Ensemble Learning
- Probability and Learning
- Unsupervised Learning
- Dimensionality Reduction
- Markov Chain Monte Carlo Methods
- Graphical Models

CS 5610 Computer Architecture

3 Credits, 3 Contact hours

Instructor: Hugo Valle

Text: Computer Architecture: A Quantitative Approach, 6e, Hennessy and Patterson

Description: Investigation of high-performance computer processing architectures, including concurrent, multicore platforms; memory hierarchy; static and dynamic scheduling; instruction-level parallelism, including branch prediction; graphics processing units; cache performance and analysis.

Pre-requisite(s): CS2810 or ECE 3710.

Educational Objectives:

- Ability to apply knowledge of math, science, and engineering
- Ability to design and implement programs as well as to analyze and interpret code and data.
- Ability to design a system, component, or process to meet desired needs.
- Ability to identify, formulate and solve computing problems.
- Ability to communicate effectively.
- Understand the impact of computing solutions in a global and societal context.
- Knowledge of contemporary issues.
- Ability to use the techniques, skills, and modern computing tools necessary for computing practice.

Topics:

- Performance Metrics and Evaluations
- Pipelining & Branch Prediction
- Instruction Scheduling
- Memory Hierarchy
- Thread Level Parallelism
- Data Level Parallelism

CS 5740 Computer Systems Security

3 Credits, 3 Contact hours

Instructor: Various

Text: Selected Readings

Description: Computer Systems Security studies the design and implementation of secure computer systems. Topics include threat models, operating system security, TCP/IP security issues, information flow control, language security, hardware security, security in web applications, and detecting/monitoring unauthorized activity. Assignments include readings from current articles, labs that involve implementing and compromising a secure computer system, and a team final project.

Pre-requisite(s): CS 2420 and CS 3100.

Educational Objectives:

- Define security in terms of risk assessment and threat models.
- Contribute meaningful discussion of ethical issues involving cybersecurity.
- Conduct a limited penetration test, staying within the allowed bounds.
- Secure a system under different threat models

Topics:

- Introduction to Security. Threat models.
- Intro to common tools. Kali Linux, Metasploitable, Metasploit, VMware.
- Risk assessment. Security Economics.
- Social Engineering. Information Reconnaissance.
- Authentication. Buffer Overflows and Countermeasures.
- Privilege Separation. Privilege Escalation.
- Virus Scanning, signatures, heuristics, etc. Rootkits.
- Sandboxing.
- Firewalls, IDS, IPS.
- Web Security.
- SQL Injection.
- Mobile Device Security.
- Privacy and Anonymization. Side-Channel Attacks.
- Medical Software. Internet of Things.

CS 5820 Compiler Design

3 Credits, 3 Contact hours

Instructor: Various

Text: Engineering: A Compiler by Keith Cooper and Linda Torczon

Description: A study of compilers, grammars, finite-state and push down automata, scanning, parsing, error handling, semantic analysis and code generation.

Pre-requisite(s): CS 2420 and CS 2130.

Educational Objectives:

- Summarize OOP and its usefulness in today's applications and work environments.
- Compare Java to other programming languages
- Analyze client requirements
- Evaluate problem solving approaches and develop algorithms
- Write pseudocode
- Compare selection structures
- Compare and contrast looping structures
- Manipulate data structures
- Develop effective structured programs
- Develop detailed test scenarios for software programs

Topics:

- Overview of Compilation
- Scanners
- Parsers
- Context Sensitive Analysis
- Intermediate Representations
- The Procedure Abstraction
- Code Shape
- Introduction to Optimization
- Data-Flow Analysis
- Scalar Optimizations
- Instruction Selection

CS 5850 Parallel Programming and Architecture

3 Credits, 3 Contact hours

Instructor: Various

Text: An Introduction to Parallel Programming. Peter Pacheco

Description: In parallel programming you will learn how to utilize multiple CPU's/Cores/Nodes in parallel to increase the performance of your applications. Different architectures will be discussed along with the advantages and disadvantages of each. This course will cover key topics parallel programming including: memory models, parallel programming architectures, Flynn's Taxonomy, synchronization, and performance analysis and tuning. In addition to learning the theoretical background of parallel programming, you will work on hands-on projects using multiple parallel programming languages and libraries including (CUDA, openMP, MPI, open CL, and python).

Pre-requisite(s): CS 3100.

Educational Objectives:

- describe the models of parallel programming
- identify the trade-offs between different parallel programming approaches
- use a variety of parallel programming approaches and techniques to solve interesting programming problems

Topics:

- Performance Metrics
- Parallel Algorithm Design
- Shared Memory Programming – Pthreads
- Memory Hierarchy
- Shared Memory Programming – openMP
- Tree-based algorithms
- Distributed Memory Programming
- Load Balancing
- Performance Optimization and Tuning
- Using the GPU
- MapReduce/Hadoop
- Parallel Programming in Python

ENGR 1000 Introduction to Engineering

2 Credits, 2 Contact hours

Instructor: Various

Text: Design Concepts for Engineers, 5e, Mark Horenstein, Pearson, 2016

Description:. An introductory course for engineering students. Engineering as a profession and career opportunities. Fundamentals of design and analysis. Team design and build project

Pre-requisite(s):

Educational objectives:

- Be familiar with the engineering curriculum
- Be familiar with the engineering disciplines and functions
- Understand the basic engineering design process
- Be able to perform a basic engineering analysis
- Know how to work effectively on an engineering design team

Topics:

- The industrial team
- Engineering fields and functions
- Basic engineering design
- The engineering design cycle
- Introduction to engineering analysis
- Dimensions and units
- General analysis methodology
- Engineering mechanics
- Electrical circuits
- Thermodynamics
- Renewable energy
- Team design project

ENGR 2240 Dynamic Systems Engineering

4 Credits, 6 Contact hours

Instructor: Alyssa Mock

Texts:
Differential Equations for Engineers, Jiri Lebl
Introduction to Linear Algebra for Science and Engineering, Norman and Wolczuk

Description:. An introduction to the modeling, analysis, and control of dynamic systems. Models of electrical, mechanical, electromechanical, and mass-transport systems in state-variable, input-output, and transfer function form. Topics include linear approximations of nonlinear systems, time domain and Laplace transform solutions, Block diagrams, feedback systems and large-scale linear systems analysis. Lecture and lab combination.

Pre-requisite(s): ECE 1270 and ECE 1400 and MATH 1210.

Educational Objectives:

- Gain an understanding of 1st and 2nd order mechanical and electrical systems
- Understand how to solve system problems using transform methods
- Be comfortable solving dynamic mechanical and electrical engineering problems using numerical and software methods

Topics:

- Differential Equation Classification
- Ordinary Differential Equations
- Partial Differential Equations
- Eigenvalues
- Laplace Transformations
- Vectors
- Linear Equations
- Matrices
- Orthonormal Basis
- Symmetric Matrices
- Least Squares Regression

MATH 1210 Calculus I

4 Credits, 4 Contact Hours

Text: James Stewart, Calculus, 7e, Brooks Cole, 2011

Instructor: Various

Description: Limits, continuity, differentiation, integration.

Pre-requisite(s): MATH 1050 and MATH 1060 or MATH 1080 or placement test.

Educational objectives:

- To give students a solid understanding of the fundamental notions of calculus.
- Conceptual understanding as well as a mathematically rigorous treatment of the subject are central to the course

Topics:

- Limits and continuity
- Derivatives
- Mean Value Theorem
- applications of derivatives
- integration
- applications of integration.

MATH 1220 Calculus II

4 Credits, 4 Contact hours

Instructor: Various

Text: James Stewart, Calculus, 7e, Brooks Cole, 2011

Description: Transcendental functions, techniques of integration, analytic geometry, infinite series.

Pre-requisite(s): MATH 1210

Educational Objectives:

- To give students a solid understanding of the fundamental notions of calculus
- Conceptual understanding as well as a mathematically rigorous treatment of the subject are central to the course

Topics:

- Transcendental functions
- techniques of integration
- applications of integration
- conic sections
- polar coordinates
- sequences and series

MATH 2210 Calculus III

4 Credits, 4 Contact hours

Instructor: Various

Text: James Stewart, Calculus, 7e, Brooks Cole, 2011

Description: Vector algebra, vector-valued functions, multivariable functions, partial derivatives, multiple integrals, line integrals, integration in vector fields.

Pre-requisite(s): MATH 1220

Educational Objectives:

- To give students a solid understanding of the fundamental notions of calculus
- Conceptual understanding as well as a mathematically rigorous treatment of the subject are central to the course

Topics:

- Vectors and analytic geometry
- vector-valued functions and motion in space
- multivariable functions and partial derivatives
- Multiple integrals
- integration in vector fields

MATH 2270 Elementary Linear Algebra

3 Credits, 3 Contact hours

Instructor: Various

Text: David Lay, Linear Algebra and its Applications, 4e, Addison Wesley, 2011.

Description: Systems of linear equations, matrices, vector spaces, eigenvalues linear transformations, orthogonality.

Pre-requisite(s): MATH 1220 OR MATH 1210 and a choice of MATH 3110 or MATH 3160.

Educational Objectives:

- To study the fundamental topics of linear algebra.
- To familiarize students with matrix theory, vector spaces and orthogonality

Topics:

- Systems of linear equations
- matrix equations
- determinants
- vector spaces
- linear transformations
- eigenvalues and eigenvectors,
- orthogonality

MATH 2280 Ordinary Differential Equations

3 Credits, 3 Contact hours

Instructor: Various

Texts:
Elementary Differential Equations 9e, Boyce and DiPrima, Wiley, 2008.
Fundamentals of Differential Equations 8e, Nagel, Saff and Snider, Addison Wesley, 2011.

Description: Methods of solution for ordinary differential equations. Exact equations, linear equations Laplace Transforms, series solutions.

Pre-requisite(s): MATH 1220.

Educational Objectives:

- To learn the most fundamental aspects of differential equations.
- To familiarize students with the meaning, methods and applications of ordinary differential equations

Topics:

- Classification of differential equations
- first order equations
- linear and second order equations
- higher order equations
- Laplace transforms
- series solutions

MATH 3410 Probability and Statistics I

3 Credits, 3 Contact hours

Instructor: Various

Text: Probability and Statistics for Engineering and the Sciences, 8e, Jay Devore, 2011.

Description: Introductory probability theory and mathematical statistics, including applications

Pre-requisite(s): MATH 1220.

Educational Objectives:

- To learn the mathematical content of probability and statistics at the undergraduate post-calculus level.
- An understanding of the applications of probability and statistics is also stressed

Topics:

- Statistical theory
- data analysis
- combinatorial mathematics
- discrete distributions
- continuous distributions
- functions of random variables
- statistical theorems
- estimation
- confidence intervals
- hypothesis testing,
- statistical computer software applications.

PHYS 2210 Physics for Scientists and Engineers I

5 Credits, 8 Contact hours

Instructor: Various

Text: Physics for Scientists and Engineers: A Strategic Approach with Modern Physics 2e, Randall Knight, Addison Wesley, 2007.

Description: First semester of a two-semester sequence in calculus-based physics, primarily for students in science, math, computer science, and pre-engineering. This semester covers topics in mechanics, including kinematics, Newton's laws, and the conservation laws of energy, linear momentum, and angular momentum. Also covered are topics in gravity, fluid mechanics, waves, and thermodynamics. Class meets five hours per week in lecture/discussion format. One 3-hour lab per week (PHYS 2219).

Pre-requisite(s)/Co-Requisite(s): MATH 1210:
Co-Requisite(s): PHYS 2219.

Educational Objectives:

- This course is meant to serve as the first half of a first rigorous course in physics using calculus.
- We will cover a variety of topics including optics, electricity and magnetism, and modern (20th century) physics

Topics:

- Motion in one and two dimensions
- velocity and acceleration
- Newton's laws of motion
- momentum
- collisions
- energy
- gravity
- orbits
- rotating and rolling
- oscillations
- fluids
- nature of matter
- thermodynamics
- waves
- sound.

PHYS 2220 Physics for Scientists and Engineers II

5 Credits, 8 Contact hours

Instructor: Various

Text: Physics for Scientists and Engineers: A Strategic Approach with Modern Physics 2e, Randall Knight, Addison Wesley, 2007.

Description: Second semester of a two semester sequence in calculus-based physics. This semester covers topics in electricity and magnetism, electromagnetic waves, light and optics, relativity, and quantum, atomic, and nuclear physics. Class meets five hours per week in lecture/discussion format. One 3-hour lab per week (PHYS 2229).

Pre-requisite(s): PHYS 2210.
Pre-requisite(s)/Co-Requisite(s): MATH 1220:
Co-Requisite(s): PHYS 2229.

Educational Objectives:

- This course is meant to serve as the second half of a first rigorous course in physics using calculus.
- We will cover a variety of topics including optics, electricity and magnetism, and modern (20th century) physics

Topics:

- Electricity and magnetism
- DC circuits
- alternating current
- Gauss's Law
- Maxwell's equations
- electromagnetic waves
- light and optics
- modern physics including: relativity, quantum, and nuclear physics

CHEM 1210 Principles of Chemistry I

5 Credits, 7 Contact hours

Instructor: Various

Text: Chemistry–The Central Science 11e., Theodore Brown et. al., Prentice Hall, 2008.

Description: The first course in a series designed primarily for science majors and others who will take more than one year of chemistry such as pre-medical students, clinical/medical laboratory scientists and some engineering students. The fundamental principles of chemistry with laboratory emphasis upon qualitative and quantitative methods of analysis. Four hours of lecture and one 3-hour lab a week.

Pre-requisite(s): MATH 1010 or equivalent and CHEM 1200 or departmental approval.
Co-Requisite(s): CHEM 1215.
Pre-requisite/Co-requisite: MATH 1050, MATH 1080, MATH 1210, or equivalent.

Educational Objectives:

- To present the fundamental concepts of chemistry with laboratory emphasis upon qualitative and quantitative methods of analysis.

Topics:

- Measurement and significant figures
- chemical balances
- identification of compounds
- simple stoichiometry
- changes and reactions
- calorimetry
- acid base stoichiometry
- acid rain reactions
- gas laws,
- colligative properties of solutions

CHEM 1230 Engineering Chemistry

5 Credits, 7 Contact hours

Instructor: Various

Text: Chemistry for Engineering Student, 4e, Brown & Holme, Cengage, 2019

Description: This course is designed primarily for engineering majors who will take one semester of introductory chemistry. This course will teach the fundamental principles of chemistry including introduction to atomic structure, chemical bonding, chemical reactions, stoichiometry, kinetics, equilibrium, thermodynamics, and materials. A 1-credit laboratory accompanies this class.

Co-Requisite(s): CHEM 1235
Pre-requisite/Co-requisite: MATH 1050.

Educational Objectives:

Students will demonstrate their understanding of:

- Organization of systems: The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.
- Matter: Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.
- Energy: Interactions within the universe can be described in terms of energy exchange and conservation.
- Forces: Equilibrium and change are determined by forces acting at all organizational levels.

Topics:

- Introduction to Chemistry
- Atoms and Molecules
- Molecules, Moles, and Chemical Equations
- Stoichiometry
- Gases
- The Periodic Table and Atomic Structure
- Chemical Bonding and Molecular Structure
- Ionic & Covalent Bonding – Lewis Structures
- Molecules and Materials
- Energy and Chemistry
- Entropy and the Second Law of Thermodynamics
- Chemical Kinetics
- Chemical Equilibrium
- Electrochemistry
- Nuclear Chemistry

APPENDIX B – FACULTY VITAE

(See https://www.weber.edu/ece/faculty-staff.html for more detailed Vitaes)

Name	**Fon R. Brown**			
Education				
PhD	Electrical Engineering	Utah State University		1998
MS	Computer Science	Brigham Young University		1989
BS	Electrical Engineering/Math	Utah State University		1984
Academic Experience				
Professor		Weber State University	2010-Present	FT
Lecturer		Utah State University	2007-2010	FT
Adjunct		Utah State University	2006-2007	PT
Other Professional Experience				
Lead SW Engineer		GE Healthcare	2005-2007	FT
Senior SW Engineer		Evans & Sutherland	1992-2001	FT
Software Engineer		Signetics	1984-1992	FT
Professional Credentials, Certifications, or Licensing				
Professional Development				
POGIL Workshop				2023
Ophir/MKS Collaboration				
Current Membership in Professional Organizations				
Institute of Electrical and Electronic Engineers				
Honors and Awards				
Teacher of the Year 2009-10, ECE Dept, USU				
Service Activities				
Chair, ECE Dept. Weber State				2021-Present
Director, MSEE, MSCE Programs				2016-2021
Advisor, Weber (Pre) Tau Beta Pi				2023-Present
MS Committee Chair, Ethan Albretsen				2016-2017
Coordinator, Departmental Honors Program				2011-2016
Advisor, Weber State IEEE Student Chapter				2011-2016
Recent Publications and Presentations				
Introduction to Digital Circuits with VHDL 3e, Linus Learning, 2022				

Name **Shellee Dyer**

Education

PhD	Electrical Engineering	University of Utah	1996
MS	Electrical Engineering	University of Utah	1994
BS	Electrical Engineering	University of Utah	1990

Academic Experience

Assistant Professor	Weber State University	2020-Present	FT
Instructor	Metro State of Denver	2018-2020	FT
Affiliate Professor	Metro State of Denver		PT

Other Professional Experience

Senior Electronics Engineer	NIST	1999-2018	FT
Post-doc Fellow	University of Colorado at Boulder	1998-1999	FT
NRC Post-doc Fellow	NIST	1997-1998	FT

Professional Credentials, Certifications, or Licensing

Professional Development

Current Membership in Professional Organizations

American Society of Engineering Education

Honors and Awards

Best Paper, Rocky Mountain Section, ASEE (2018)
WSU ARCC grant $7500 for fusion splicer (2022)
WSU ARCC grant $26,000 for optical spectrum analyzer (2021)
NIST Equal Employment Opportunity/Diversity Award (2005)

Service Activities

Recent Publications and Presentations

S. Dyer, “Teaching quantum computer engineering: practical exercises using the IBM quantum experience,” ASEE Rocky Mountain Section Conference, Golden, Colorado, May 2023

S. Dyer, “Educating neurodiverse college students: what professors should do,” WSU Thrive Symposium, March 2023.

C. Gentry, O. Magana Loaiza, M. Wade, F. Pavanello, T. Gerrits, S. Lin, J. Shainline, S. Dyer, S. Nam, R. Mirin, and M.Popovic, “Monolithic source of entangled photons with integrated pump rejection,” in Conference on Lasers and Electro-Optics, paper JTh4C.3, May 2018.

S. Dyer, D. Swigert, and J. Proano, “Using mobile devices to improve engineering education: a process control laboratory example,” in ASEE Zone IV Conference, March 2018.

L. Shalm, E. Meyer-Scott, B. Christensen, P. Beirhorst, M. Wayne, M. Stevens, T. Gerrits, S. Glancy, D. Hamel, M. Allman, K. Coakley, S. Dyer, C. Hodge, A. Lita, V. Verma, C. Lambrocco, E. Tortorici, A. Migdall, Y. Zhang, D. Kumor, W. Farr, F. Marsili, M. Shaw, J. Stern, C. Abellan, W. Amaya, V. Pruneri, T. Jennewein, M. Mitchell, P. Kwiat, J. Beinfang, R. Mirin, E. Knill, and S. Nam, “A strong loophole-free test of local realism,” in Conference on Lasers and Electro-Optics, paper FW4C, May 2016.

F. Marsili, M. Stevens, A. Kozorezov, V. Verma, C. Lambert, J. Stern, R. Horansky, S. Dyer, S. Duff, D. Pappas, A. Lita, M. Shaw, R. Mirin, and S. Nam, “Hotspot relaxation dynamics in a current-carrying superconductor,” Phys. Rev. B, vol. 93, pp. 094518, 2016.

Name **Tye Gardner**

Education

PhD	Electrical Engineering	University of Utah	2020
BS/MS	Electrical Engineering	University of Utah	2015

Academic Experience

Assistant Professor	Weber State University	2020-Present	FT
Teacher (7th Grade)	Granite School District	2015-2016	FT

Other Professional Experience

NSF Graduate Research Fellow	University of Utah	2015-2020	PT
Electrical R&D Engineer	Ripple LLC	2019-2020	FT
Graduate Research Assistant	Berkeley National Laboratory	2014-2015	PT
Industry Control & Automation	L3 (MPRI)	2009-2011	FT

Professional Credentials, Certifications, or Licensing

Professional Development

Model-based systems engineering course from MIT
Model-based systems engineering course from Israeli Institute of Technology
Pursuing MBA at WSU

Current Membership in Professional Organizations

Institute of Electrical and Electronic Engineers

Honors and Awards

Gwen William Prize (2024)
Hemmingway Collaborative Research Award (2022, 2024)
NSF Non-Academic Research Internship Award (2018)

Service Activities

Graduate Mentor – University of Utah	2016-2020
Senior Project Supervisor – University of Utah	2016-2020

Recent Publications and Presentations

R.H. Swain, A.J. O'Hare, K. Brandley, A.T. Gardner “Individual differences in social intelligence and perception of emotion expression of masked and unmasked faces,” Cognitive Research: Principles and Implications, 2022.

A. T. Gardner, H. J. Strathman, and R. M. Walker, “A Multiplexed Electrochemical Measurement System for Characterization of Implanted Electrodes,” IEEE International Symposium on Circuits and Systems, Seville, Spain, 2020.

A. T. Gardner, H. J. Strathman, D. J. Warren, and R. M. Walker, “Impedance and noise characterizations of Utah and microwire electrode arrays,” IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology, 2018.

A. T. Gardner, R. M. Walker, H. J. Strathman, and D. J. Warren, “Signal and noise sources from microwire arrays implanted in rodent cortex,” 2018 IEEE Life Sciences Conference, 2018.

A. T. Gardner, J. Mize, D. J. Warren, and R. M. Walker, “Comparative characterization of in vivo and in vitro noise of the SIROF Utah electrode array,” Proceedings of IEEE Sensors, 2017.

M. Sharma, A. T. Gardner, H. J. Strathman, D. J. Warren, J. Silver, and R. M. Walker, “Acquisition of neural action potentials using rapid multiplexing directly at the electrodes,” Micromachines, Invited, 2018.

M. Sharma, A. T. Gardner, J. Silver, and R. M. Walker, “Noise and impedance of the SIROF Utah electrode array,” Proceedings of IEEE Sensors, 2017.

R. M. Walker, I. S. Subramanian, A. A. Bajwa, L. Rieth, J. Silver, T. Ahmed, N. Tasneem, M. Sharma & A. T. Gardner, “Integrated neural interfaces,” IEEE Midwest Symposium on Circuits and Systems (MWSCAS), 2017.

Name **Eric Gibbons**

Education

PhD	Bioengineering	Stanford University	2017
MS	Bioengineering	Stanford University	2013
BS	Biomedical Engineering	University of Utah	2011

Academic Experience

Assistant Professor	Weber State University	2019-Present	FT

Other Professional Experience

Post-doc Researcher	University of Utah Dept. of Radiology	2017-2019	FT

Professional Credentials, Certifications, or Licensing

Professional Development

Current Membership in Professional Organizations

International Society for Magnetic Resonance in Medicine
Institute of Electrical and Electronic Engineers

Honors and Awards

NIH T32 Cardiovascular Imaging Training Grant, 2017
ISMRM Educational Stipend Award, 2013, 2014, 2015, 2016
National Science Foundation Graduate Research Fellowship, 2012
Stanford University School of Engineering Dean's Doctoral Diversity Fellowship, 2011
University of Utah College of Engineering Arel Berrier Scholarship, 2010

Service Activities

Weber State University ECE Program Coordinator, 2021-Present
Weber State University Faculty Senate Member, 2020-Present
Weber State Faculty Senate Executive Committee, 2020-2022
Reviewer, IEEE Transactions on Biomedical Engineering
Reviewer, International Society of Magnetic Resonance in Medicine
Reviewer, New England Journal of Medicine

Recent Publications and Presentations

A. S. Chaudhari, B. Gunel, B. Ozturkler, P. Adamson, Z. Fang, R. Heckel, E. K. Gibbons, G. E. Gold, B. A. Hargreaves, S. Vasanawala, J. M. Pauly, and A. Desai, "Mitigating data paucity and distributional shifts for accelerated mri alongside new clinically-relevant evaluation metrics," in Proceedings of Biomedical and Astronomical Signal Processing Frontiers, Villars-sur-Ollon, Switzerland, 2023, p. 28.

E. K. Gibbons, Z. Fang, A. D. Desai, C. M. Sandino, G. E. Gold, B. A. Hargreaves, and A. S. Chaudhari, "Benchmarking accelerated MRI: a head-to-head comparison of deep learning reconstruction and super-resolution techniques," in Proceedings of International Society for Magnetic Resonance in Medicine, 29th Annual Meeting, London, United Kingdom, 2022, p. 1873.

E. K. Gibbons, A. S. Chaudhari, G. Adluru, and E. V. R. DiBella, "Rapid myocardial perfusion mri reconstruction using deep learning networks," in Proceedings of International Society for Magnetic Resonance in Medicine, 27th Annual Meeting, Sydney, Australia, 2020, p. 7047.

A. S. Chaudhari, K. J. Stevens, J. P. Wood, A. K. Chakraborty, E. K. Gibbons, Z. Fang, A. D. Desai, J. H. Lee, G. E. Gold, and B. A. Hargreaves, "Utility of deep

learning super-resolution in the context of osteoarthritis mri biomarkers," Journal of Magnetic Resonance Imaging, vol. 51, no. 3, pp. 768–779, 2020.

E. K. Gibbons, K. K. Hodgson, A. S. Chaudhari, L. G. Richards, J. J. Majersik, G. Adluru, and E. V. R. DiBella, "Deep learning for DSI parameter map generation without image preprocessing," in Proceedings of International Society for Magnetic Resonance in Medicine, 27th Annual Meeting, Montreal, Canada, 2019, p. 3359.

E. K. Gibbons, K. K. Hodgson, A. S. Chaudhari, L. G. Richards, J. J. Majersik, G. Adluru, and E. V. DiBella, "Simultaneous NODDI and GFA parameter map generation from subsampled q-space imaging using deep learning," Magnetic Resonance in Medicine, vol. 81, no. 4, pp. 2399–2411, 2019.

A. S. Chaudhari, Z. Fang, F. Kogan, J. Wood, K. J. Stevens, E. K. Gibbons, J. H. Lee,G. E. Gold, and B. A. Hargreaves, "Super-resolution musculoskeletal MRI using deep learning," Magnetic Resonance in Medicine, vol. 80, no. 5, pp. 2139–2154, 2018.

E. K. Gibbons, S. S. Vasanawala, J. M. Pauly, and A. B. Kerr, "Body diffusion-weighted imaging using magnetization prepared single-shot fast spin echo and extended parallel imaging signal averaging," Magnetic Resonance in Medicine, vol. 79, no. 6, pp. 3032–3044, 2018.

E. K. Gibbons, P. Le Roux, S. S. Vasanawala, J. M. Pauly, and A. B. Kerr, "Robust self-calibrating nCPMG aquisition: Application to body diffusion-weighted imaging," IEEE Transactions on Medical Imaging, vol. 37, no. 1, pp. 200–209, 2018.

E. K. Gibbons, P. Le Roux, J. M. Pauly, and A. B. Kerr, "Slice profile effects on nCPMG SS-FSE," Magnetic Resonance in Medicine, vol. 79, no. 1, pp. 430–438, 2018.

E. K. Gibbons, P. Le Roux, S. S. Vasanawala, J. M. Pauly, and A. B. Kerr, "Body diffusion weighted imaging using non-CPMG fast spin echo," IEEE Transactions on Medical Imaging, vol. 36, no. 2, pp. 549–559, 2017.

Name **Christian Hearn**

Education

PhD	Electrical Engineering	Virginia Tech	2012
MS	Electrical Engineering	Virginia Tech	2001
BS	EE Technology	Old Dominion University	1997
BS	Mechanical Engineering	Virginia Tech	1989

Academic Experience

Professor	Weber State University	2012-Present	FT
Instructor	Old Dominion University	2004-2007	FT

Other Professional Experience

Research Engineer	Applied EM, Inc.	2006-2012	FT/PT
Electrical Engineer	Nanosonic Ltd.	2003-2004	PT
Mechanical Engineer	Naval Surface Warfare Center	1989-1997	FT

Professional Credentials, Certifications, or Licensing

Professional Engineer (Virginia)

Professional Development

Technical Collaboration w/KIHOMAC, DoD and VT
Attended Utah RF & Wireless Day

Current Membership in Professional Organizations

Institute of Electrical and Electronic Engineers

Honors and Awards

Service Activities

Hosted Utah NASA Space Grant Consortium	2023
ARCC Committee	2017-present
Office of Undergraduate Research Committee	2014-2016
Science Olympiad	2014-2017

Recent Publications and Presentations

Finger, Matt., Hearn, C.W., Open-Source Antenna Pattern Measurement System; SDR-Based Student Research and Development, GRCon 2022, Sept 24-29, 2022

Hearn, C.W., Birch, D.S., Newton, D., Chatlin, S.L., Open-Source Antenna Pattern Measurement System, Antenna Measurement Techniques Association (AMTA), Nov 2-5, 2020,

Hearn, C.W., Open-Source Antenna Pattern Validation Using FEKO, Applied Computational Electromagnetic Society (ACES), March 22-24, 2020, Monterey, CA

Hearn, C.W., Open-Source Antenna Pattern Measurement System, Utah RF & Wireless Day 2019, Sept 2019, Brigham Young University, Provo UT

Hearn, C.W. and Chiou, F.Y. IEEE-SME Exam, WSU-EET Program Adjustments and Lessons Learned, ASEE conference for Industry and Education Collaboration (ASEE-CIEC) February 8-10 2017

Hearn et al, Data Acquisition in Wireless Router Link Testbed using GNU Radio Companion GRCON Technical Proceedings Paper 2016

Name **Justin Jackson**

Education

PhD	Electrical Engineering	University of Utah	2008
ME	Electrical Engineering	University of Utah	2004
MBA	Business Administration	Weber State University	2003
BS	Electronics Engineering Tech	Utah State University	2000

Academic Experience

Professor	Weber State University	2007-Present	FT
Teaching Assistant	University of Utah	2003-2007	FT
Adjunct	Stevens-Henager College	2003-2003	PT

Other Professional Experience

Consultant	Lockheed Martin	2014-2015	FT
ASIC Design Engineer	Primewave Communications	2001-2002	FT
Hardware Design Engineer	Linux NetworX	2000-2001	FT
Electrical/Computer Design Engineer	Smart Solutions	1999-2000	FT

Professional Credentials, Certifications, or Licensing

Professional Development

Current Membership in Professional Organizations

American Society for Engineering Education
Order of the Engineer

Honors and Awards

Honorary Commander, HAFB, 2024
Brady Distinguished Teaching Award, 2023
Utah AIAA Engineering Educator of the year, 2015

Service Activities

Director, MSEE, MSCE Programs	2021-Present
Chair, ECE Dept. Weber State	2018-2021
Program Coordinator EE/CE	2010-2021
Weber State Faculty Senate	2016-2019
MS Committee Chair, Jordan Olive	2017-2018
Salt Lake Community College Engineering Department Program Advisory Committee	2010-Present

Recent Publications and Presentations

Dhanya Nair, Grant Stankaitis, Sean Duback, Robert Geoffrion, Justin B. Jackson, Handwriting Correction System using Wearable Sleeve with Optimal Tactor Configuration, 2021 IEEE 18th International Conference on Ubiquitous Robots (UR), Gangneung, Korea (South), 2021, pp. 283289

Daniel Philpot and Justin B. Jackson, Fully Printed Solar Cells Design Project, Utah Academy for Math, Arts, and Sciences, Cedar City, Utah March, 2021

Evan Chief, Ross Frazier, and Justin B. Jackson, Remote Operating Sensor System, WSU Undergraduate Research Symposium, Ogden, Utah (2016)

Jay Atkinson, Ben Oborn, and Justin B. Jackson, Compact, High Efficiency Power Supply, WSU Undergraduate Research Symposium, Ogden, Utah (2016)

Mohammad A. U. Usman, Brady J. Smith, Justin B. Jackson, Matthew C. DeLong, Mark S. Miller, Titanium-Catalyzed Silicon Nanostructures Grown by APCVD, Journal of Electronic Materials, Vol. 44 No. 1, January 2015

Name **Alyssa Mock**

Education

PhD	Electrical Engineering	University of Nebraska	2017
BS	Mechanical Engineering	University of Nebraska	2011

Academic Experience

Assistant Professor	Weber State University	2021-Present	FT

Other Professional Experience

Post-doc Researcher	Naval Research Laboratories	2019-2021	FT
Post-doc Researcher	Linköpings universitet	2018-2019	FT
Post-doc Researcher	University of Nebraska	2012-2017	PT

Professional Credentials, Certifications, or Licensing

Professional Development

Current Membership in Professional Organizations

American Vacuum Society
American Society for Engineering Education

Honors and Awards

Deep Tech Grant, Post-Baccalaureate Certificate in Materials Science ($812,475), 2023
Office of Undergraduate Research Grant ($2315 – ATR-ellipsometry liquid cell design and fabrication, 2023
EAST Merit Scholar Award
Presidential Innovative Teaching Grant ($9596 –Continuation of peer mentorship of female and minority engineering students. Collab. with Dr. Randy Hurd), 2023
Finalist of 2023 Curtis W. McGraw Research Award – ASEE
Paul Drude Award – Generalized ellipsometric analysis of ultra-wide bandgap metal oxides with low-crystal symmetry, ICSE-9, Beijing China, 2022

Service Activities

AVS Spectroscopic Ellipsometry Topic Group Chair	2022-present
ICSE-X Denver Colorado Ground Team Committee	
ICSE-X Denver Colorado Awards Committee	
Vice-Chair of Technical Group on Spectroscopic Ellipsometry in American Vacuum Society	2022

Recent Publications and Presentations

J. Spencer, A. Mock, A.G. Jacobs, Y. Zhang, M.J. Tadjer, A Review of Band Structure and Material Properties of Transparent Conducting and Semiconducting Oxides: Ga2O3, Al2O3, In2O3, ZnO, SnO2, CdO, NiO, CuO, and Sc2O3, Appl. Phys. Rev. 9, 011315 (2022)

J.A. Freitas, Jr., J.C. Culbertson, N. Nepal, A. Mock, M.J. Tadjer, Z. Feng, and H. Zhao, Influence of oxygen partial pressure on properties of monoclinic Ga2O3 deposited on sapphire substrates, J. of Vac. Sci. & Tech. A 39, 033414 (2021)

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Name **Jonathan West**

Education

PhD	Engineering	University of New Mexico	2017
MS	Electrical Engineering	University of New Mexico	2015
BS	Electrical Engineering	University of New Mexico	1995

Academic Experience

Assistant Professor	Weber State University	2020-Present	FT
Instructor	Grand Canyon University	2018-2020	FT
Lecturer III	University of New Mexico	2017-2018	FT

Other Professional Experience

Electrical Design Engineer	Applied Technology Associates	2010-2013	FT
Electrical Design Engineer	Boeing/SVS	2008-2009	FT
Electrical Design Engineer	Electro-Science Technologies	2003-2008	FT

Professional Credentials, Certifications, or Licensing

HAM Radio License

Professional Development

Current Membership in Professional Organizations

Honors and Awards

Outstanding Teacher, Weber State ECE Dept 2022

Service Activities

ARCC Committee	2022-Present
Peer Review Committee	2023
Host, Ogden HAM Radio Licensing Classes	2024

Recent Publications and Presentations

Name **Trent Tholen**

Education

MBA	Aerospace & Defense	University of Tennessee	2022
MS	Electrical Engineering	University of Idaho	2019
BS	Electrical Engineering	University of Utah	2010

Academic Experience

Adjunct	Weber State University	2019-Present	PT

Non-academic Experience

Lead Integration Engineer	Air Force Nuclear Weapons Center	2023-Present	FT
Supervisory General Engineer	AFMC/Air Logistics Center	2021-2023	FT
SME Engineer	AFMC/Air Logistics Center	2011-2021	FT

Professional Credentials, Certifications, or Licensing

Professional Engineer	2002
APDP Level II Certification	2014
Top Secret Security Clearance	

Professional Development

Trained System Safety reviewer

Current Membership in Professional Organizations

Honors and Awards

General Larry O. Spencer Award, 2016
Air Force Exemplary Civilian Service Award

Service Activities

National Fire Protection Association (NFPA) 70B “Standard for Electrical Equipment Maintenance” Principal Committee Member
National Fire Protection Association (NFPA) 77 “Recommended Practice on Static Electricity” Principal Committee Member

Recent Publications and Presentations

US Patent 6898816, CA 2423441

APPENDIX C – EQUIPMENT

Computational Equipment	Quantity
Computer (Windows)	52
Computer (Linux)	26
Laser Printer	6

Electronics Lab Equipment	Quantity
Keysight 4-Channel Oscilloscope	37
Keysight Function Generator	37
Keysight Multimeter	37
Keysight Power Supply	37
Tektronics Oscilloscope	34
Tektronics Function Generator	31
Agilent Multimeter	11
Fluke Multimeter	9
Rigol Power Supply	12
Rigol Multimeter	12
Keysight Multimeter (older)	12
Keysight Power Supply (older)	12
BK Power Supply	11
BK Universal Counter	6
Capacitor/Inductor Analyzer	4
Siglent Power Supply	2
Siglent Function Generator	2
Siglent Oscilloscope	2
Siglent Multimeter	2
Tektronics Logic Analyzer	2
Other Power Supply (GW, Shen Chen, etc.)	12
Other Multimeter (EZ, LG)	5
Other Function Generator (Instek, HP, Agilent)	9
Soldering Irons	44

Training Equipment	Quantity
Elvis II Trainer Boards	8
NI DAQ	9
8051 Trainer	36
Basys 3 Trainer	28
Robot Vehicle	5
Robot Arm	3
Baxter Robot	1

Power Lab Equipment	Quantity
Hampden 3-phase Power Supply	6
Hampden Test Base	6
Hampden Adjustable Resistive Load	6
Hampden Adjustable Reactive Load	6
Hampden 3-phase Transformer	2
Hampden 1-phase Transformer	12
Hampden Prony Brake	6
Hampden Dynamometer	6
Hampden DC Machine	6
Hampden Synchronous Machine	6
Hampden Multi-function Machine	6
Hampden Induction Motor	6
Hampden Dissectible Transformer	6
Hampden Shunt Rheostat	6
Hampden Watt Meter	8
Hampden Phasing Lamps	2
Dranetz Power Analyzer	6
Handheld Multimeter	18
Clamp multimeter	18
Tachometer	6
Variable Frequency Drive	5
Variac	2

Fabrication Equipment	Quantity
PCB Router	1
PCB Shear	1
OK Pick and Place Machine	1
Lynx Stereo Microscope	1
Surface Mount Soldering Station	1
Reflow Oven	1
Electronic hot plate	1
3D Printer	2
Drill Press	1
Disk/Belt Sander	1
Band Saw	1
Various Hand tools	>100

Specialized Lab Equipment	Quantity
LeCroy 300MHz Oscilloscope	1
LeCroy 400MHz Oscilloscope	1
Tektronics RF Signal Generator	1
Agilent Spectrum Analyzer	1
Agilent Network Analyzer	2
HP Spectrum Analyzer	1
Microwave Spectrum Analyzer	1
Nikon Optical Microscope	1
Keysight Lightwave Measurement System	1
Yokogawa Optical Spectrum Analyzer	1
Elmo Femtosecond Laser	1
Other Lasers	3
Optical Table	1
Optical Stage	11
Thermo Scientific SEM	1
IR Vase Ellipsometer	1
Spectroscopic Ellipsometer	1
Zeiss Microscope	1
High-speed Camera	1
Potentiostat	1

Specialized Facilities	Quantity
Anechoic Chamber (in process)	1
Clean room	1
Wet bench with hood	1
Dry bench with hood	1
Clean Bench	1

APPENDIX D – INSTITUTIONAL SUMMARY

1. The Institution

a. Name and address of the institution

Weber State University
3750 Harrison Blvd.
Ogden, Utah 84408

b. Name and title of the chief executive officer of the institution

Brad Mortensen, President
Weber State University
Mail Code 1001
Ogden, Utah 84408-1001

c. Name and title of the person submitting the Self-Study Report.

David Ferro, Dean
College of Engineering, Applied Science & Technology
Weber State University
Mail Code 1801
Ogden, Utah 84408-1801

d. Name the organizations by which the institution is now accredited, and the dates of the initial and most recent accreditation evaluations.

Northwest Commission on Colleges and Universities

Date of initial accreditation:	1932
Date of last accreditation:	2021

2. Type of Control

Weber State University is controlled by the State of Utah through the Utah State Board of Higher Education, the higher education arm of the Utah Legislature.

3. Educational Unit

The Computer Engineering Program is housed within the Department of Electrical and Computer Engineering which administers five degrees:
1. BS Electrical Engineering
2. BS Computer Engineering
3. BS Biomedical Engineering
4. MS Electrical Engineering
5. MS Computer Engineering

The Department of Electrical and Computer Engineering is one of seven academic units in the College of Engineering, Applied Science & Technology (EAST). The chair of the Department of Electrical and Computer Engineering, Fon Brown, reports to the dean of the College, David Ferro. David Ferro reports to the Provost, Ravi Krovi, and Ravi Krovi reports to the president (CEO), Brad Mortensen.

4. Academic Support Units

Names and titles of individuals responsible for each of the units that teach courses required by the program:

Fon Brown, Professor, Chair, Department of Electrical and Computer Engineering
Sandra Fital-Akelbek, Professor, Chair of the Department of Mathematics
Colin Inglefield, Professor, Chair, Department of Physics
Brandon Burnett, Associate Professor, Chair, Department of Chemistry
Kyle Feuz, Associate Professor, Chair, School of Computing

5. Non-academic Support Units

Names and titles of individuals responsible for each of the units that provide non-academic support to the program:

Within the College of Engineering, Applied Science and Technology

Judy Smith	ECE Department Administrative Assistant
Gina Naisbitt	Executive Assistant to the Dean
Aimee Golden	Academic Advisor assigned to the ECE Department
Kaylene Whicker	Career Advisor (All departments)
Alicia Christensen	Director, Center for Technology Outreach
Brad Naisbitt	IT Manager
Rainie Ingram	Graduate Enrollment Director

Outside the College of Engineering, Applied Science and Technology

Wendy Holliday	Dean of the Library
Jeffrey Hurst	Dean of Students
Jed Spencer	Director, Financial Aid & Scholarships
Cori Horne	University Registrar

6. Credit Unit

Weber State University is on the semester system. One credit hour represents one class hour or three laboratory hours per week. Each semester consists of approximately 14 weeks of instruction plus three or four additional days for final examinations. The fall, spring and summer semesters are of equal duration

7. Tables

Complete the following tables for the program undergoing evaluation.

Table D-1. Program Enrollment and Degree Data

BS Computer Engineering

	Academic Year		Enrollment Year					Total Undergrad	Total Grad	Degrees Awarded			
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
Current Year	23/24	FT	20	25	20	27	N/A	92	N/A	N/A	6	0	N/A
		PT	14	12	16	22	N/A	64	N/A				
1 year prior to current year	22/23	FT	20	25	19	27	N/A	91	N/A	N/A	9	3	N/A
		PT	17	12	17	21	N/A	67	N/A				
2 years prior to current year	21/22	FT	17	27	18	27	N/A	89	N/A	N/A	7	1	N/A
		PT	21	21	19	21	N/A	82	N/A				
3 years prior to current year	20/21	FT	17	32	24	23	N/A	96	N/A	N/A	3	4	N/A
		PT	17	21	14	17	N/A	69	N/A				
4 years prior to current year	19/20	FT	19	32	23	20	N/A	94	N/A	N/A	2	3	N/A
		PT	16	18	12	13	N/A	59	N/A				

Give official fall term enrollment figures (head count) for the current and preceding four academic years and undergraduate and graduate degrees conferred during each of those years. The "current" year means the academic year preceding the on-site visit.

FT—full-time
PT—part-time

Table D-2. Personnel

BS Computer Engineering

Year[1]: 2024

	HEAD COUNT		FTE[2]
	FT	PT	
Administrative[2]	0.5	o	0.5
Faculty (tenure-track)[3]	7.5	0	7.5
Other Faculty (excluding student Assistants)	0	2	
Student Teaching Assistants[4]	0	0	0
Technicians/Specialists	0.1	0	0.1
Office/Clerical Employees	0.75		0.75
Others[5]	0	0	0

Report data for the program being evaluated.

1. Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.

2. Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.

3. For faculty members, 1 FTE equals what your institution defines as a full-time load

4. For student teaching assistants, 1 FTE equals 20 hours per week of work (or service).

5. Specify any other category considered appropriate, or leave blank.

ECE 4010/4020
SENIOR PROJECT WORKBOOK

by
Dr. Fon Brown
Dr. Jonathan West
Dr. A. Tye Gardner

Revised 14 August 2020
Weber State University
Electrical and Computer Engineering
Ogden, Utah 84408-1703

Preface

The Department of Engineering has instituted the Senior Projects Program to help facilitate the student's transition into industry and to provide a capstone experience in Electrical or Computer Engineering. The program consists of two consecutive courses, ECE4010 and ECE4020.

Students should, either before starting ECE4010 or within the first week thereafter, decide upon a project that is both interesting to them and substantial enough to justify approximately 300 hours of effort (per student). Students are expected to form teams of 2-3 members and to find a suitable advisor, preferably from the industry relating to their project. (An employed student may work alone on a project of interest to his or her employer, but an additional advisor will be required.)

During these two courses, students will develop a project plan, execute it, present design reviews, and produce documentation. They will be graded on based on their ability to:

1. work as a team (appropriate division of labor, coordination with other team members),
2. manage their project (set and accomplish goals, keep to a schedule),
3. research, design and prototype, and
4. communicate, both by written document and formal presentation.

The purpose of this workbook is to clarify what is expected from each team and to provide guidelines that have proven helpful to teams in the past.

Acknowledgement

This workbook is modeled on a similar workbook written by Dr. Bill Clapp, Former Chair of the Department of Computer and Electronics Engineering Technology at Weber State University.

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1.0 PURPOSE OF SENIOR PROJECTS

The purpose of senior projects is to provide students with realistic project development experience similar to what may be expected in industry. The senior project experience is divided into building skills in four major areas: (1) teamwork, (2) project management, (3) research & development, (4) communication. These are, in the author's experience, the most important skill areas to the success of an engineer.

Teamwork:

Engineering projects typically take place in teams, and a productive team will always be greater than the sum of its parts. Each member of a team must fulfill his or her share of the load, and ideally, improve the performance of other members of the team. Team members must help each other both to define and to accomplish the task of the team. In this course, team building situations naturally arise and students are evaluated based on how they respond to those situations and their overall effectiveness as a team.

Project Management:

Delivering projects in a timely manner within budget is key to competitiveness in electrical and computer related industries. Careful planning and execution of a project plan are very important to controlling schedules, costs and features for development projects. Successful engineers have an understanding of project management and its importance to the organization.

Research and Development:

Engineers must be technically competent to design circuits and systems to solve problems, but not all designs need to start from scratch. Engineers must be able to perform research that leads to solutions and they must be able to apply design principals learned elsewhere to the problem at hand. Furthermore, engineers must be able to fabricate professional quality prototypes to implement and test their designs.

Basic knowledge of soldering, printed circuit design, and hardware skills are required for well-built prototypes.

Communication:

Engineers must be able to clearly document their activities so others can easily understand what they have done. Products require sufficient documentation that allows someone else to understand and modify the product for different applications. Schematics and block diagrams must follow industry standards. Circuit descriptions must be technically correct and easy to read.

Engineers must also be able to verbally communicate with clarity and ease of understanding. Presentation skills are important for all engineers, particularly those working in teams.

2.0 COURSE DESCRIPTIONS

ECE 3090

Program Management (ECE 3090) is the first course in the series of three required for graduation. ECE 3090 is a two credit hour class. The course requires the completion of the following significant milestones:

1. Form a Team
2. Proposal Approved

After the teams have been formed, each team will meet with the senior projects coordinator 30 minutes each week. Students are expected to contribute about 10 hours per week for a total 150 hours during the semester. A letter grade will be given at the end of the semester.

ECE 4010

Senior Projects I (ECE 4010) is the second course in the series of three required for graduation. ECE 4010 is a two credit hour class. The course requires the completion of the following significant milestones:

1. Project Plan Complete
2. Hardware Components in Hand
3. Critical Circuits Proven
4. Preliminary Design Review

After the teams have been formed, each team will meet with the senior projects coordinator 30 minutes each week. Students are expected to contribute about 10 hours per week for a total 150 hours during the semester. A letter grade will be given at the end of the semester.

ECE 4020

Senior Projects II (ECE 4020) is the third course in the series required for graduation. ECE 4020 is a two credit hour class. The course requires the completion of the following significant milestones:

1. Proposal Obligations Fulfilled
2. Project Demonstration
3. Documentation and Poster Complete
4. Final Design Review
5. Log Book Complete

Each team must meet with the senior projects coordinator at least 30 minutes each week. Students are expected to contribute enough hours per week to meet schedule. A letter grade will be given at the end of the semester.

3.0 SENIOR PROJECTS EVALUATION

Each student or team is assigned a grade by the coordinator for the following criteria, grade points are then assigned, weighted and totaled. The final grade is assigned based on the total number of points. Design review grades are taken from presentation evaluation forms. Goal scores are based on weekly goal records.

ECE 4010 Team Evaluation (A = 4, B = 3, etc.)

Teamwork		**Points**		**Total**
Team meetings – students worked as a cohesive team	ABCDE	_____	× 2 =	_____
Coordinator Meetings – productive, team was prepared	ABCDE	_____	× 2 =	_____
Project Management				
Project plan – clear, complete task list, milestones, etc.	ABCDE	_____	× 3 =	_____
Project milestones – team met documented milestones	ABCDE	_____	× 2 =	_____
Research and Development				
Research – sufficient project-related research was done	ABCDE	_____	× 3 =	_____
Problem Solving – team found solutions to problems	ABCDE	_____	× 3 =	_____
Quality Engineering – good design and documentation	ABCDE	_____	× 3 =	_____
Impact/Complexity – project reflects a senior-level design	ABCDE	_____	× 2 =	_____
Communication				
Project Proposal – clear and submitted on time	ABCDE	_____	× 2 =	_____
Total Team Score (out of 88)				_____

ECE 4010 Individual Evaluation (A = 4, B = 3, etc.)

Teamwork		**Points**		**Total**
Participation – student carried his/her share of the load	ABCDE	_____	× 2 =	_____
Project Management				
Goals – student met his/her weekly goals	ABCDE	_____	× 3 =	_____
Communication				
Log Book – student's logbook was clear and well-kept	ABCDE	_____	× 2 =	_____
Preliminary design review – see evaluation form	ABCDE	_____	× 4 =	_____
FE Practice Exam				
Number of questions answered correctly (max 26)		_____	× 1 =	_____
Total Individual Score (out of 70)				_____
Total Team Score (From ECE 4010 Team Evaluation)			**+**	_____
Total (out of 158)				_____
Final Grade				_____

158-147	146-142	141-137	136-131	130-126	125-122	121-111
A	A-	B+	B	B-	C+	C

ECE 4020 Team Evaluation

Project Demonstrated
If project was not demonstrated, enter a final grade of E or I. YES NO

Teamwork		**Points**		**Total**
Team meetings – students worked as a cohesive team	ABCDE	_____	× 2 =	_____
Coordinator Meetings – productive, team was prepared	ABCDE	_____	× 2 =	_____
Project Management				
Project milestones – team met documented milestones	ABCDE	_____	× 2 =	_____
Research and Development				
Problem Solving – team found solutions to problems	ABCDE	_____	× 2 =	_____
Quality Engineering – constructed to quality standards	ABCDE	_____	× 3 =	_____
Packaging – Final product has professional appearance	ABCDE	_____	× 2 =	_____
Impact/Complexity – project reflects a senior-level design	ABCDE	_____	× 3 =	_____
Communication				
Design documentation – clear, complete and concise	ABCDE	_____	× 4 =	_____
Supplementary documentation – BOM, user's guide, etc.	ABCDE	_____	× 2 =	_____
Late Demonstration Penalty (up to 15 points)			**–**	_____
Late Documentation Penalty (up to 10 points)			**–**	_____
Total Team Score (out of 88)				_____

ECE 4020 Individual Evaluation

Teamwork		**Points**		**Total**
Participation – student carried his/her share of the load	ABCDE	_____	× 2 =	_____
Project Management				
Goals – student met his/her weekly goals	ABCDE	_____	× 3 =	_____
Communication				
Log Book – student's logbook was clear and well-kept	ABCDE	_____	× 2 =	_____
Final design review – see evaluation form	ABCDE	_____	× 4 =	_____
FE Practice Exam				
Number of questions answered correctly (max 26)		_____	× 1 =	_____
Total Individual Score (out of 70)				_____
Total Team Score (From ECE 4020 Team Evaluation)			**+**	_____
Total (out of 158)				_____
Final Grade				_____

158-147	146-142	141-137	136-131	130-126	125-122	121-111
A	A-	B+	B	B-	C+	C

4.0 ADVISORS

Each team needs advisors (mentors) to ensure that the educational goals of senior projects are accomplished. Not only are advisors usually needed to ensure project completion; they are to be used to improve the communication skills between students and engineers. Use of outside advisors also improves relations between local industry and Weber State University.

The following criteria should be used concerning advisors:

1. Each team needs to find its own off-campus advisor*. The advisor should be an engineer in the field of the team's project or should at least be employed with a company in an engineering capacity. The advisor must agree to provide assistance to the team in an advisory capacity only. The advisor must not get so involved that the student learning objectives are compromised.

2. The advisor must be willing to attend the team's senior project presentations (at the end of each semester). The advisor will also become part of the evaluation team that grades the students.

3. Some teams may have more than one advisor. Each team (including advisors) must have a minimum of three people, so if a student is doing a senior project without a classmate, a second advisor will be required. For example, a lone employed student might have his or her immediate supervisor and another engineer from the same company as the two advisors. Alternatively, larger teams may need to have two or more advisors if their project is so diverse that one advisor is not enough.

4. Advisors should be treated as supervisors who only have a limited amount of time to devote to team concerns. Advisors should generally be utilized for no more than 30 minutes each week. The students should have the appropriate questions written down in advance before the advisor is contacted. The students should be very careful not to abuse the advisor's willingness to help.

5. ECE Faculty members should not be used as official advisors except in certain circumstances*, but they may be available to help at their convenience. You should attempt to get help from your advisor(s) before turning to the faculty.

*If the project supports faculty research or is a cooperative effort with the Community Involvement Center, a faculty member may serve as the advisor.

5.0 LOG BOOKS

Each member must keep an accurate log of his or her activities during the senior projects classes. Class meetings, team meetings, phone calls, conversations, commitments, trips, ideas, schematics, calculations and sketches should be recorded in your logbook along with the date and the amount of time spent on the activity. These entries are to be made in a bound notebook in chronological order.

Your log book is a contemporaneous record of your activities and as such it is a legal document. If you keep your log book using good documentation practices, it can be used in a court of law as evidence of your work. A log book may save or cost an employer millions of dollars, depending on how it is kept.

Log books for ECE 4010 and ECE 4020 are required to follow the guidelines below:

1. Log books must be bound such that pages cannot be inserted or deleted without leaving evidence. Three ring binders, spiral bound notebooks or books that use glue bindings are not acceptable.
2. All pages must be numbered. If the log book does not have pre-printed page numbers, it is acceptable to number each page by hand as it is used.
3. All work must be neat, legible and in ink.
4. Printed work may be included in the log book if it is glued or taped such that it cannot be removed without leaving evidence.
5. Each page must be signed (or initialed) and dated as it is used. If a page contains work from different dates, it must be separated with a horizontal line, and each section must be signed (or initialed) and dated.
6. Blank pages or large blank spaces are not acceptable. If you wish to leave a blank page or large blank space, draw a diagonal line from one corner to another, then initial and date it.
7. Do not obliterate. Obliteration is defined as (a) overwriting something, (b) scribbling out something or (c) using white-out to cover something. The correct way to handle a small error is to strike it out with a single horizontal line. For large errors, use a single diagonal line. If the strikeout occurs on a different day, then it must also be initialed and dated.
8. Use your log book as a workbook. Do not transfer notes from scratch paper into your log book.

Write clearly; points are deducted for sloppy log books. Do not write on the back of a page except to strike it out. (But exhibits such as datasheets or code listings may be affixed there.) Each day, the student should take about five minutes per hour spent to summarize what was done and how much time it took. The average size notebook (60 pages) should be about half full by the end of ECE 4010 and completely full by the end of ECE 4020. Log books will be evaluated at the end of each semester.

6.0 PROPOSAL

The senior project must address a contemporary, unresolved issue or problem using the principals of engineering design at a senior level, including knowledge and skills from more than one Junior Core and Senior Elective course. Each team must write a proposal that clearly states the problem to be addressed, the approach the team is taking to solve the problem and what the team will deliver when the project concludes. The proposal must convince the faculty that the project is worthy of being a senior project, and all faculty members in the department must approve and sign it. The proposal should clearly state what is to be accomplished by the team to prevent any misunderstandings between the faculty and students. The proposal, signed by all ECE faculty, is due for ECE 4010 students on the second Tuesday of the semester.

Students or teams who have taken ECE 3090, project management, may use the proposal that they wrote during that course. Other students, or those who elect to pursue a different project may use a simplified proposal format that conforms to the following guidelines:

1. The proposal must be a short document that clearly describes the student commitment to the project. Team goals, commitments and deliverables shall be clearly stated to avoid later confusion.

2. Team members and advisors must be listed including e-mail addresses and phone numbers. The companies that the advisors work for shall also be listed.

3. The proposal should be divided into three sections as described in the example document below.

4. The proposal shall be single space using one-inch margins on the left and right.

5. The proposal shall be error free. The students will correct any errors that are found on the proposal.

6. The proposal must be approved and signed by all the members of the faculty in the Electrical or Computer Engineering Program (excepting those on sabbatical). <u>The proposal must first be approved and signed by the senior project coordinator before other faculty signatures are sought</u>.

    a. Starting Spring 2022, faculty should evaluate each project for a combined impact/complexity score on a 1 to 5 scale, with 5 being the highest. This evaluation will help ensure high-quality projects eligible to receive full scores at later evaluations.
        i. Complexity scores should reflect considerations including expected project hours, the number and difficulty of required new skills, and the number of junior and senior level courses that will be applied to the project.
        ii. Impact scores should reflect a combination of how the project will influence the community, scientific knowledge, the reputation of Weber State and our department, and/<u>or</u> the careers of the students involved in the project.
        iii. It is the student's responsibility to ensure the final project is satisfactory in terms of complexity and impact. Unsatisfactory projects will not receive a passing grade.
    b. All projects will be reassessed no earlier than week 8 of ECE 4010. Faculty will make suggestions to adjust the scope and requirements as necessary. The students will work with the senior project coordinator to define and implement those changes.

7. The original copy of the proposal must be given to the senior project coordinator for safekeeping in the team folder. The students should make and retain a copy of the signed proposal.

EXAMPLE ABBREVIATED PROPOSAL

<PROJECT TITLE> PROPOSAL

TEAM MEMBER'S NAME	EMAIL ADDRESS	PHONE NUMBER
_____	_____	_____
_____	_____	_____
_____	_____	_____

TEAM ADVISOR	COMPANY	PHONE NUMBER
_____	_____	_____

PROJECT DESCRIPTION:

Section 1: Define the problem to be solved. This section must include:

- Why the problem is important and who it is important to
- A background on existing/similar solutions
- What sets your solution apart

Section 2: Explain how the problem is going to be solved. This section must include:

- A short description of relevant engineering theory
- How you will approach the solution and any tools required
- A list of milestones with detailed descriptions. This section should also include a Gantt chart, but clear milestones and deliverables will be sufficient.
- An estimated budget

Section 3: Describe the hardware and software that will be presented at the conclusion of the project. It is your responsibility to define good deliverables. Unclear deliverables are subject to faculty judgement on whether the project is complete and satisfactory, which may result in a lower or incomplete grade. When defining deliverables, consider the following:

- Good deliverables are specific including specifications of what *isn't* in the scope of the project
- You must specify which components will be designed by you and which are re-used from other sources (e.g., if using an algorithm, are you writing the code or using a library)
- Include specific programming languages and environments. Do not use the Arduino environment, board, or shields

FACULTY	APPROVAL	DATE		Complexity	Impact
Dr. Fon Brown	_____	_____	_____	_____	_____
Dr. Justin Jackson	_____	_____	_____	_____	_____
Dr. Christian Hearn	_____	_____	_____	_____	_____
Dr. Eric Gibbons	_____	_____	_____	_____	_____
Dr. Jonathan West	_____	_____	_____	_____	_____
Dr. Shellee Dyer	_____	_____	_____	_____	_____
Dr. A. Tye Gardner	_____	_____	_____	_____	_____

Dr. Alyssa Mock _____ _____ _____ _____

(Example only. If there are new faculty or some are on sabbatical, adjust the list accordingly.)

7.0 PROJECT PLAN

Once your team is assembled and the proposal is signed, you will need to work on your project plan. Your project plan is due by the end of the fourth week of ECE 4010, but it is strongly recommended that you complete it sooner. Once your project plan is complete, you should try very hard to stick to the schedule it dictates. You will be graded on your ability to make a schedule then keep to it.

A project plan is a document that explains the scope of the project, a breakdown of the tasks necessary to accomplish it and the resources required for each task. The project plan also provides a schedule for the tasks (subject to the inevitable resource constraints) and gives a project timeline with a set of project milestones.

Research (See Section 13) must be done concurrently while developing a project plan. The task breakdown in the plan guides your research, and your research helps you estimate the time and resources required for each task (which is necessary if you want an accurate schedule).

The project plan may be stored as an MS Project file or even an Excel document, but whichever format you use, the document must contain the following four sections:

1. Scope of Project
   This section describes the planned project, why it is being built and who the stakeholders are. (Stakeholders are the people or organizations for whom the project is being built as well as those who will operate, maintain or develop it. The list of stakeholders includes, at a minimum, your team and your advisor(s).) This section explains the relationship of the project to the system in which it will operate or to other systems with which it will interface. It also describes the role each stakeholder will play in the development and maintenance of the project.
2. Project Tasks
   This section is the heart of the project plan. It defines each task necessary to complete the project in terms of its tangible inputs and outputs. An estimate of the resources, budget and time required for each task must be included. Complicated tasks may be broken down into a task hierarchy if it is helpful. Don't forget to include time for things like debugging and system integration.
3. Task Schedule
   Based on the inputs and outputs of Section 2 and the resource constraints that always exist, this section schedules the tasks (gives them start and end dates). As a consequence of this schedule, certain milestones will emerge, such as *preliminary design review complete* or *prototype fabrication complete*. These milestones should be listed on a timeline included in this section. This section must include a Gantt Chart.
4. Budget
   This section lists all the required resources and expenditures required for the project. (This normally includes engineering labor and overhead, but for senior projects, these two items would be omitted.)

The project plan must be approved and signed by all the stakeholders then submitted to the senior projects coordinator.

Keep in mind that the project plan is a "living document." In other words, if a task takes more or less time than estimated, the project plan should be updated to reflect a new schedule, and if the change to the schedule is substantial, it should be reapproved by the stakeholders (an informal or verbal approval

is sufficient) and resubmitted to the senior projects coordinator.

8.0 DESIGN REQUIREMENTS AND CONSTRAINTS

All design efforts begin by enumerating the requirements and constraints. Requirements generally specify what the design must do, whereas the constraints are specific limits that the design must not exceed.

Requirements may be categorized as functional, performance, usability, aesthetic, interface, etc. To illustrate, consider the design of a smart-phone. An example of a functional requirement might be that the phone must use a G4 network if one is available but fall back to a G3 network if not. A performance requirement might specify how many applets may run simultaneously or the amount of time the phone operates before the battery dies. A usability requirement may insist that buttons be a certain size or that the menu of built-in tools be defined in a certain way. Generally, requirements come from the customer (the stakeholder for whom the design is done).

Constraints, on the other hand, are limitations to which the design must adhere. Again, constraints fall into numerous categories but the ones that are most likely to apply to your project are:

1. Cost (economic) Constraints – A design has many costs associated with it. First, there is the non-recurring engineering cost (NRE) that includes the cost of research, tooling, licensure and, were this not a senior project, the engineering labor. But that's not all, there are parts cost, manufacturing costs and overhead. As an added complication, these costs change with quantity, so often a an analysis of the market is necessary before these costs can even be estimated. For your project, the cost constraints boil down to the cost of any parts, shipping and licenses you need to purchase, and these must fall within the budget set forth and approved in the project plan.
2. Physical Constraints – Often, it is required that a device fits in a certain volume or that it consumes less than a certain amount of power. These constraints limit the physical properties of a device. Returning to the smart-phone example, a physical constraint might be that the phone fit the same sleeve as a previous version.
3. Scheduling (timing) Constraints – With most devices, particularly in today's economy, it is crucial that a device not hit the market late. In a matter of 6 months to a year, a cutting-edge technology can become old and uninteresting. Hitting the market late can cost millions of dollars and can turn a potentially successful product into a failure. It is important, therefore, that the project meet the schedule set forth in the project plan. Moreover, for senior projects, failure to meet the project schedule may have even more catastrophic results – that is a failure to graduate on time.
4. Safety Constraints – It is important that any device we design be safe if used properly. Exposed electrical contacts or mechanical pinch-points are generally not acceptable. A device designed to test pressure sensors, for example, may drive the sensor into a test fixture using a pneumatic ram. If it is at all possible for the operator to get his fingers between the ram and the test fixture, it is necessary to design an interlock to keep this from happening. Safety constraints cover a wide range of human or animal health may address issues as diverse as burn hazards or muscle strain.

9.0 DOCUMENTATION

Students in ECE 4020 are required to document their project. Depending of the type of project, students may choose to document their project either with an industry style design document or an academic research paper. In either case, students must design a poster to summarize their project and results. For design documents, the circuit schematic and code listing (if applicable) should be included as appendices. For research papers, these are separate documents. The poster must be completed on or before demonstration day. The design document or academic paper is due one week thereafter and must be distributed (electronically) to the faculty and advisor(s) by that time. A hard copy of this document plus any other documentation (e.g. user manual or bill of materials) is due at the time of the design review. (Code listings may be omitted from the circulated documents but must be included in the hard copy.)

Design Document

The design document serves to fully document an engineering design and should be written in such a way that an engineer with similar skill can understand, replicate or modify your design.

Format

The format of this document varies from one employer to the next, but a good design document will include, at a minimum, the following sections:

1. Introduction
   This section explains in general terms what your device is and what problem it solves.
2. Scope
   This section defines the scope of the *document*. The scope tells the reader what the document covers, and more important, what it doesn't.
3. Design Overview

   3.1. Requirements
   This section enumerates the design requirements (i.e. what the device must do). Requirements usually fall into sub-categories such as functional requirements, performance requirements, interface requirements, etc. (See Section 8.) All the requirements should be testable (Item 5, below).

   3.2. Constraints
   This section enumerates the design constraints (i.e. what limitations are imposed on the design). Constraints include cost, physical, scheduling and safety constraints. Often, constraints are not tested, per se. Instead, analysis of the design is used to verify that the constraints are satisfied.

   3.3. Applicable Standards
   This section lists the engineering standards applicable to the design (if any). Engineering standards are part of many designs, particularly those that communicate electronically (e.g. use USB, I2C, SPI, CAN, RS-232, Ethernet, etc.).

   3.4. Dependencies.
   This section specifies what external devices or supplies are required for a device to function (e.g. a power supply, clock, or a microprocessor bus).

   3.5. Theory of Operation

This section provides a high-level overview of the design, including block diagrams and possibly flow charts. The section should explain what each block does and how the pieces fit together.

3.6. Design Alternatives
This section is optional and is included if some design alternatives were considered and rejected. Each design alternative and the reason(s) for rejection should be presented.

4. Design Details
   This section provides a level of detail sufficient for another engineer to understand and duplicate your design. This section should not include complete schematics and code listings (those must be in the Appendix), but if an excerpt from the schematic or code listing helps clarify a point, it may be included as a figure. As a general rule, the design details section will constitute more than half of the design document (excluding Appendices).
5. Testing
   This section enumerates the tests that were performed to verify that the design meets the requirements. Each test describes the test procedure, the expected results, the actual results and the requirement(s) that it verifies.
6. Conclusion
   This section summarizes test results and makes observations about the performance and functionality of the design. Also, it is likely that you have acquired some insight that will improve the design for next time. This section is a good place to put that kind of information.
7. References and Bibliography
   This section lists the references to other works you used to write this document.
8. Appendices
   This is the appropriate place to put items for reference only, such as full schematics, data sheets and code listings.

You may add additional sections or reorganize if it is helpful, but do not omit any of these sections without approval of the senior project coordinator. You should endeavor to be as clear, concise and complete in your documentation as possible. Engineers are not impressed with long, wordy descriptions when a short and simple statement will do.

Research Paper

In some cases (particularly where the student is interested in graduate school) a research paper that can be published in an engineering journal is appropriate. Again, the paper needs to provide enough details about the design that another engineer can duplicate the results, but the format differs from the design document discussed earlier.

Format

Research papers are more focused on the problem that the design solves rather than the design itself, and the circuit design itself becomes part of a larger approach to obtain data or solve a problem. Again, formats differ, but the sections described below are widely accepted.

1. Abstract
   This is a single paragraph (usually 200 words or less) that summarizes the entire paper. Often, the abstract is published in an index and it is only thing that is used in a database search. (A list of keywords sometimes follows the abstract, and these are also used in database searches.)
2. Introduction
   This section serves three purposes. It first introduces the subject in a broad and general way, then with each succeeding sentence narrows the focus until it reaches the problem addressed by the paper. Second, it includes a literature review that lists the seminal contributions of others scientists and engineers to the problem outlined earlier. Third, it describes your specific contribution (i.e. design) along with an overview of the rest of the paper.
3. Methods
   This section describes the methods used solve the stated problem and the means of evaluating the efficacy of the solution. Since the design is part of the solution, it is appropriate it describe it here. Again, there is no set format, but another engineer or scientist should be able to duplicate your results (Section 4) using the description of the design you provide in this section.
4. Results
   This section describes the stimulus (test conditions) and the raw results obtained from the approach (design) described in Section 3. Commentary about the meaning or efficacy of these results should be reserved for the Discussion Section, below.
5. Discussion
   This section interprets the results and discusses the efficacy of the approach in solving the original problem. Topics of discussion might include: how do these results compare with other approaches, how do the results compare with modeled or expected behavior, what is new and significant about this approach, etc. The goal of this section is to interpret the results that lead to the main conclusion of the paper.
6. Conclusion.
   This section does not introduce any new information or insights about the problem, methods and results in this paper. Its main purpose is to succinctly highlight the important conclusions described earlier.
7. Further Research (optional)
   If your research or design has opened the doors to new problems or a different approach, you should include a section that briefly describes the problem(s) to be solved or the (potentially superior) approach to be taken.
8. Acknowledgements
   This section should acknowledge those who funded the project as well as contributors who do not rise to the level of author.
9. References
   The paper should contain a list of references formatted according the requirements of the journal to which it is submitted. You may not include a reference unless it is cited in the paper.

Again, you should endeavor to be as clear, concise and complete in your paper as possible.

Poster

Teams are required to summarize their design and results on a poster suitable for submission to an undergraduate conference (e.g. NCUR or the OUR Research Symposium). The poster will be printed

and mounted at department expense and afterwards be displayed in the hallway near the engineering department office. The poster should be completed on or before the project is demonstrated to the faculty on demonstration day. Students should make sure to account for the time needed to print and mount the poster.

Schematics

For any electronic circuit design, the design document should include, in one of its appendices, a complete set of schematics. These schematics must be drawn using CAD software. (There are many free applications available that can be used for schematic capture, e.g. ExpressSCH or Eagle.) The following guidelines should be followed for schematics in this course:

1. Each component should have a reference designator printed next to it. A reference designator is a single letter abbreviation along with a number. Where possible, you should number your components starting with the upper left of the schematic. Use the designator abbreviations given in the list below:

Component	Abbreviation	Examples
Capacitors	C	C1, C2, C3, ...erl
Diodes	D	D1, D2, D3, ...Dx
Resistors	R	R1, R2, R3, ...Rx
Transistors	Q	Q1, Q2, Q3, ...Qx
IC's	U	U1, U2, U3, ...Ux
Connectors	J	J1, J2, J3, ...Jx

2. Each component should also have the value or part number printed next to it. Resistors, capacitors and inductors require values. Other components require part numbers. Units (e.g. Ω and μF) must be given for all values unless specified in the notes (see below). Part numbers for integrated circuits may be omitted if a legend is provided. All reference designators and values go to the right or above the component symbol.

3. Notes should be drawn in the lower left corner if possible. Notes allow you to make useful comments that apply to the circuit as a whole or to a class of components. For example, rather than specifying the tolerance of each resistor and capacitor, you might include the notes below. (They also allow you to omit the units on each component value, which can sometimes make the schematic clearer.)

   NOTES:
   1. All resistance values are in ohms, 1/4 W, ±5%, unless otherwise noted.
   2. All capacitance values are in microfarads, ±20%, unless otherwise noted.

4. Unused gates (if any) should be drawn on the bottom of the schematic and should show their IC designators and pin numbers. Each unused input should be tied high or low to prevent any inputs from floating. The unused gates section also serves as a directory of gates that may be used in future design changes.

5. Each integrated circuit and connector must have a pin number and pin function printed by each connection. The pin number goes outside the symbol, above or to the right. The function of that pin should be abbreviated and located inside the symbol. The pin function may be omitted for gates or amplifiers drawn with standard symbols.

6. Avoid four-way interconnections. The only exceptions should be for transistor biasing circuits and data busses.

7. Schematics that use more than one page should label nodes or use I/O markers for inter-page connections.

Code Listing

For projects that require software or programmable logic, the design documentation should include a code listing. The listing is a plain text file that includes the source code for the software or logic chip. The file should include a file header (a set of comments at the top of the file), and the code should conform to some basic rules:

1. The file header should include the file (module) name, the author's name(s), the date and a description of the software/logic module. A revision history is not required but is recommended.
2. Each procedure, task, function or subroutine should have a header that names the inputs, outputs and a description that explains what the subroutine does. For assembly language, the header should also include which registers or memory locations are destroyed.
3. Use comments liberally. A good rule of thumb is that 40% of assembly code lines should have or be comments. For higher level software languages or hardware description languages, 30% is a more appropriate number.
4. Use symbolic constants where possible. Don't use uncommented magic numbers. A literal constant is okay if there is a comment that explains where it came from.
5. Don't make self-evident comments. For example, the code: `foo++; // increment foo` would not be acceptable.
6. Documentation should be sufficient that your average senior ECE student could recreate the design.
7. Clearly label and cite any code that was not designed by you. Failure to do so is plagiarism.

10.0 OTHER DOCUMENTATION

Students in ECE 4020 must provide two other documents to complete the documentation package for their project. These documents must be turned in on the day of the final design review but need not be circulated.

User's Manual

While the design documentation fully documents your design, it is a very cumbersome way to figure out how to install or use it. A better document for this purpose is a User's Manual. This document need not be long, but should fully explain to a non-engineer how to install and use your device. You may organize your user's manual in any way you think appropriate, but it is recommended that you look at several commercial user's manuals to get ideas.

Parts List (Bill of Materials)

The schematics in the design document need to be accompanied by a complete parts list. The parts list is not normally included as part of the design document because it can change as prices change or as parts are discontinued by one vendor and become available from another. The parts list should include the following information:

1. Project Title
2. Date

   Every time an item is changed on the parts list, be sure to put a new date on the parts list.
3. Reference Designators

   List the parts in alphanumeric order by the reference designators.
4. Parts Descriptions

   Parts descriptions should describe the part in detail. For example: Capacitor entries need the value, tolerance, type of capacitor (electrolytic, mylar, etc.), voltage rating, axial or radial lead, and lead distance.
5. Name of Manufacturer

   List the company that actually made the part. Some parts (Radio Shack) are sold without the manufacturer printed and should be listed as unknown.
6. Manufacturer's Part Number

   List the actual number that would be used to order the part.
7. Vendor

   List the company or source where the parts were purchased or obtained.
8. Cost

   List the cost that was paid for the part.

SAMPLE PARTS LIST

Project Title:_____ Date: _____

Ref #	Part Description	Manufacturer/ Part Number	Vendor/ Cost

11.0 DESIGN REVIEWS

During the last week of ECE 4010 and ECE 4020, teams are required to schedule a design review.

For students in ECE 4010, this is a preliminary design review, which means that the students should present:

1. the problem they are solving,
2. the research they have accomplished,
3. the proposed design (including justification for their design decisions),
4. the schedule of tasks and milestones yet to be completed.

For Students in ECE 4020, this is a final design review, which means that the students should present:

1. the problem they are solving,
2. their final design for the project,
3. test results that verify that the design solves the problem,
4. total cost of the project in manpower and dollars.

The design review presentations are the responsibility of the team. The team should follow the guidelines below to ensure a smooth presentation:

1. Determine a location for the presentation and have that location approved by the senior project coordinator. Students who are doing a project for a local company are encouraged to make their presentations at the company. Reserve that facility for the presentation. For on-campus presentations, the department secretary has the room schedules and can assist you in locating an empty room.

2. Determine a presentation time that the advisor(s) and most of the faculty can attend. Inform faculty, advisors and guests well in advance of your scheduled presentation (e.g. three weeks or more) so that scheduling conflicts can be resolved.

3. At least one week before the design review, send a formal e-mail invitation to your advisor(s) and those faculty who signed the team's proposal. The formal invitation should include the title, presenters, time, date, and location of the design review. <u>For final design reviews, a copy of the design documentation (or research paper) must be attached to the invitation for review</u>.

4. Practice your presentation before you attempt to give it officially to the faculty. It is always obvious who has practiced and who has not. If you are planning to use the multimedia equipment, it is important that you practice using it. Students are asked to make a preliminary presentation to the senior project coordinator during one of the 30-minute meetings. The senior project coordinator will make recommendations that should be followed.

5. Prepare the room before the presentation. It is recommended that you reserve the room one hour before the start time of your presentation to allow enough time to set up and test your project. Obtain and try out the multimedia equipment to make sure that it is working correctly. Avoid cluttered and hard to use rooms.

The recommended one-hour format for the presentation is as follows:

0:00 to 0:05 Hand out the presentation outlines to the faculty, advisors and guests (if available). A team member introduces the team, advisors, and guests to the faculty.

0:05 to 0:10 One or more team members clearly describe the problem to be solved including any social, economic or political ramifications it may have.

0:10 to 0:25 (ECE 4010) One or more team members describe the approach to the problem, the research that was done to justify the approach, the proposed design and justification for the design decisions that were made. Members should mention but not belabor rejected design decisions. The team members conclude by summarizing the status of the project and the schedule for the next semester.

0:10 to 0:25 (ECE 4020) One or more team members describe the final design, the tests that were done and the results of those tests. Team members may then demonstrate the project either live or by video, and conclude by summarizing the status of the project, how well it performed and what might have been done better.

0:25 to 0:40 Questions and Answers.

0:40 to 0:50 The team members, guests, and students leave the room so the faculty and advisors can deliberate. The senior project coordinator collects the evaluation forms.

0:50 to 0:60 The team is invited back into the room and the faculty will provide a critique of the project and presentation.

Note: All log books must be available for inspection before and after the presentation. For ECE 4020, the the user's manual (if any) and the parts list must also be available for inspection.

The following items will be collected by the senior projects coordinator at the end of the final design review:

1. Log books from each team member.
2. Design documentation including schematics and code listings, if appropriate.
3. The User's Manual and the parts list.
4. Evaluation forms from the other faculty and advisor(s).

Students may have their log books back after the coordinator has time to grade them.

12.0 TEAMWORK

The ability of engineers to work in teams is crucial to most employers. The senior project provides an opportunity to develop team building skills. It is highly recommended that a team include engineers and technologists from different disciplines The Engineering department has a cooperative agreement with Electrical Engineering Technology so that EET students may sign up for EET4010/4020 but join an Electrical or Computer Engineering team. Having a technologist on the team is an invaluable asset when it comes time to lay out circuit boards or fabricate circuits.

Team building skills are evaluated by the senior project coordinator based on the student's performance in the following areas:

Share of the Load

Each member of a team must carry his or her share of the load. Weekly goals are set by the team and the senior project coordinator monitors progress. Goals should be set so that each member has about 10 hours of work per week, but all team members are expected to contribute enough time to accomplish their weekly goals. The hours logged and goal completion are indicators of whether or not a student is carrying their share of the load. Students found not carrying their share of the load for more than a week may be removed from the team or suffer a reduction in their teamwork grade.

Meetings with Team Members

The members are expected to meet regularly to set goals and accomplish tasks to complete the goals. Each member must be willing to meet with the team on a regular basis. Meeting times must be arranged that can accommodate each team member. Any students who do not attend team meetings must be reported to the senior project coordinator immediately. Students may be removed from a team after missing more than one team meeting. The senior project coordinator will assign a letter grade as a relative indicator of whether or not the student was regularly meeting with the team. Each meeting missed will lower the student's team meeting grade by a half letter grade.

Meetings with Coordinator

Each team will meet with the senior projects coordinator each week to keep the coordinator informed as to the progress of the team. Weekly goals will be evaluated and a new weekly goal sheet will be given to the coordinator. It is the team's responsibility to coordinate a meeting time with the senior projects coordinator. Any student who misses meetings may be dropped from the team after two unexcused absences. Sickness and accidents are considered a legitimate reason to miss a meeting and no penalty will result as long as the other team members pick up the workload. The senior projects coordinator will assign a letter grade based on the effectiveness of the meeting and the accomplishment of goals.

13.0 PROJECT MANAGEMENT

Project management involves forming a project development plan, then allocating time and resources to execute the plan. Careful planning and execution is essential to the success of any engineering project.

Project Plan

Your project plan must be turned in to the senior project coordinator during (or prior to) your 20-minute meeting in the sixth week of ECE 4010. The coordinator will assign a grade based on its detail and completeness. Plans that do not adequately break down the task(s) at hand or that do not schedule them effectively may result in a poor grade. Each time the project plan changes substantially, the coordinator will need a new copy to track your milestones, but the grade will remain unchanged.

Milestones

Once the project plan is complete, you should endeavor to meet the milestones it dictates. The senior projects coordinator will monitor your progress based on the milestones in your plan. Inasmuch as this is probably your first project, considerable latitude will be given if your miss one or two milestones, but if the problem becomes habitual, expect to lose one grade letter (rubric page 3) for each major milestone missed.

Weekly Goals

Each team should submit a Weekly Goal Record or use a very detailed milestone chart to outline their progress when they meet with the senior projects coordinator. **The sheet should be filled out before the meeting with the coordinator starts**. Make a copy of the goal sheet to keep and submit the original copy to the senior projects coordinator.

The following items should be completed on the Weekly Goal Form (See Page 23):

1. Team Members. List the last names of the team members in alphabetical order.

2. Course number. List the name of the course you are currently taking (ECE 4010 or ECE 4020).

3. Week number. List the week that the goal record is turned in to the senior projects coordinator.

4. Date. List the date that the goal record was turned in to the senior projects coordinator.

5. Goals for Team Member #*n*. Number and list the goals for team member #*n*. The goals listed should be what the team wants done for the week. **These are team-generated goals, not senior project coordinator directed goals**. List the number of hours that you plan to spend on that particular goal. Do not use the words "research", "write", or "troubleshoot" without clearly describing what you are going to learn, write, or fix. Each goal must be measurable, that is to say that there must be an objective way to tell if the goal has been accomplished.

6. Accomplishment Criteria for the Goal. Write a brief summary of how an objective observer could know if the goal is accomplished or not.

The following are examples of suitable goals and accomplishment criteria:

A. Goal: Research three types of microprocessors and obtain the data sheets. Select one to use for the project. (3 hrs)
   Accomplishment Criteria: Copies of data sheets in hand. Rationale for choice documented in logbook.
B. Draw a rough schematic of the microprocessor, RAM, and ROM sections. (4 hrs)
   Accomplishment Criteria: Schematic documented in logbook
C. Write the circuit descriptions for the microprocessor, RAM, and ROM sections on a word processor. (5 hrs)
   Accomplishment Criteria: Document written and reviewed by all team members.
D. Wire-wrap the microprocessor, RAM, and ROM sections of the project. Check continuity of connections. (7 hrs)
   Accomplishment Criteria: Hardware wire-wrap completed. Individual connections checked off schematic as part of continuity check.

A template for the weekly goal record can be found on page 23 of this workbook.

14.0 RESEARCH AND DEVELOPMENT

Research and Development skills are evaluated an attempt to measure the student's abilities to solve design problems.

Topical Research

Each team member will conduct basic research. Library or Internet search results should be recorded in your log book and presented during weekly meetings with the senior projects coordinator. Research is crucial and should dominate your time during the project planning phase. Once the plan is complete, research is still necessary, but it will occupy a relatively small amount of your time.

Circuit Design

Each member of a team must display good design techniques. Teams are not expected to design circuits that have never been designed before. Original circuit designs are unlikely and may not be the best for the job. Most designs are usually a combination of existing circuits. Good research techniques should unveil other circuit designs that could be used in your design. The use of other designs must be brought to the attention of the senior project coordinator and your design document should credit the original designer. Whether a design is original or not will not be the issue. The issue is whether or not the students understand the circuit well enough to modify or troubleshoot it themselves. The senior projects coordinator will assign a letter grade for the design and research effort by the students.

Teams are encouraged to use ST microprocessors. Teams will not use the Arduino environment, microprocessors, boards, shields, or circuit layouts without written approval from the majority of the faculty. This prohibition extends to any environment that abstracts the design process similar to Arduino. Use of any such tool will result in a non-passing grade for the project. If you are not sure if a tool is appropriate, check with your senior project advisor and at least one other faculty member before proceeding.

Problem Solving

Each member of the team and the team as a whole must present good problem solving techniques. During the course of the project many problems will arise that must be solved by the team. Problem solving techniques will be observed by the senior projects coordinator. The senior projects coordinator will assign a letter grade to each student for his or her problem solving techniques.

Circuit Construction

Circuit construction skills are practiced and evaluated to improve the student's ability to construct quality prototypes. Circuits can be constructed using any permanent or semi-permanent technique such as printed circuit boards or wire-wrap. Use of solder-free prototype boards is not acceptable.

Good soldering skills are crucial to building prototypes. All solder connections must be made correctly. The following guidelines should be followed:

1. Use only a quality 25 to 60 watt soldering iron.
2. Use either 60/40 or 63/37 rosin core solder.
3. Make sure that the connections are clean before soldering.
4. Clean all printed circuit (PC) board connections with flux remover after soldering.
5. Spray PC boards with protective polyurethane coating to prevent surface corrosion.
6. Cover all open connections with heat-shrink tubing. All high voltage connections must be well insulated to prevent shock.

Packaging

Unless the project consists of a circuit board to be included inside an existing enclosure, all projects must be packaged in a cabinet. The packaging must follow the guidelines given below:

1. Switches, controls, and indicators must be labeled on the cabinet front panel.
2. All 110 VAC operated devices should be fused with inline fuse holders.
3. All 110 VAC connections must be well insulated to prevent a shock hazard. Use heat shrink tubing on all exposed connections.
4. Any wires passing through the case must have strain relief devices to prevent the wires from shorting to the case. If the case is metal, grommets are required.
6. Mechanical bolts and nuts should have lock washers installed. Bolts should extend through the nuts more than one thread but less than five threads.
7. All inter-wiring connections should be bound with cable ties.

15.0 PROJECT TIMELINE AND DEADLINES

Students in ECE 4010 and ECE 4020 are required to meet certain deadlines. Most of these deadlines are mentioned throughout this document but are listed together here for convenience.

ECE 4010 Deadlines

Milestone	Deadline
Project Proposal Signed (all faculty)	2nd Tuesday of the Semester
Project Plan Signed	Meeting With Coordinator, 4th Week of Class
Preliminary Design Review	Last Week of Class

ECE 4020 Deadlines

Milestone	Deadline
Product Demonstration	Demonstration Day*
Invitation/Documentation Circulated	One Week Prior to Final Design Review
Final Design Review	Last Week of Class
Documentation Revisions (if needed)	First Day of Final Exams

*Demonstration Day is scheduled by the Engineering Department about 3 weeks prior to the last day of class. This date will be announced at the beginning of the semester.

If a project is not demonstrated (or if the coordinator deems the demonstration unacceptable) on Demonstration Day, up to15 points will be deducted from each team member's total score. If a project is not demonstrated satisfactorily on or prior to the time scheduled for the design review, the final grade of all team members will be E (fail). The coordinator may assign an incomplete grade (I) if there are extenuating circumstances.

Each team must distribute design review invitations with design documentation attached to the faculty at least one week prior to the design review. If this design documentation is late or indicates a lack of effort, up to10 points will be deducted from each team member's total score.

As a consequence of the design review, the faculty may insist on revisions to the design documentation. If such revisions are required, a hard copy of the revised documentation must be submitted to the coordinator on or before the first day of final exams. (If no revisions are required, the coordinator will have collected the hard copy during the design review.) Note: The communication grade for design documentation (on the ECE 4020 Team Evaluation worksheet) is based on the final version of the documentation without regard to the quality or tardiness of earlier drafts.

Absolutely no work will be accepted after the first day of final exams.

16.0 FE PRACTICE EXAM

Students in both ECE 4010 and ECE 4020 are required to take a 45-question FE Practice Exam. Questions for this exam are culled from previous FE (Fundamentals of Engineering) Exams. (The FE Exam is a standardized test administered nationally by NCEES – The National Council of Examiners for Engineering and Surveying).

The exam can be taken in any WSU testing center anytime between the first and last day of class. It is a closed book exam, except that you may bring a copy of the NCEES FE Reference Handbook. The handbook should not be necessary, however, because any tabular data you need will be provided in the exam questions. Still, the handbook does include equations and formula that may prove useful. The exam should take two hours or less, however you will be given three hours to complete it.

Your exam score counts 17% of your grade, and you need to answer 26 of the 45 questions correctly in order to receive full credit (26 points). If you answer fewer than 26 questions correctly, your exam grade will be reduced accordingly.

Students are encouraged to consider taking the FE exam after graduation. This practice exam will give you some idea what to expect.

17.0SPECIAL INTEREST ITEMS

The following items are of special interest to students:

1. Students may take this class as CEL (community-engaged learning) if the senior project satisfies the requirements set forth by the Center for Community-Engaged Learning (Shepherd Union Building Room 327). Projects of this nature can often be funded by grants and faculty may serve as advisors. Students can also receive an excellence in service award (which entails a certificate and an honorary cord to wear at graduation) if they submit their hours to the Center for Community-Engaged Learning.

1. Students should not begin working on a senior project until their project has been approved with a completed proposal. Project approval can be granted before officially registering for ECE 4010. This might occur if a student wants to begin working on his or her project during the summer when senior projects is not offered. Project approval may be given prior to the summer break and that would allow students to begin their project.

2. Students earn individual grades for each senior projects class. Each grade, once earned, will not be changed because of changed circumstances or by a project that was not completed. For example, if a student fails to complete ECE 4020, he or she will not have to repeat ECE 4010.

3. A team may complete its project during ECE 4010 if it presents both its preliminary and final design reviews during the semester. If a team completes its project in ECE 4010, they will earn the same grade for ECE 4020 without having to attend class or meetings. (There may also be a possibility that the requirement to complete ECE 4020 could be waived, but to do this, you would need to contact the ECE Program Coordinator.)

4. Incomplete, "I", will only be given to students because of illness or accidents. Procrastination or unforeseen design problems will not be rewarded by incomplete grades.

5. Students who realize that they will not make the end of semester deadlines should withdraw from the course before the end of the seventh week. Students that realize that they will not make the end of semester deadlines after the seventh week of the semester will be given the grade that they have earned. Passing grades are seldom given to those who have not completed all of the requirements.

6. Have fun and make senior projects a worthwhile experience.

7. Feel free to share your thoughts and concerns about senior projects to the senior project coordinator. Changes and improvements are made because of feedback from students, faculty, and advisors.

DESIGN REVIEW PRESENTATION EVALUATION

Name of Evaluator: _____ ECE 4010___ ECE 4020___ Date _____

Individual Grades

Student #1:_____

Professional Attire	A	B	C	D	E
Speaking ability.	A	B	C	D	E
Knowledge of the project.	A	B	C	D	E
Share of the load	A	B	C	D	E

Student #2:_____

Professional Attire	A	B	C	D	E
Speaking ability	A	B	C	D	E
Knowledge of the project	A	B	C	D	E
Share of the load	A	B	C	D	E

Student #3:_____

Professional Attire	A	B	C	D	E
Speaking ability	A	B	C	D	E
Knowledge of the project	A	B	C	D	E
Share of the load	A	B	C	D	E

Team Grades

1.	Introduction / Overview	A	B	C	D	E
2.	Explanation of the Problem	A	B	C	D	E
3.	Slides and/or other Visual Aids	A	B	C	D	E
4.	Presentation Organization	A	B	C	D	E
5.	Results (ECE 4020 only) N/A	A	B	C	D	E
6.	Conclusion	A	B	C	D	E
7.	Impact/Complexity	A	B	C	D	E

Comments:

Coordinator Use Only	Student 1	Student 2	Student 3
Total Grade Points			
Grade Point Average			

DEMO EVALUATION

Name of Evaluator: _____ Date _____

Individual Grades

Student #1:_____

Professional Attire	A	B	C	D	E
Speaking ability.	A	B	C	D	E
Knowledge of the project.	A	B	C	D	E
Share of the load	A	B	C	D	E

Student #2:_____

Professional Attire	A	B	C	D	E
Speaking ability	A	B	C	D	E
Knowledge of the project	A	B	C	D	E
Share of the load	A	B	C	D	E

Student #3:_____

Professional Attire	A	B	C	D	E
Speaking ability	A	B	C	D	E
Knowledge of the project	A	B	C	D	E
Share of the load	A	B	C	D	E

Team Grades

1.	Poster: quality and clarity	A	B	C	D	E
2.	Hardware: professional quality workmanship	A	B	C	D	E
3.	Functionality: does what was promised	A	B	C	D	E
4.	Impact/Complexity	A	B	C	D	E

Comments:

Coordinator Use Only	Student 1	Student 2	Student 3
Total Grade Points			
Grade Point Average			

WEEKLY GOAL RECORD

Project Title: _____

Course: 4010 4020 Week: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Date completed form was submitted: _____

Goals and Accomplishment Criteria for Team Member #1_____:

1.

2.

3.

Goals and Accomplishment Criteria for Team Member #2_____:

1.

2.

3.

Goals and Accomplishment Criteria for Team Member #3_____:

1.

2.

3.

End of Week Grade by the Senior Project Coordinator

Team Member #1 _____ Team Member #2 _____ Team Member #3 _____

APPENDIX F – GRADUATE SURVEY INSTRUMENT

WEBER STATE UNIVERSITY

Electrical & Computer Engineering Dept
Graduate Survey

This survey is to be administered to senior ECE students just prior to graduation.

The information gathered by this survey is for ABET accreditation purposes only and will not be publicly disclosed.

Today's Date _____

Graduation Date _____

Major EE _____ CE _____ BME _____

The WSU Electrical Engineering program is accredited by the Engineering Accreditation Council (EAC) of ABET. ABET requires engineering programs to assess student learning outcomes, and your answers to the questions below will help us make that assessment.

Please answer the following question for each outcome:

The WSU Electrical, Computer or Biomedical Engineering program prepared you to achieve the following outcomes:

a. An ability to apply knowledge of mathematics, science and engineering.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

b. An ability to design and conduct experiments, as well as to analyze and interpret data.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

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

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

d. An ability to function on multidisciplinary teams.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

e. An ability to identify, formulate and solve engineering problems.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

f. An understanding of professional and ethical responsibility.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

g. An ability to communicate effectively.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and social context.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

i. A recognition of the need for, and an ability to engage in, life-long learning.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

j. A knowledge of contemporary issues.

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

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

strongly agree __ agree __ neither agree nor disagree __ disagree __ strongly disagree __

What are the strengths of the WSU Electrical & Computer Engineering program?

What are the weaknesses of the WSU Electrical & Computer Engineering Program?

What changes would you recommend for the WSU Electrical & Computer Engineering program?

Thank you!

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APPENDIX G – INTERNSHIP SURVEY INSTRUMENT

Confidential

WEBER STATE UNIVERSITY

Internship Employer Survey

Instructions to employer

For office use only EE___ CE___ BME___

The purpose of this survey is to provide the Electrical and Computer Engineering (ECE) faculty at Weber State University an employer's evaluation of student interns. **This survey is to be completed by the employer, not the intern.** Please answer the questions to the best of your knowledge. The results of this survey and the intern's self-assessment will be used to issue a grade to the student for ECE 3890 Internship. In addition, the results of the survey will be used as part of the assessment process of the WSU ECE programs for ABET accreditation.

Date _____

Name of intern _____

Intern's work period: Start date _____ End date _____

Approximate total number of hours worked by the intern _____

Supervisor or manager of intern:

Name _____ Phone _____

Email _____

1. Briefly describe the primary duties and responsibilities of the intern. Use additional sheets if needed.

A.

B.

C.

D.

2. The intern set goals at the beginning of the internship and reported them to the EE 3890 instructor. To the best of your knowledge, did the intern accomplish these goals?

   Yes ___ No ___ Comments

   _____

3. The intern performed his/her duties on schedule.

   Strongly disagree Disagree Neutral Agree Strongly agree

   Comments

   _____

4. The intern reported to work on time.

   Strongly disagree Disagree Neutral Agree Strongly agree

   Comments

   _____

5. The intern demonstrated professionalism and ethical behavior.

   Strongly disagree Disagree Neutral Agree Strongly agree

   Comments

   _____

6. The intern demonstrated an ability to learn new concepts, skills, procedures, policies, etc. that are pertinent to the job.

   Strongly disagree Disagree Neutral Agree Strongly agree

   Comments

   _____

7. The intern was an effective communicator.

   Strongly disagree Disagree Neutral Agree Strongly agree

   Comments

   _____

8. Overall, I am satisfied with the performance of the intern.

   Strongly disagree Disagree Neutral Agree Strongly agree

   Comments

   _____

9. If there was a full time engineering position open at my company, I would hire this intern.

   Strongly disagree Disagree Neutral Agree Strongly agree

   Comments

   _____

10. If you were to issue a letter grade to the intern for his/her work, what would it be?

    A A− B+ B B− C+ C Fail

    Comments

    _____

If you wish to provide further feedback or suggestions, please use the space below or feel free to add additional sheets.

Thank you for completing this survey.

Rev. 2024