I. Assessment Outcomes from the Course Syllabus

☐ (A) Ability to apply knowledge of mathematics, science and engineering.

☐ (B) Ability to design and conduct experiments as well as analyze and interpret data.

☒ (C) Ability to design a system, component, or process to meet desired needs.

☒ (D) Ability to function on multidisciplinary teams.

☒ (E) Ability to identify, formulate, and solve engineering problems.

☐ (F) An understanding of professional and ethical responsibility.

☒ (G) Ability to communicate effectively in written and oral formats.

☐ (H) A broad education necessary to understand the impact of engineering solutions in global, economic, and societal context.

☐ (I) Recognize the need for, and have the ability to engage in life long learning.

☐ (J) Have a broad education and knowledge of contemporary issues.

☐ (K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.

II. List of Course Topics

- Project design/implementation overview.
- Project/product life-cycle.
- Understanding the customer and addressing their needs.
- Tour of SEL manufacturing facility (TQM in action)
- Teamwork, expectations, and course deliverables.
- Communication skills.
- Designing for quality
- Electronic designs for reliability.
- Project management.
- Detailing the product idea and it’s design
- Details of product design and manufacturing
List of Course topics – Cont’d.

- Giving effective presentations
- Intellectual property rights
- Ethics in Engineering

This course is a survey of the project design process necessary for the teambuilding and preliminary design work on projects to be completed in EE416 (Senior Design) in the following semester. The student team projects and their associated sponsors are listed below:

<table>
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<tr>
<th>Team Name</th>
<th>Sponsor/Mentor(s)</th>
<th>Project Description</th>
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<tbody>
<tr>
<td>Falcon</td>
<td>Digilent, Inc.</td>
<td><strong>Image Acquisition</strong>&lt;br&gt;Our team is to design, build and implement an image acquisition system that will interface to the high-speed connector on the Digilent Nexus board. To do this we need to select an imager with a fixed lens system that uses VGA style output. We must then interface the camera to connect to the FX-2 connector on the Nexus board. Once the physical hardware has been designed we must verify its operation as well as provide reference designs of its use. This will be done by at first capturing an image and then transferring it to a PC. The capture and control of the image and camera will be done using VHDL. After the initial design we will then write a VHDL module to interface to Xilinx’s Micro-blaze soft-core microprocessor. From here we will write an image processing library mixing between C and VHDL to maximize performance.</td>
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<td>Hawk</td>
<td>Digilent, Inc.</td>
<td><strong>FPGA Robot Platform</strong>&lt;br&gt;The Team Hawk project is to build a robotic platform using an FPGA-style board, from Digilent. The project goal is to develop a modular platform that can be extended or modified for different applications and peripherals. The robot will use closed-loop motor feedback of its drive system and is capable of remote control using a standard hobby RC controller. The robot will also track its position using dead reckoning and other sensory inputs. Using the tracking system the robot will be able to return to a “home” position by itself on command. The end result will be a functional demonstration robot that highlights the abilities of the Digilent Nexys control board and peripherals. The APIs will be designed to allow Digilent to reuse the APIs for future projects. Digilent could use these APIs to make a robotics kit, for customers to customize their own robot.</td>
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<tr>
<td>Osprey</td>
<td>Digilent, Inc.</td>
<td>Wind Turbine Power Generation &amp; Integration</td>
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|             | John Yates              | Team Osprey is currently in the process of designing a wind turbine power generation farm and determining a process to integrate the power generated into the power grid. Our goals are to tackle current industry issues involving environmentally clean power generation specifically targeting wind turbines. As such, the major obstacle in wind power generation is devising a way to harness a mechanical power source (the wind) which is not constant, and convert it to electrical power which must hold certain constant restraints (frequency & voltage).  
Clean electrical power that completely renewable has become a forefront in power generation around the world. With chemical fuel increasing in price at an alarming rate, the demand for alternative energy sources is reaching an all-time high. New technologies are under development to harness alternate fuel sources, wind turbines being one of them. It is an objective of Team Osprey to understand the current ideas behind wind power generation and to be involved in the clean energy revolution. |

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<tr>
<th>Owl</th>
<th>Linear Technology</th>
<th>Power Supply Design Demonstration Platform</th>
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|             | Ed Perkins              | This project will involve the creation of a circuit board that contains several buffer circuits that provide power with varying characteristics to a number of various loads. Using several topologies we will create linear and switch-mode regulators that are used in modern technologies and methods. The regulators will have a control circuit that will set parameters such as operating voltage, switching frequency, transient response, turn-on time, etc. These regulators will contain inductors and capacitors that we will be able to vary so that we can see the differences when connected to the loads.  
The outputs of the regulators will be connected to several user-selectable loads (digital and/or analog devices, together with resistive, capacitive, and/or inductive components in various combinations). The performance of the various power supplies to load setups will be analyzed to determine which regulator(s) are optimized for specific loads.  
This board will be designed with the intent of helping to educate students in the area of power electronics. The students will have the opportunity to adjust different aspects of the supplies and connect them to a number of loads which we will have previously analyzed. Our results of the analysis will be discussed in a guide that we will prepare that will indicate the theory behind each supply as well as recommendations for optimal performance. |

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<tr>
<th>Pheasant</th>
<th>PNNL</th>
<th>Time of Flight Measurement</th>
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|             | Thomas Seim             | The time of flight mass spectrometer is a device used to measure the structure and composition of matter. This is accomplished by applying an electric field upon a group of ions. This electric field then moves the ions at a high rate. Each ion then accelerates at a different rate based on its mass to charge ratio.  
The time of flight measurement project's goal will be to implement a device that will measure the time of ions traveling through the drift region and into a detector that will be located at the end of the flight. This will result in a form of a pulse in the speeds up to Pico-seconds. |
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<td>Robin</td>
<td><strong>Analysis of Chaotic Signals</strong>&lt;br&gt;Instead of the typical signal processing techniques like FFTs and DFTS, we will be using non-linear transform analysis in this project. The benefit of the non-linear time series techniques is that they provide a faster and more effective way of analyzing differential equations without the use of calculus. The techniques will be used to extract signals that are buried in noise. For our purposes, we will define chaos as noise. An example of this type of application would be extracting the fetal heartbeat (a very small signal) from the mother's heartbeat. The small signal of the fetus has frequency shifts, so typical frequency filtering is not useful in this case. However, non-linear analysis would allow us to easily separate the two signals. The overall goal for this project is to implement these techniques in an FPGA. In order to test the FPGA we will research and create our own data in the form of vibration and sound analysis, and/or radar signal processing.</td>
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<td>Quail</td>
<td><strong>Collecting Relay Data via a GE D25</strong>&lt;br&gt;Team Quail’s project is to discover the best configuration of the GE D25 Remote Terminal unit to pass on vital fault information to Tacoma Power dispatcher’s control center from various power substations. When a fault occurs, a relay logs fault information and will pass it on to the D25 RTU, which then (based on its configuration) will filter out which pieces of information to send out to the people at Tacoma Power. Our team will set up the D25 and relays, and then simulate these faults to analyze various configurations of the D25 RTU.</td>
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<td>Roadrunner</td>
<td><strong>Handicapped Assistance Product</strong>&lt;br&gt;A person with M.S. or paralysis has very little muscle control, and often little or no way of communicating with others. Using a piezo-electric strip, or a pair of electrodes, the voltage associated with the voluntary contraction of a muscle can be detected and measured, and thus implemented as a form of communication. It will be used as an alternate interface for a computer. The measured voltage will be digitized and filtered and the signal will be sent to a windows laptop.&lt;br&gt;Software on the computer will be able to discern between different muscle contractions signals from the user and map them to functions on the laptop such as speech synthesis, cursor movement, or even input to a game.</td>
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This course culminates in a written project plan that is formally presented to a panel of Faculty, working Electrical Engineers, and Electrical Engineering Graduate Students for evaluation. This course is then followed-up by EE416 where the project plans are actually implemented over the period of one semester.
### III. Course Assessment Summary Table: each row of the table is devoted to each of the checked outcomes in part I.

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<thead>
<tr>
<th>Outcome</th>
<th>Description</th>
<th>Specific Measures</th>
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<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>This is the primary component for EE415. The students were divided into 8 groups of 3 or 4 students, and assigned to project groups for the purpose of developing a formal Project Plan. This includes special attention to Marketing and the Customer, Quality and Reliability, Engineering Design, and Manufacturing.</td>
<td>1) Each team delivered a complete written project proposal defining the Marketing/Customer issues, Quality/Reliability issues, Engineering Design issues, and Manufacturing issues for the implementation of the project. 2) Each team delivered an oral presentation demonstrating each student’s participation and knowledge of the project. This oral presentation was evaluated by a panel of EE faculty, working electrical engineers, and EE graduate students.</td>
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<td>(D) Ability to function on multidisciplinary teams.</td>
<td>The teams were, by their very nature multi-disciplinary. Each team was comprised of 3 or 4 students with diverse interests (e.g. digital circuits, analog circuits, power, hardware, electro-physics, computer engineering, etc.) Together, they were tasked with completing a complete project proposal with a presentation demonstrating each student’s participation and knowledge of the project.</td>
<td>1) Sponsors and Mentors assessed their teams on that team’s ability to work together, follow creative instruction, and communicate clearly and effectively with the Sponsor or Mentor. 2) Each student was required to prepare a self-evaluation and peer evaluations of their team members at the end of the semester. This review also has a focus of cooperation and teamwork.</td>
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<td>(E) Ability to identify, formulate, and solve engineering problems.</td>
<td>This item dovetails with the objectives listed for Assessment Outcome (C) above – and is the basis in developing a solid Project Plan. Teams focus on Marketing and the Customer in order to identify and quantify the need that their project will fulfill. They then examine the Quality and Reliability issues in order to ascertain the boundaries for delivering an acceptable product to the Customer. They also lay out the foundation for the Engineering Design, and take into account Manufacturing issues in that design.</td>
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<td>(G) Ability to communicate effectively in written and oral formats.</td>
<td>Each team was required to meet regularly as a whole – once per week at the minimum. At the end of the semester, the teams were required to deliver a formal written proposal for their project, and then had to present that project proposal orally.</td>
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<td>1) During the course of the semester, these teams were required to meet regularly to work on their project. From those meetings, each student was expected to have personal notes in a laboratory notebook that traced their project plan development. 2) Teams delivered written drafts focusing explicitly on the areas of Marketing and the Customer, Quality and Reliability, Engineering Design, and Manufacturing. 3) The final project plan as a whole was also evaluated for its viability as a successful document at guiding an implementation team.</td>
<td>1) Part of the sponsor’s/Mentor’s assessment is focused directly on the ability of the team to effectively communicate. 2) Each team is assessed as a group as well as individually for their oral project plan presentation. 3) Teams delivered written drafts of the plan components several times during the semester. These focused explicitly on the areas of Marketing and the Customer, Quality and Reliability, Engineering Design, and Manufacturing.</td>
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IV. Using the table as a guide, for each outcome summarize your evaluation of the students’ achievement of that outcome; cite student performance on the identified measures as evidence to support your conclusions.

(C) Ability to design a system, component, or process to meet desired needs.

Lectures for the class provide guidance and structure to the design process. In-class assignments and discussion create the foundation upon which the individual teams will build their project. Project teams are each guided by a sponsor/mentor who has a clear direction that they provide to the students. The teams then work to follow the project’s sponsor/mentor’s vision for the development of their project plan. The resulting project plan is then the basis for implementing the project in the following semester.

(D) Ability to function on multidisciplinary teams.

Project teams are by their very nature interdisciplinary, and include students with diverse interests (e.g., digital circuits, analog circuits, power, hardware, electro-physics, computer engineering, etc.). Teams are assigned based upon several factors including: each student’s requested area of investigation, a basic skills assessment survey, and the range of available projects and their varied topics. This led to assignment of the eight project teams — each with a complement of between 3 and 4 members.

Initially, there was some contention for a couple of popular projects. There were also some initial concerns about one or two team members that an individual would have preferred to avoid. However, in general, the students functioned well within their teams. Although there was inevitable some frustrating moments for a couple of students, many of these people realized the valuable learning experience in finding ways to work cooperatively under this challenge. This was measured at the end of the semester via peer reviews.

(E) Ability to identify, formulate, and solve engineering problems.

The primary purpose of generating the project teams is to have them identify, formulate and develop a solution to an engineering problem posed by a sponsor/mentor. As in (C) above, these teams are assigned a given problem to explore, and the teams work in concert with this mentor throughout the semester for guidance as they delve into the relevant technical areas.

The objective of this exploration is to develop a cohesive and thorough project plan that outlines the solution to the problem in question. Often these solutions require the pulling together of technical expertise from many different areas such as analog/digital signal processing, power systems analysis, or robotics. Further, teams must also call upon a variety of technical skills in order to solve their problem; such as, C or VHDL programming (very important), printed circuit board design and assembly, and a variety of specialized design software.

Ultimately, the students demonstrate their solutions to the posed engineering problems with a written project plan combined with an oral project plan presentation.
(G) Ability to communicate effectively in written and oral formats.
Students regularly met with their teams in a group setting for planning and discussion of their respective projects. Each team had a team leader that was responsible for coordinating the efforts of the team. Team leaders demonstrated their communication skills in both oral and written means as they brought questions and concerns from the teams to the instructor's attention. These communications were augmented by 3 face-to-face meetings between the teams and the instructor for the purpose of guiding the process of project development. Each team member was queried about their participation in the project design, and was required to explain various aspects of the project in an impromptu fashion.
At the end of the semester, the teams each produced a written project plan which detailed the implementation path for their project. This included a focus on marketing and the customer, reliability and quality assurance, engineering design, and manufacturing issues.
Finally, each team made a formal oral presentation of their project plan before a panel of evaluators – consisting of faculty, working electrical engineers, and graduate students. This presentation gave each student an opportunity to display their oral presentation skills, as well as their depth of knowledge in the specialized subject matter of their project.

V. Qualitative Assessment of Student Performance: using the arguments above and other data support the claim that students who completed this course with a grade of C or better have achieved each of the intended outcomes of this course.
Those students who received a grade of C or better have demonstrated competence in their field of study through practical application of skills. Dealing with the competing daily challenges of the undergraduate university experience, they met regularly outside of the class and developed a project plan similar to the experience many will have in industry.
On the whole, mentors were very pleased with the work performed by their assigned project teams. Mentor evaluation scores had a mean of 86.77% and ranged from 61% to 100%.
Concerns for 2 of the teams in this semester, evidenced by a low mentor score, will hopefully serve to motivate these teams to follow the mentor's direction more closely in the next semester.
The teams' presentations were very well received by a very critical panel of WSU faculty, working electrical engineers, and graduate students. This panel noted a couple of weak teams as well as a couple of outstanding teams. The panel's average team score was 80.61% with a range of 68% to 95%.
The peer evaluations were typically beneficial for the students. Although this was an appropriate opportunity for team members to return poor evaluations for individuals who ultimately impeded the team's progress during the semester, the scoring fell in a relatively narrow range of 81% to 97%. Those with high scores had worked very hard within the team structure and were well respected by their teammates.
Considering the wide array of grading information sources, the final scoring for this class is done via statistical measurement. Hence, the center of the C range was the class mean, with a grade width of 1/3 standard deviation. Each grade segment above and below consisted of an additional 1/3 standard deviation such that the center of the B range was 1 standard deviation above the center of the C range and the center of the A range is 1 standard deviation above the center of the B range.
In a class where the grade range is contracted within the perimeter of 2 standard deviations, I choose to raise the base scores for the entire class until the top score reaches an A+. I then reflect on the grade shift and make certain that this proposed final grade is reasonable and appropriate for all class members. That was indeed the case for this class.
VI. Concerns: state any concerns you may hold about this class – were the students adequately prepared coming into it? Are there topics or outcomes where (some) students were weak after completing the course? Other concerns? Were there any comments on students’ course evaluations that should be addressed in future instances of the course? This section is very important for improving our program: it provides critical input to the curriculum committee for identifying areas requiring attention.

There are 3 basic concerns for EE415 in the future:

1) Due to the quick assignment of the instructor to this class before the semester started, inadequate time was available to line up all of the speakers and projects for the class. The order of presentations was determined by speaker availability more often than by logical sequence. Further, although the instructor was able to announce a majority of the projects on February 9, several students commented that they would like to receive their projects and team assignments earlier in the semester. This situation could be eased greatly by making the teaching assignment for EE416 one semester ahead of time so that all of the weekly speakers and projects can be determined and be ready to go at the beginning of the semester. Otherwise, it is truly a mad dash to schedule speakers and collect project sponsors and mentors for the beginning of the semester.

2) Careful consideration must be made in the assembling of the various teams at the start of the semester. I made a mistake in those assignments this semester in not obtaining student GPA’s prior to creating the teams. This has caused some disparity in the teams with one group of students in particular being very “high-powered”. In the future, it is imperative that the instructor obtain all the information that they can about the past academic achievements of the students in order to assure that the skills available are distributed more evenly across the various teams.

3) In review of student’s other academic responsibilities, it became clear that a few were taking 3rd year courses during EE415 in order to “catch-up” on what they needed to know for their “senior” projects. This seems counterproductive, in general, as now they have even greater pressure on them to learn material for their project – the same learning with twice the workload. Is it the case that these students believe that they have to take a class in order to learn a subject? Or is it the case that they find it easier to have it all laid out for them by an instructor in a formal setting? Perhaps this is not limited to this college, but, rather is a widespread phenomenon across the campus. If so, perhaps the University should consider a 1 hour class on learning new skills on your own. Although that seems a bit like an oxymoron, perhaps that’s the only way the skill may be learned – and ultimately, the initiative taken.

Signature ________________________________ Date: __________________________

Please email a copy of the completed form to Patricia Arnold, patricia@eecs.wsu.edu and deliver a signed hardcopy to her mailbox.