Assessment of Student Learning Plan (ASLP): Engineering Program

2014-15 Academic Year

A. College, Department/Program, Date

College _CSTH______________________________________
Department/Program _Engineering___________________________________
Date _*6/12/2015*_________________________

B. Contact Person for the Assessment Plan

Name and title __*Mariusz Jankowski*__________________________

C. Degree Program

Name of Degree Program _*BSEE and BSME*__________________________

D. Assessment of Student Learning in Your Program

Step 1: Identify Student Learning Outcomes ***(What are students able to do by the end of your program?)***

a. List 3-5 of the most important student learning outcomes for your program.
b. Then, identify which student learning outcomes were assessed this past academic year.

The student outcomes are what students are expected to know and be able to do when they graduate. The Department of Engineering uses Accreditation Board for Engineering and Technology (ABET) a-k student learning outcomes as its own set of criteria. Specifically, we expect our graduates to be able to:

a. apply knowledge of mathematics, science and engineering fundamentals to the solution of engineering problems;
b. design and conduct engineering experiments, as well as to analyze and interpret data from these experiments;
c. design devices, components and/or systems, to meet specific needs with realistic constraints;

d. function effectively on teams involving students from diverse backgrounds;
e. identify, formulate and solve engineering problems;
f. understand the professional and ethical responsibilities of a practicing engineer;
g. communicate effectively in oral, written, graphical and visual ways;
h. understand the role and impact of engineering solutions in the broader societal context;
i. recognize the need for and engage in self-directed learning;
j. gain knowledge and understanding of contemporary issues;
k. use the techniques, skills, and modern engineering tools, such as computer languages, instrumentation, engineering and business applications and electronic media, necessary for engineering practice.

Step 2: How and When were the Learning Outcomes assessed?

a. Briefly describe the assessment tools, measures, or forms of evidence that were utilized to demonstrate students' accomplishment of the learning outcomes selected.

The on-going assessment process involves gathering student performance data in all the engineering classes listed in Tables 1 and 2 that contain a boxed check mark. Achievement is documented using supporting materials collected and tabulated by the course instructor. Additional assessment data is obtained from the end-of-semester course questionnaires distributed to students, also called self-assessment. Each instructor prepares a questionnaire for each course and is responsible for administering it, analyzing the responses and incorporating the results into the continuous improvement process. The assessment data is documented in a Student Performance Assessment Data (SPAD) file for each course and each semester in which the course is offered. The faculty continuously share this information and discuss ways in which we can use this data to shape the curriculum. Assessment instruments can be as diverse as there are instructors in the program. The metric goals for these course outcomes are determined by the faculty in the form of homework assignments, exams, technical reports, and other assessment vehicles that validate student achievement of the outcomes. Attaining a given outcome is expressed by exhibiting satisfactory performance. The level needed for satisfactory performance is based on the standard published in the university catalog, which defines satisfactory performance as a grade of C or better. The measure used to determine the equivalent of a grade of C in every assessed assignment is determined by each faculty member based on their expert knowledge of their respective fields of engineering. To produce graduates that will ultimately achieve the Program Objectives (see http://usm.maine.edu/engineering/mission), we rely on the accumulated demands placed on the students by the entire faculty in the program to achieve the student outcomes. This process is carried out every time a course identified for assessment is taught in the program.

Table 1. Mapping of engineering courses to electrical engineering student outcomes.

symbol ✓ marks outcomes addressed by a course

symbol ☑ marks outcomes explicitly selected for assessment

Course	Title	a	b	c	d	e	f	g	h	i	j	k
Gen-Ed	USM's general education curriculum	✓	✓		✓		✓	✓	✓		✓	
EYE 112	Built Environment: Energy											
ELE172	Digital Logic	☑	☑	☑	☑	☑	✓	✓				☑
ELE216	Circuits I: Steady-State Analysis	✓	✓			✓		✓		✓		✓
ELE217	Circuits II: System Dynamics	☑	☑		☑	✓		☑		☑		✓
EGN248	Differential Equations and Linear Algebra											
EGN260	Materials Science for Engineers	✓				✓		✓	✓		✓	
ELE271	Introduction to Microprocessors	✓	✓	✓	✓	✓		✓	✓	✓		✓
EGN301	Junior Design Project			✓	☑	✓	☑	✓	☑	☑	☑	✓
EGN304	Engineering Economics	✓					☑	✓	☑	✓	☑	✓
ELE314	Linear Signals and Systems	☑	✓	☑		☑		✓		✓		☑
ELE323	Electromechanical Energy Conversion	✓	✓			☑		☑	☑	✓	☑	☑
EGN325	Control Systems											
ELE342	Electronics I	✓	✓	✓	✓	✓						✓
ELE343	Electronics II	☑	☑	☑	☑	☑		☑				☑
ELE351	Electromagnetic Fields	✓				✓		✓		✓		✓
EGN402	Senior Design Project	✓	☑	☑		☑		☑		☑		✓
ELE486	Digital Signal Processing											
	Outcomes SPAD coverage check	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
	Outcomes syllabus coverage check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 2. Mapping of mechanical engineering courses to engineering student outcomes.

symbol ✓ marks outcomes addressed by a course

symbol ☑ marks outcomes addressed and assessed for a course

Course	Title	a	b	c	d	e	f	g	h	i	j	k
Gen-Ed	USM's general education Curriculum	✓	✓		✓		✓	✓	✓		✓	
MEE150	Applied Mechanics: Statics	☑	☑		☑	☑		✓				
ELE216	Circuits I: Steady-State Analysis	✓	✓			✓		✓		✓		✓
ELE217	Circuits II: System Dynamics	☑	☑		☑	✓		☑		☑		✓
MEE230	Thermodynamics I: Laws and Principles	☑	✓			☑		☑				✓
MEE251	Strength of Materials	✓	☑	☑	☑	✓		✓				✓
EGN260	Materials Science for Engineers	✓				✓		✓	✓		✓	
MEE270	Applied Mechanics: Dynamics	☑	☑		✓	☑		✓				✓
EGN301	Junior Design Project			✓	☑	✓	☑	✓	☑	☑	☑	✓
EGN304	Engineering Economics	✓					☑	✓	☑	✓	☑	✓
ELE 323	Electromechanical Energy Conversion	✓	✓			☑		☑	☑	✓	☑	☑
MEE360	Fluid Mechanics	✓	☑	☑	✓	✓		☑				✓
MEE372	Computer-Aided Design of Machine Elements	✓	✓	✓	✓	✓		✓		✓		✓
MEE373	Dynamics of Machines and Mechanisms	✓	✓	☑	☑	✓		✓		☑		☑
MEE331	Thermodynamics II: Flows and Cycles	✓	✓			✓		✓				✓
EGN402	Senior Design Project	✓	☑	☑		☑		☑		☑		✓
	Outcomes SPAD coverage check	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
	Outcomes syllabus coverage check	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

b. Briefly describe when and how you implemented the assessment activity.

Assessment activity is an ongoing process and occurs every semester for every course with a boxed check mark in Tables 1 and 2 offered in that semester.

<u>Step 3: Process of Using the Assessment results to Improve Student Learning</u>

a. Briefly describe your unit's process of reviewing the program assessment results, and how you expect to improve student learning.

The program continuously monitors its success to reach its educational objectives. Based on the results of such evaluations and the feedback that the faculty receive from students, alumni, and the local industries, the program improves its curriculum. The following tools are used for performing the mentioned continuous improvement:

1. SPAD results in individual courses
2. End-of-semester questionnaires
3. Alumni interviews and surveys
4. Discussions with the Engineering Student Committee (ESC)
5. Advising survey
6. Advisory Board feedback
7. Exit interview

To maximize student achievement, the faculty strives to improve and modernize teaching methods, and to continually adapt course contents to the changing realities of scientific and technological advances. Therefore, changes occur naturally and continuously as part of the primary responsibility of the faculty to the students and to their profession. The current continuous improvement process adds important elements to the art and profession of teaching. It permits a more fact-based and data-driven approach and therefore directs program improvement efforts in a more efficient and systematic way. The individual faculty's desire to innovate and experiment continues to be the primary source of action but is better informed and better managed through this process. The items listed below have resulted directly from the continuous improvement process.

Actions specific to the BSEE program:

Problem: Because of the limitation in the total number of credits, two fundamental engineering courses, namely controls and digital signal processing were offered as elective courses. As a result, even though many students used to take these courses, there was a possibility that some students would graduate without enough knowledge in these areas.

Action: An opportunity arose in 2014 to increase the number of required courses in the electrical engineering curriculum. We used that opportunity to introduce those 2 courses as requirements.

Assessment: Formal assessment of this change will be performed after sufficient number of students have graduated with this new requirement.

Problem: There are many skills that graduates need to obtain in order to become successful engineers. Many of those skills are not part of the official curriculum and cannot be included because of the limit on the number of credits. As a result, students did not receive formal training on the use of software tools like SolidWorks, MATLAB, LabVIEW, and *Mathematica*, as well as Machine Shop operations and Industrial Power skills.

Action: Based on the feedback received from the students, the department developed and is now offering six one-credit courses on the mentioned engineering skills. These courses are electives and do not count toward graduation requirements.

Assessment: The exit interview in the spring of 2015 shows that while taking these courses is not mandatory, more that 50% of the graduates in that semester took at least one of these courses.

Problem: Due to the lack of faculty members and a small number of students in upper-division classes, four required junior and senior electrical engineering courses were on two year rotation. This matter made scheduling for students less flexible.

Action: The enrollment growth that the program experienced since 2012 allowed required classes to be taught annually. We successfully recruited several adjunct faculty to supplement our teaching capacity. As a result, all required electrical engineering courses will be offered annually starting from fall 2015.

Assessment: Based on the previous feedback from students it will clearly be a major improvement in the program. Formal assessment of this matter will be performed in the future.

Problem: Labs for the required electrical engineering courses were all embedded in the corresponding courses. As a result, no record of taking labs were mentioned in the students' transcripts. Also, the lab content could not be covered as well as it was needed since the number of credits for offering lecture and lab as a combined course was not enough.

Action: To address this problem, three electrical engineering lab courses were added in 2014. They include: *ELE 219 Circuits Laboratory*, *EGN 329 Electromechanical and Control Systems Laboratory*, and *ELE 489 Analog and Digital Signals Laboratory*. Four embedded labs were retained, based on the assessment by the instructor that they were more efficiently delivered in the current format.

Assessment: Based on the previous feedback from students it will clearly be a major improvement in the program. Formal assessment of this matter will be performed in the future.

Problem: A technical writing course was absent from the program. Even though students had writing assignments and essays in many required engineering courses, a formal course on technical writing was not a requirement of the degree. Such a course is being offered in other engineering programs in the state and the lack of such a course in our curriculum could have transferability issues for our students.

Action: A technical writing course was added to the curriculum in 2015.

Assessment: Formal assessment of this change will be performed in the future.

Problem: The computer programming course that students used to take was an introductory course on Java programming that had a 1-credit lab as well. This programming language is not the most suitable programming language for engineering students. The mater has been brought up to the attention of the faculty by students in Exit Interviews several times.

Action: It was determined that based on engineering and industrial needs, a course in C++ would be the best substitute. A pilot class is scheduled to be offered in the fall of 2015 as an option to substitute for current requirement.

Assessment: Formal assessment of this change will be performed in the future. If the experience is successful, we may convert that option into a requirement.

Problem: One of the important voids in students' math education in the electrical engineering program has been linear algebra. While students could take linear algebra as a general technical elective course, still some graduated without being formal educated on this topic in their math courses. However, many engineering courses needed some basic understanding of this subject for being fully and most efficiently understood and implemented. Because of that, engineering faculty in courses that needed linear algebra had to spend considerable class time to provide this basic math knowledge to the students. Furthermore, the differential equations course delivered by the math department was a requirement in the electrical engineering program, but students complained that they could not see practical applications based on how it was delivered.

Action: *MAT 350 Differential Equations* was replaced by *EGN 248 Introduction to Differential Equations and Linear Algebra* in 2012, following a model that has been used successfully at many engineering program throughout the country. This requirement is now the responsibility of the Engineering Department.

Assessment: Exit interviews have shown that students feel more prepared to understand their engineering courses when they take the newly developed differential equations course that includes linear algebra. Also, they like to see more engineering applications in a math course like EGN 248.

Problem: The engineering design sequence had to be formally approved by the Core Curriculum Committee in order to satisfy the capstone requirement of the general education curriculum.

Action: The sequence of EGN 301 and EGN 402 was proposed as engineering capstone to the USM's Core Curriculum Committee and it was approved. This was an attempt to integrate the design experience into a broader context in which concerns such as environmental considerations and ethics came to the forefront of the practice of engineering, not as an add-on.

Problem: Electrical Engineering students did not have a course that could present economic aspects of engineering. But many engineering activities require an understanding of financial, economic, ethical and accounting aspects of engineering projects.

Action: *EGN 304 Engineering Economics* was introduced as a requirement since 2012.

Assessment: Formal assessment of this change will be performed in the future.

Problem: The electronics 2-course sequence was changed in 2010 to start in the 4th semester instead of the 5th semester. Feedback from the instructor indicated that it resulted in poor student performance by virtue of inadequate preparation, since it became concurrent with the 2nd semester of circuits.

Action: The electronics sequence was moved back to the 5th semester in 2014.

Assessment: Formal assessment of this change will be performed in the future.

Problem: When the new general education curriculum was adopted by the university in 2011, the public speaking requirement was converted into a general creative expression requirement. We quickly realized that it was a mistake not to require public speaking explicitly.

Action: *THE 170 Public Speaking* was reintroduced as a requirement in in 2013.

Assessment: No formal assessment of this change is possible, since the number of students affected is not statistically significant.

Actions specific to the BSME program:

Problem: Three combined courses on statics and strength of materials as well as the combined course on statics and dynamics and finally the combined course on thermo-fluid systems used to be offered. Students expressed difficulty understanding all of the materials that needed to be covered in such combined courses. The other issue was that since such combined courses are not offered in other engineering programs, students had difficulty in transferring their credits.

Action: The following new courses that cover the same topics in a more comprehensive manner: Statics (MEE 150), Strength of Materials (MEE 251), Dynamics (MEE 270), Thermodynamics II (MEE 331), and Fluid Mechanics (MEE 360) were added to the curriculum during 2011 and 2012.

Assessment: Based on the previous feedback from students that is reflected in the SPAD forms it has clearly been a major improvement in the program.

Problem: Many of the mentioned revisions needed the addition of more credits to the program. So, the problem was how to accommodate this need.

Action: The total number of credits in electrical engineering that mechanical engineering students needed to take was 12. So, to address the mentioned problem, make the curriculum more comparable to other mechanical engineering programs, and to improve transferability, from 2014 this number was reduced to 10.

Assessment: Based on the previous feedback from students it has clearly been a major improvement in the program.

Problem: Because of the limitation in the total number of credits, two fundamental mechanical engineering courses, i.e. vibrations and heat transfer were offered as elective courses. As a result, even though many students used to take these courses, there was a possibility that some students graduate without enough knowledge in these areas. This matter was also mentioned by the reviewers during the internal review of the program in 2014.

Action: The program added the two courses, i.e. vibrations and heat transfer to the list of required courses, starting from 2014.

Assessment: Formal assessment of this change will be performed in the future.

Problem: There are many skills that graduates need to obtain in order to become successful engineers. Many of those skills are not part of the official curriculum and cannot be included because of the limit on the number of credits. As a result, students did not receive formal training on the use of software tools like SolidWorks, MATLAB, LabVIEW, and *Mathematica*, as well as Machine Shop operations and Industrial Power skills.

Action: Based on the feedback received from the students, the program developed and is now offering six one-credit courses on the mentioned engineering skills. These are non-required courses so the credits gained by taking these courses are not counted towards graduation.

Assessment: The exit interview in the spring of 2015 shows that while taking these courses is not mandatory, more that 50% of the graduates in that semester took at least one of these courses.

Problem: Due to the lack of faculty members, four required junior and senior mechanical engineering courses were on two year rotation. This matter made scheduling for students less flexible.

Action: In order to solve this problem and improve the student faculty ratio, a search for a lecturer in mechanical engineering was done and a new faculty member was hired in spring of 2015. As a result, all required mechanical engineering courses will be offered annually starting from fall 2015.

Assessment: Based on the previous feedback from students it will clearly be a major improvement in the program. Formal assessment of this matter will be performed in the future.

Problem: Labs for the required mechanical engineering courses were all imbedded in the corresponding courses. As a result no record of taking labs were mentioned in the students' transcripts. Also, the lab content could not be covered as well as it was needed since the credit for offering lecture and lab as a combined course was not enough.

Action: To address this problem, four mechanical engineering lab courses were added in 2014. They include, statics and strength of materials lab, dynamics and vibrations lab, thermodynamics lab, fluids and heat transfer lab. The labs of Computer-aided Design of Machine Elements and Design of Machines and Mechanisms are still embedded in the courses in order to provide the option of solving various problems using the three different methods: simulation, experiment and theory. In order to make it possible, one credit was added to the mentioned two courses.

Assessment: Based on the previous feedback from students it will clearly be a major improvement in the program. Formal assessment of this matter will be performed in the future.

Problem: A technical writing course was absent from the program. Even though in many courses, students have writing assignments and essays, a formal course on technical writing was not a requirement for the degree. Such a course is being offered in other engineering programs in the state and it lack of this course, could make some transferability issues for students that wish to transfer to other universities.

Action: A technical writing course was added to the curriculum in 2015.

Assessment: Formal assessment of this change will be performed in the future.

Problem: The computer programming course that students used to take was an introductory course on Java programming that had a 1-credit lab as well. This language was probably not the most suitable programming language for engineering students. The mater has been brought up to the attention of the faculty by students in Exit Interviews several times.

Action: It was determined that based on engineering and industrial needs, a course in C++ would be the best substitute. This class has been offered in fall 2015.

Assessment: Formal assessment of this change will be performed in the future.

Problem: One of the important voids in students' math education in the mechanical engineering program has been linear algebra. In the previous curriculum, students did not have a chance to be formally introduced to this course. While students could take linear algebra as a general elective course, still some graduated without being formal educated on this topic in their math courses. However, many engineering courses needed some basic understanding of this subject for being fully and most efficiently understood and implemented. Because of that, engineering faculty in courses that needed linear algebra had to spend considerable amount of time in order to provide this basic math knowledge to the students. Also, not many application could be seen in the traditional differential equations course.

Action: Changing differential equations (MAT 350) course to the combined differential equations and linear algebra (EGN 248) offered by the department since spring 2012. In this course, students not only become familiar with linear algebra, but also they study differential equations during experiencing applied engineering problems.

Assessment: The exit interviews have shown that students feel more prepared to understand their engineering courses when they take the newly developed differential equations course that includes linear algebra. Also, they like to see more engineering applications in a math course like EGN 248.

Problem: Engineering capstone needed to be formally approved by the Core Curriculum Committee.

Action: The sequence of EGN 301 and EGN 402 was proposed as engineering capstone to the USM's Core Curriculum Committee and it was approved. This was an attempt to integrate the design experience into a broader context in which concerns such as environmental considerations and ethics came to the forefront of the practice of engineering, not as an add-on.

Problem: Mechanical Engineering students did not have a course that could present economic aspects of engineering. But many engineering activities require an understanding of financial, economic, ethical and accounting aspects of engineering projects.

Action: Developing and offering Engineering Economics (EGN304) since spring of 2012.

Assessment: Formal assessment of this change will be performed in the future.

E. Are there "community engagement" activities integrated in your departmental curriculum?

a. Please indicate which of the components, listed below, are included in your program's curriculum, and then indicate if the activities are required or optional for students in your major.

Community Engagement Activity	*Included*	*Required/Optional*	
Student Research (related to a community-based problem)	_O__	R	O
Student-Faculty Community Research Project	_O__	R	O
Internship, or a Field Experience	_O__	R	O
Independent Study (community-related project)	_O__	R	O
Capstone Course (community-related project)	_O__	R	O
Service-Learning (a component of a course)	___	R	O
Study Abroad, or an International Program	___	R	O
Interdisciplinary Collaborative Project (community related)	___	R	O
Student Leadership Activities (related to a team project)	_O__	R	O
Students/Faculty Community Leadership (advisory boards, committees, conference presentations)	_O__	R	O
Other Activities (not mentioned above):			
Conference presentations (Thinking Matters)	_R__		

b. Please list the courses (i.e. EDU 400) that have a "community engagement" activity in your program:

Entry-level courses:

Mid-level courses: EGN 301, EGN 304

Upper-level courses: EGN 402