2018 ASSESSEMENT REPORT FOR BACHELORS OF BIOSYSTEMS ENGINEERING DEGREE PROGRAM

The Department of Biosystems Engineering (BSEN) was formalized under the name Agricultural Engineering in 1919. The department was renamed Biosystems Engineering in 1998. It is an academic unit within and receives financial support from the College of Agriculture.

The department began offering undergraduate degree programs in Agricultural Engineering in 1938. The Agricultural Engineering degree program received ABET accreditation in 1954. In 1998, the undergraduate program name was changed to Biosystems Engineering. Biosystems Engineering students receive the Bachelor of Biosystems Engineering degree from the Samuel Ginn College of Engineering.

The Biosystems Engineering pathway emphasizes application of engineering to biological systems and natural resources, and is built on a strong foundation of biological sciences in addition to traditional chemistry and physics topics. The Ecological Engineering option (added in 2010) provides more emphasis on the use of engineering to preserve and enhance our environmental and natural resources. The Forest Engineering option (began in 2000) focuses on engineering problems in forest ecosystems and in the forest products industry. Forest Engineering students may also choose to pursue a minor in "Forest Resources", which is offered by the School of Forestry and Wildlife Sciences. The additional forestry courses for this minor allow the students to pursue professional forestry registration. In the Forest Engineering Option, students complete an additional summer forestry practicum between the sophomore and junior years. Also, they complete several additional junior and senior level courses in forest science.

Twelve of the 15 full-time BSEN faculty contribute to the undergraduate program. The remaining three faculty members do not have teaching appointments as follows: one faculty member is the College of Engineering Associate Dean for Research, the second faculty member has 100% extension appointment, and the third faculty member has 50% administrative appointment (as Director of the Auburn University Water Resources Center) and 50% research appointment. As of Fall 2017, there are 165 undergraduate students in the BSEN undergraduate program with an average of 33 students graduating every year over the past two years.

Student Learning Outcomes

1. Specificity of Outcomes

Below are the current set of student learning outcomes (SLOs) for the BSEN undergraduate program. The SLOS are the same as the learning outcomes defined by ABET – the accreditation body for engineering programs.

a. Apply knowledge of mathematics, science and engineering;
b. Design and conduct experiments, as well as to analyze and interpret data;
c. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability;
d. Function on multi-disciplinary teams;

e. Identify, formulate, and solve engineering problems;
f. Understand professional and ethical responsibility;
g. Communicate effectively;
h. Gain a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
i. Recognize the need for, and an ability to engage in life-long learning;
j. Gain knowledge of contemporary issues; and
k. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

BSEN uses the new 2019-2020 ABET SLOs to supplement and better define the above SLOs as follows:

- Outcome d: Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- Outcome f: Recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- Outcome g: Communicate effectively with a range of audiences including fellow students, other engineering disciplines, and professionals in the related fields of agriculture, environment and other life sciences, architecture, construction, law, healthcare, as well as the public.
- Outcome h, and j: Recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- Outcome i: Acquire and apply new knowledge as needed, using appropriate learning strategies.

2. Comprehensive Outcomes

The outcomes listed above are comprehensive i.e. they reflect the breadth, depth and scope of the knowledge, skills and attitudes that the students from the BSEN undergraduate program should have at the time of graduation. In addition, the outcomes are essentially the outcomes stipulated for ABET-accredited engineering programs.

3. Communicating Student Learning Outcomes

- The above list of student learning outcomes is made available to students, faculty and the general public on the departmental website at: http://eng.auburn.edu/bsen/academics/undergraduate/educational-objectives.html
- The student outcomes can also be found in the following rooms in Corley building classrooms 302 and 307, computer lab (Room 307), and student design studio room 305. The department of Biosystems engineering is housed in the Corley building.
- The student outcomes are also listed in the Undergraduate Student Handbook, which is given to every incoming BSEN freshman at Camp War Eagle, and is also available to all students via our website. Copies of the handbook are also kept in the commons areas of the Corley building.
- All ABET SLO's are discussed at the beginning of BSEN 2210, which is the first in-major class for all BSEN undergraduates.
- The student outcomes are discussed at several faculty meetings and during the departmental advisory council (DAC) meetings (at least twice within a six year period). During these meetings, the results of assessment of these learning outcomes are evaluated and discussed including if necessary improvements to the assessment methodology, course syllabi and curricula.

Curriculum Map

There are three pathways to the Bachelor of Biosystems Engineering degree namely - Biosystems Engineering pathway, Ecological Engineering Option, and Forest Engineering Option. Tables 1 to 3 provide a summary of how the established program outcomes are covered in the courses offered to students in the curriculum of each of the three BSEN degree pathways. The tables also show the level at which each SLO is emphasized (introduced, reinforced, or emphasized) in a course.

All three pathways begin with common coverage of mathematics, physics, chemistry and computing in the freshman year. Mathematics progresses from calculus through differential equations in the sophomore year. All students are required to complete a sequence of biology related courses that begin with the basic biology course. The Biosystems Engineering pathway and the Ecological Engineering option continue the biology sequence with organismal biology and microbiology courses. The Forest Engineering option pathway continues the biology sequence with courses in forest biology, forest management, dendrology, and silviculture. The Ecological Engineering option students also take an additional elective in ecology.

All students are required to take at least 7 credit hours of fundamental chemistry sequence (Chemistry I and Chemistry II). The students continue with the sequence by completing courses such as basic soil sciences, geotechnical engineering, waste management and utilization engineering, and/or introduction to environmental engineering. Therefore, each pathway provides the student with an experience in basic through advanced topics in biology and chemistry, with emphasis on applications in the final courses. These courses prepare BSEN students to be able to apply engineering to biological systems.

Two sophomore level courses (1 - engineering methods in biosystems, and 2 - biological and bioenvironmental heat and mass transfer in biosystems) are used to bridge the freshman experience and the junior and senior level work in the biosystems engineering program. These two sophomore courses also serve as the foundation of the spiral curricula concepts that are embedded in the biosystems engineering program. The engineering methods course is used to build a new culture of engineering professionalism for biosystems engineering students while building competence in problem identification, formulation, and solution, and other topics such as computer-aided design. The heat and mass transfer course (not taken by forest engineering option students) follow closely the thermodynamics course and reinforce the development of competence in thermal science topics.

The junior and senior years of the program contain course experiences that provide the majority of the preparation for further study and careers in biological engineering-related fields. In the junior year, all students take the hydraulic transport in biological systems course, and the natural resource conservation engineering course. The biosystems engineering pathway and ecological engineering option students also take a course in instrumentation and controls for biosystems. These three courses are part of the spiral curriculum model where topics covered in the sophomore-level courses in engineering methods, and heat and mass transfer are reinforced in the junior year. In the senior year, all students take the geospatial technology course thereby preparing the students with the skills that will enable them to use tools, sensors and controls to develop spatially-referenced information needed in design of biological systems. The spiral approach is also embedded in all of the senior year courses such that topics and exercises that involve the design of systems for biological products, and to protect natural resources and the environment are reinforced.

In addition to the above, the preparation of students in the Biosystems Engineering pathway also includes a course that covers the design of systems, processes or components that process food and other biological materials through thermal and mechanical means (process engineering in biosystems). This is followed by a course in the senior year on mechanical systems design. A parallel theme in the curriculum is the application of engineering to ecosystems and related water and soil resources through the natural resource conservation engineering, irrigation system design, and waste management and utilization engineering courses. The Biosystems Engineering pathway also includes two courses designated as biosystems engineering electives. These courses, which must be upper division engineering courses, can be selected by the students from a list of recommended courses developed by the biosystems engineering faculty or alternate courses may be selected after consultation with the BSEN undergraduate program coordinator.

The preparation of students in the Ecological Engineering option includes an introduction to environmental engineering course in the junior year. This is followed by senior-level courses that deal with design of systems that protect natural sources and the environment (site design for biosystems, ecological engineering, watershed modeling, and waste management and utilization engineering). The Ecological Engineering option also includes an ecological engineering elective and an ecology elective. Students select from a list of recommended courses (all are upper division courses) developed by the biosystems engineering faculty or alternate courses may be selected after consultation with the BSEN undergraduate program coordinator.

All students in the Forest Engineering option complete a series of forest courses and a series of engineering courses. Both sets of courses (forest biology, field mensuration, forest management, forest surveying, measurements 1, dendrology, geotechnical engineering, site design for biosystems, timber harvesting analysis methods, and silviculture) are selected to prepare students to be able to apply engineering to forest operations. The Forest Engineering option includes one forest engineering elective course. This course, which must be an upper division engineering course, is selected by the student from lists of recommended courses developed by the biosystems engineering faculty, or an alternate course may be selected after consultation with the BSEN undergraduate program coordinator.

Each of the courses with biosystems engineering or forest engineering prefixes provide numerous opportunities for students in the three pathways to gain experience and competence in the use of modern tools and techniques for engineering practice. Examples include the use of GPS equipment, data acquisition systems, hydrologic modeling software, and computer-aided design tools.

All three curriculum pathways culminate in the capstone design course, where students work in teams to complete a major design experience. Students in the three pathways work together in these teams and often work on design topics for which they may not have had prior experience. This major design experience provides the final opportunity for students to gain competence in being able to understand the role of engineering in society, communicate, provide leadership in multidisciplinary team environments, and to begin the process of developing professionally.

Through the various courses in the junior and senior years, the students are prepared to identify and solve engineering problems in the environment and natural resources (e.g. all students complete the natural resource conservation engineering and the geospatial technology for biosystems courses, and other natural resources engineering topics). Also, all students have been prepared to identify and solve engineering problems in various phases of the production, processing, storage, manufacture, utilization, and recycling of biological products, and to develop and implement sustainable, safe, and practical design solutions

through combination of courses in biological and bioenvironmental heat and mass transfer, hydraulic transport in biological systems, mechanical power, process engineering in biosystems, site design for biosystems, waste management and utilization engineering, irrigation systems, timber harvesting analysis methods, ecological engineering, and watershed modeling.

All the three pathways provide opportunities through the university's core curriculum, for students to gain a broader education necessary to understand the role of engineering in a global and societal context. This understanding is strengthened through courses/topics such as renewable energy, biomass and biofuels engineering, commercial poultry and livestock housing, hydraulic control systems design, sustainability and professional practice.

In summary, the three pathways for the Biosystems Engineering program are able to successfully address the program outcomes as discussed above. Overall, the Biosystems Engineering pathway devotes 57 hours of coursework to engineering topics. Out of these 57 hours, 43 hours are devoted specifically to Biosystems Engineering (or closely related) topics that help students achieve program outcomes. In the Ecological Engineering Option, 55 hours of coursework are devoted to engineering topics. Of these 55 hours, 42 hours are devoted specifically to Biosystems Engineering (or closely related topics) that helps students achieve program outcomes. With regards to the Forest Engineering Option, 51 hours are devoted to engineering topics of which 37 credit hours are Biosystems Engineering (or closely related topics). Again, these engineering courses are designed to help students achieve the program outcomes.

Table 1. Mapping of Program Outcomes with specific courses in the Biosystems Engineering pathway.

Course		Program Outcomes										
		a	b	c	d	e	f	g	h	i	j	k
Freshman Year												
COMP	1200	i	i									i
MATH	1610	i										
CHEM	1030	i	i									
Core History 1									i			
ENGL	1100							i				
ENGR	1100								i			
ENGR	1110				i	i	i	i	i	i		i
MATH	1620	i										
PHYS	1600	i	i									
ENGL	1120							i				
Core History 2									i			
Sophomore Year												
BSEN	2210	r		i	i	i		r			i	r
ENGR	2010	r										r
ENGR	2050	r										r
MATH	2630	r										
BIOL	1020	r							r			
BSEN	2240	r		r		r						r
ENGR	2070	r										r
ENGR	2350	r										r
MATH	2650	r										
BIOL	1030	r							r			
Junior Year												
CHEM	1040	r										
BSEN	3310	r	r	r	i	r		r				r
BIOL	3200	r							r			
CSES	2040	r					i		r		i	
BSEN	3230	e	r	r	i	r	i		r		i	e
BSEN	3240	e	r	r		r		r	e		r	e
BSEN	3610	e		e								
STAT	3010	r	r									r
Core Social Science									r			
Senior Year												
BSEN	3210		e			r					r	e
BSEN	5220		e		i	r		r				e
BSEN	4210	e	e	e		e			e		r	e
BSEN	4300				r	e	e	e	e	i	e	e
BSEN	Elect	r		r		r		r				e
Core Ethics							i		i			
BSEN	5230	e	e	e	e	e		e				
BSEN	4310			e	e	e	e	e	e	e	e	e
BSEN	Elect	e		e		e		e				e
Core Fine Arts									r			
Core Literature									r			

Learning Outcome Levels: i = introductory, r = reinforcement, e = emphasized

Table 2. Mapping of Program Outcomes with specific courses in the Biosystems Engineering – Ecological Engineering Option.

Course		Program Outcomes										
		a	b	c	d	e	f	g	h	i	j	k
Freshman Year												
COMP	1200	i	i									i
MATH	1610	i										
CHEM	1030	i	i									
Core History 1									i			
ENGL	1100							i				
ENGR	1100								i			
ENGR	1110				i	i	i	i	i	i		i
MATH	1620	i										
PHYS	1600	i	i									
ENGL	1120							i				
Core History 2									i			
Sophomore Year												
BSEN	2210	r		i	i	i		r			i	r
ENGR	2010	r										r
ENGR	2050	r										r
MATH	2630	r										
BIOL	1020	r							r			
BSEN	2240	r		r		r						r
ENGR	2070	r										r
MATH	2650	r										
BIOL	1030	r							r			
Core Fine Arts									r			
Junior Year												
CHEM	1040	r										
BSEN	3310	r	r	r	i	r		r				r
BIOL	3200	r							r			
CSES	2040	r					i		r		i	
BSEN	3230	e	r	r	i	r	i		r		i	e
BSEN	3610	e		e								
CIVL	3230	e		r		r			r		r	r
STAT	3010	r	r									r
Core Social Science									r			
Senior Year												
BSEN	5510	e		e		e		r				e
BSEN	5560		r	e	r	e			e		r	e
BSEN	5220		e		r	e		r				e
BSEN	4300				r	e	e	e	e	i	e	e
Ecol. Eng	Elect	r		r		r		r				r
Ecology	Elect	r							r		r	
BSEN	5230	e	e	e	e	e		e				
BSEN	4310			e	e	e	e	e	e	e	e	e
BSEN	5520	e				e					e	e
Core Literature									r			
Core Ethics							i		i			

Learning Outcome Levels: i = introductory, r = reinforcement, e = emphasized

Table 3. Mapping of Program Outcomes with specific courses in the Biosystems Engineering – Forest Engineering Option.

Course		Program Outcomes										
		a	b	c	d	e	f	g	h	i	j	k
Freshman Year												
COMP	1200	i										i
MATH	1610	i										
CHEM	1030	i	i									
Core History 1									i			
ENGL	1100							i				
ENGR	1100								i			
ENGR	1110				i	i	i	i	i	i		i
MATH	1620	i										
PHYS	1600	i	i									
ENGL	1120							i				
Core History 2									i			
Sophomore Year (inc. Summer Practicum)												
BSEN	2210	r		i	i	i		r			i	r
ENGR	2010	r										r
ENGR	2050	r										r
MATH	2630	r										
BIOL	1020	r							r			
MATH	2650	r										
ENGR	2350	r										r
STAT	3010	r	r									r
ENGR	2070	r										r
CHEM	1040	r										
FORY	3020	r							r			
FORY	3050	r	r		r				r			
FORY	3060	r			r		i	r	r		i	
FOEN	3040	r			r		i		r			r
Junior Year												
BSEN	3210		e			r					r	e
BSEN	3310	r	r	r	i	r		r				r
FORY	3180	r	r									
FORY	3100	r							r			
BSEN	3230	e	r	r	i	r	i		r		i	e
Core Fine Arts									r			
Core Social Science									r			
CIVL	3310	e		r		r			r		r	r
Senior Year												
BSEN	5220		e		r	e		r				e
BSEN	4300					e	e	e	e	e	e	e
BSEN	5560		r	e	r	e		e	r			e
FOEN	5710	e		e								
FORY	5230	e			e				e		e	
BSEN	4310			e	e	e	e	e	e	e	e	e
FOEN	Elect	r		r		r						r
BSEN	Elect	r		r		r		r				r
Core Ethics							i		i			
Core Literature									r			

Learning Outcome Levels: i = introductory, r = reinforcement, e = emphasized

Measurement

All assessment data efforts occur using a) capstone design course (BSEN 4310), b) hydraulic transport for biosystems course (BSEN 3310), c) fundamentals of engineering (FE) examination results, and d) Educational Benchmarking Inc. (EBI) survey data. BSEN 4310 is used because the student learning outcomes are focused on graduating seniors and therefore, we wanted to capture assessment data close to when student complete the program requirements. BSEN 3310 is being used because this is the first upper level course for all students in the three BSEN pathways. Rubrics used in grading in BSEN 3310 and 4310 are given in tables 5, 6, & 7 below. The rubrics were agreed upon by BSEN faculty for grading of lab reports, eportfolio and presentations by BSEN students.

The Fundamentals of Engineering (FE) examination is a nationwide exam taken by students who are close to finishing and recent graduates of undergraduate engineering programs to test their basic knowledge in mathematics, science and engineering. The test is also the first of two tests that an engineer must pass in order to be licensed as a Professional Engineer. Even though it is not compulsory, BSEN students are encouraged to take the FE exam before graduation. For the 2018-2019 academic year, BSEN will be implementing a new requirement that students in BSEN 4300 Professional Practice must take the FE exam. The FE examination data are used primarily to assess the achievements of Outcomes A and F.

Since 2000, graduating Biosystems Engineering students are required to complete a national survey administered through Educational Benchmarking Inc. (EBI). The EBI surveys document student response to questions on learning outcomes and other questions related to experiences as Auburn engineering student. For this report cycle, we do not have EBI survey data. *Due to a transition in leadership of the department, the EBI survey was not administered to the students in this reporting cycle. A summary of the data collection attributes is found below.

Table 4: Outcome-Measure Alignment: Measures used to assess the learning outcomes of BSEN students.

Measure	Outcomes assessed	Frequency	Type	Data Collection	Desired Results
FE Exam	A, F	Annually	Direct Measure	External exam	Percent passing equal or higher than national average
BSEN 3310	B	Every Fall	Direct Measure	Course Embedded	Average of 70 or higher on the rubric used for lab report grading
BSEN 4310	C, D, E, G, H, J, K	Every Spring	Direct Measure	Course Embedded	Average of 70 or higher from providing engineering solution to real-life design problem
BSEN 3310	I	Every fall	Direct Measure	Course Embedded	Average of 70 or higher on rubric used for eportfolio grading
EBI survey*	A-K	Annually	Indirect Measure	Survey	4 out of 7

Table 5: Rubric for Assessing Outcome G (communications)

Expectation	Exceeds	Meets	Partially meets	Unsatisfactory
Range	**>95%**	**80-94%**	**65-79%**	**<65%**
Speaking skills **(20 pts max)**	All of audience can hear presentation; maintains eye contact with audience, clear, expressive voice; poised, good posture, no distracting mannerisms **(19-20)**	Most of audience can hear presentation; eye contact most of the time; clear voice, but not as expressive; a little nervous, not as polished **(16-18)**	Difficult to hear; occasional eye contact; some mumbling, little or no expression; nervous, some distracting mannerisms; reads much of slides **(13-15)**	Audience cannot hear presentation; no eye contact; hard to understand, monotone; speaker uncomfortable and uninterested; reads slides word for word **(<13)**
Audience interaction **(20 pts max)**	Held audience's attention throughout; points made in creative way; listened carefully to audience questions and responded directly to question asked **(19-20)**	Held audience attention most of the time; polite in answering questions, but not as directly **(16-18)**	Difficult holding audience attention, facts presented with little or no imaginations; lengthy answers, sometimes without answering questions asked **(13-15)**	Completely lost audience attention, started responding before questions finished; answers often unrelated to the question asked **(<13)**
Visuals **(20 pts max)**	Visually pleasing and easy to read; good use of white space, color, backgrounds; images and graphics support and enhance content **(19-20)**	Adequate layout, but with some fonts, colors, backgrounds difficult to read **(16-18)**	Difficult to read, cluttered appearance, images improperly size; some distracting graphics or animations **(13-15)**	Confusing layout, text extremely difficult to read; many graphics, sounds, animations, distract from the presentation **(<13)**
Organization **(20 pts max)**	Presented in logical sequence; introduction and background give proper content; key points and conclusions are clear and well developed **(19-20)**	Most information presented in illogical sequence; clear introduction, adequate background; some relevant information **(16-18)**	Some problems with sequencing; lacks clear transitions; incomplete or overly detailed introduction; emphasis given to less important information **(13-15)**	Little or no organization, difficult to follow; missing or ineffective introduction; confusing or no background; key points unclear **(<13)**
Background information; project constraints; **(40 pts max)**	Thoroughly, but concisely describes background information; excellent understanding of design constraints **(38-40)**	Background information; project constraints sufficient but slightly flawed **(32-37)**	Little background information; flawed and incomplete understanding of project constraints **(26-31)**	Poorly stated or missing background information, and project constraints **(<26)**
Design objectives and design approach **(60 pts max)**	Well-defined objectives; well thought out design approach, excellent use of engineering principles to formulate problem **(57-60)**	Minor flaws in objective; correct engineering analysis but incomplete **(48-56)**	Poorly defined objectives; incoherent use and application of engineering principles **(39-47)**	Poorly stated or missing objective, serious deficiencies in use and application of engineering principles, **(<39)**
Methods/analysis **(40 pts max)**	Uses best-suited tools, analysis, approaches; describes analysis in detail; understands pros/cons of methods **(38-40)**	Uses a variety of appropriate techniques; describes methods and analysis; good understanding of methods **(32-37)**	Uses limited number of standard techniques; incomplete description of methods; basic understanding of methods **(26-31)**	Poor selection of techniques; no description; does not understand methods used **(<26)**
Conclusions and recommendations **(20 pts max)**	Insightful conclusions; recommendation reflects excellent understanding of project **(19-20)**	Conclusions and recommendations are relevant to the design project but may be slightly flawed **(16-18)**	Conclusions should be supported by stronger evidence from design project; minimum recommendation **(13-15)**	Conclusions are unsupported , no recommendations **(<13)**
Project management and team coordination **(20 pts max)**	Effective and efficient project planning/scheduling. Effective coordination amount team members **(19-20)**	Adequate project planning/scheduling; Adequate coordination among team members **(16-18)**	Some planning and coordination but not sufficient to achieve project goals **(13-15)**	Poor project planning. Team members are disorganized **(<13)**

Adapted from Chemical Engineering, University of North Dakota

Table 6: Rubric for Assessing Outcome B (lab & design reports)

	<64%	**65-79%**	**80-94%**	**>95%**
Criteria	Unsatisfactory (<64%)	Partially meets expectations (65-79%)	Meets expectations (80 – 94%)	Exceeds expectations (> 95%)
Engineering Design Solution	Engineering details of how solution was obtained lacking	Some engineering details, but may include extraneous or loosely related material	Provides adequate engineering details to support solution and argument	Provides ample engineering details to support a well-reasoned solution/argument
Data/design analysis and evaluation	Fails to draw conclusions, overlooks differences in results	Paraphrases data, identifies some differences, identifies some conclusions	Evaluates data, notices differences, seeks out information, formulates conclusions	Views information critically, synthesizes data, uses reasonable judgment, conclusions in line with data/design
Organization	Ad-hoc structure, little evidence of organization, little or no sense of wholeness and completeness	Attempt at organization, but little sense of wholeness and completeness	Organization pattern is logical and conveys completeness and wholeness with few lapses	Organization pattern is logical and conveys completeness and wholeness
Style	Limited or inappropriate vocabulary for the intended audience and purpose	Limited and predictable vocabulary, perhaps not appropriate for intended audience and purpose	Uses effective language and appropriate word choices for intended audience and purpose	Uses effective language, makes engaging, appropriate word choices for audience and purpose
Grammar	Does not follow rules of standard English	Generally does not follow the rules of standard English	Generally follows the rules for standard English	Consistently follows the rules for standard English
Figures and Tables	Figures and tables do not support the text, or are poorly designed	Figures and tables sometimes support the text, and sometimes well designed	Figures and tables generally support the text, and are usually well designed	Figures and tables always support the text, and are well designed
References and sources of information	References and other sources of information consistently not cited for material used in report	References and other sources of information not cited for some material used in the report, or inappropriate sources cited	References and other sources of information cited for material used in the report. Most of the sources are appropriate to support the discussion	References and other sources of information cited for material used in the report. All sources support the discussion

Source: Adapted from Auburn Office of University Writing handout

Table 7: Rubric used in BSEN 3310 for assessing outcome I (E-portfolio)

Criteria	Did not turn in an ePortfolio 0%	Unsatisfactory <65%	Acceptable 65-80%%	Effective 80-95%	Exceptional 95-100%
Response to ePortfolio Assignment **(75 points)**	Did not complete ePortfolio assignment.	Does not have any of the requirement components, failed to complete a significant part of the assignment	Has few of the required components and failed to complete a significant part of the assignment.	Has most of the required components; completed the assignment.	Has all of the required components, completed the assignment, added extra material.
Reflection **(40 points)**	Did not complete ePortfolio assignment.	Reflection missing including absence of growth and goals for continued learning.	Some the reflections describe growth and goals for continued learning.	Most of the reflections describe growth and include goals for continued learning.	All reflections clearly describe growth, accomplishments and include goals for continued learning (long and short term).
Artifacts **(30 points)**	Did not complete ePortfolio assignment.	The artifacts and work samples do not related to the purpose of ePortfolio.	Some of the artifacts and work samples are related to the purpose of ePortfolio.	Most artifacts and work samples are related to the purpose of ePortfolio.	All artifacts and work samples are clearly and directly related to the purpose of the ePortfolio. A wide variety of artifacts is included.
Layout and Readability **(20 points)**	Did not complete ePortfolio assignment.	ePortfolio is difficult to read due to inappropriate use of fonts, type size for headings, sub-headings and text, and/or inconsistent use of font styles (italic, bold, underline).	ePortfolio is mostly difficult to read due to inappropriate use of fonts, type size for headings, sub-headings and text, and/or inconsistent use of font styles (italic, bold, underline).	ePortfolio is generally easy to read.	ePortfolio is easy to read.
Grammar **(20 points)**	Did not complete ePortfolio assignment.	Several grammar, spelling and punctuation errors.	Some grammar, spelling and punctuation errors.	Very few grammar, spelling and punctuation errors.	Free of grammar, spelling and punctuation errors.
Navigation **(15 points)**	Did not complete ePortfolio assignment.	The navigation links are confusing, and it is difficult to locate artifacts and move to related pages or a different section. There are significant problem with pages connecting to preceding pages or the Table of Contents. Many of the external links do not connect to the appropriate website or file.	The navigation links are somewhat confusing, and it is often unclear how to locate an artifact or move to related pages or a different section. Some of the pages connect to the Table of Contents, but in other places, the links do not connect to preceding pages or to the Table of contents. Some of the external links do not connect to the appropriate website or file.	The navigation links generally function well, but it is not always clear how to locate an artifact or move to related pages or different section. Most of the pages connect to the Table of Contents. Most of the external links connect to the appropriate website or file.	The navigation links are intuitive. The various parts of the portfolio are labelled, clearly organized and allow the reader to easily locate an artifact and move to related pages at a different section. All pages connect to the Table of Contents, and all external links connect to the appropriate website or file.

Adapted from: http://ssc.prcc.edu/wp-content/uploads/2011/12/Sample-e-Portfolio-Rubric.pdf; https://www2.uwstout.edu/content/profdev/rubrics/eportfoliorubric.html

7. Data Collection

FE Exam Results are provided by NCEES testing twice a year (fall and spring). These results are aggregated by the institution, exam taken (examinees may choose among several discipline-specific exams) and also which major the examinee indicated. Our data reflects those students from Auburn who indicated the "Agricultural" major and took the "Other" and "Environmental" exams. Although not all BSEN students take the FE exam, this examination remains a useful source of assessment data, and those students that take the exam are representative of our typical student. As from Fall 2018, all senior students will be required to take the FE exam during senior year as part of the BSEN 4300 course..

Grades for e-Portfolio (Outcome I) and Outcome B are assessed and provided by the faculty member responsible for teaching BSEN 3310. All BSEN students regardless of curriculum option take BSEN 3310 during the spring.

Outcomes C, D, E, G, H, J, & K are assessed using specific grades in BSEN 4310 during the spring semester. All of these assignments are graded using rubrics or directly by the faculty member in charge of instruction for BSEN 4310.

The EBI survey (developed by EBI) is administered to senior students by the BSEN department head during class in BSEN 4310 early in the Spring semester. The completed survey is processed by EBI and the results sent back to the College of Engineering and the department.

Results

Table 8: Summary of assessment results and interpretation of the results

Outcome	Measure	Results	Desired Result	Interpretation & Action Plan
A,F	FE Exam Results	81% passing rate of graduating seniors	Equal or better than national passing (88% in 2017)	Pass rates are not the recommended metric to look at when utilizing FE exam data, however the small number of students we have taking the exam make it difficult to interpret exam scores. One historical trend for our students is that the 9 year pass rate is much higher (92%) for the "Other Disciplines" exam rather than the "Environmental" exam (67%). Some of the reasons for this are due to the subjects covered by each exam, others are more benign, such as the Other Disciplines exam generally having higher pass rates overall.
B	Grade in aspect of BSEN 3310 lab report rubric that deals with data analysis, interpretation and presentation from 5 lab reports	81.8% grade	Greater than 70%	Students met the requirement but instructor will continue to work with students further improve on their ability to analyze, interpret and present data.
C, D, E, G, H, J, K	Grade in selected assignment in capstone design project (see Table 9)	(see Table 9)	Greater than 70%	Students met the requirement but about 11% of the students received grades below 70% for outcomes d, e and g. Instructors will continue to monitor the grades for these outcomes. A new program for teaching students about contemporary issues and life long learning will be developed (see Purposeful Reflection & Action Plan)
I	ePortfolio grade in BSEN 3310	83% grade	Greater than 70%	Students met the requirement but about 8% of the students had grades lower than 70%. The instructor will begin to identify by mid-semester students that are struggling with creating ePortfolio and refer them to the AU ePortfolio Project office for further assistance. A new rubric for life-long learning will be developed.
A-K	EBI survey	n/a*	n/a*	The EBI survey was not administered for this reporting cycle due to the uncertainty during transition of department heads in BSEN. BSEN faculty will continue to monitor outcomes "g" and "i" as mentioned in last year's report.

*survey was not administered in 2017 because of the transition in leadership of BSEN department.

Table 9: Mean student grades for ABET outcomes in BSEN 4310 - capstone design course.

Outcome	Outcome and Work Description	Grade (%)	% below 70%
c	Design system, component, process (*Design journal and design data grade)*	93	0
d	Function on multidisciplinary teams (*Teamwork grade)*	86	13
e	Identify, formulate, and solve engineering problems (*Evaluation of final design)*	80	0
g	Communicate effectively (*Oral presentation grades &Written design project report grades)*	87	0
h	Understand engineering in global context. *Societal/global awareness grade*	88	0
j	Contemporary issues (*Information resources exercise)*	88	0
k	Techniques and tools for engineering practice (Project drawings*)*	87	0

Historical Trends:

Table 10 shows historical results from 2011-2017 for the learning outcome measurements. Cells highlighted in red represent values that were below the desired results in a course or below the national average for that year (FE and EBI). Only one (2011 SLO k) was equal to or below the desired goal of of 70% or higher but the results from this SLO has greatly improved over the past 6 years. Note also that the 2017 values for the EBI survey results are n/a as the survey was not given as mentioned before.

FE Pass rates have generally improved over the years. Scores on direct measures have remained consistent over time and remain above the goal of 70%. Improvements can be made for SLO "b" and "i". A strategy for improving SLO "i" is outlined in the Use of Results section.

Additional Observations:

Faculty administering the BSEN 4310 class have noted opportunities to better define assignments that will make assessment of the SLO's more clear. Examples will be to incorporate a team building exercise and module on leadership and teamwork into the course to improve performance in the teamwork grade. A teamwork rubric will also be developed to be used as a departmental standard.

In addition to developing a new rubric for life-long learning, faculty have noted the need to incorporate a new methodology for teaching students about learning strategies, global, social, economic, and ethical issues. See the "Use of Results" section for further detail. Previous results from the EBI survey indicated a need to improve life-long learning in the curriculum. All of these proposed improvements to assessing the SLOs related to BSEN 4310 were agreed upon during a half day retreat in May 2018 that included the two faculty members that are the current instructors of record for the capstone design sequence of course (BSEN 4300 and BSEN 4310), and two other faculty members that previously taught these two courses.

Based on EBI scores, BSEN faculty agreed that is a need to improve communication skills (outcome G) of BSEN students. More lectures hours were therefore devoted in BSEN 4310 (capstone design course) to oral presentation and to scientific report writing. Also more opportunities were provided for additional peer and instructor feedback on group presentations, and the amount of oral and team presentations were increased. This resulted in improvement in grades related to communication (82 to 87 with no individuals falling below 70%).

Table 10: Longitudinal Results for SLO Measurements

Measure	SLO	Outcome Description	2011	2012	2013	2014	2015	2016	2017	Avg
BSEN 3310	b	Design and conduct experiments, analyze data	86	80	81	76	77	80	82	**80**
	i	Recognize need for lifelong learning	-	-	-	79	84	82	83	**82**
BSEN 4310	c	Ability to design a system, component or process	85	81	84	84	77	83	93	**84**
	d	Ability to function on multidisciplinary teams	79	82	91	88	81	82	86	**84**
	e	Identify, formulate, and solve eng problems	81	87	83	86	83	84	80	**83**
	g	Communicate effectively	84	84	82	85	79	82	87	**83**
	h	understand impact…global, env., social context	84	90	85	88	84	83	88	**86**
	j	Understand contemporary issues	83	82	82	81	78	84	88	**83**
	k	Ability to use modern engineering tools	70	90	89	97	92	80	87	**86**
FE Pass rate	a, f	apply knowledge of math, sci, eng / prof. and ethic	64%	43%	100%	75%	63%	70%	81%	**71%**
EBI Survey	a	Apply knowledge of math	6.09	5.76	5.92	6.13	6.29	6.15	na	
	a	Apply knowledge of science	5.91	5.65	5.83	6.33	6.57	6.20	na	
	a	Apply knowledge of engineering	6.18	6.12	6.17	6.21	6.29	6.30	na	
	b	Ability to design experiments	5.64	6.00	5.42	5.71	5.86	5.70	na	
	b	Ability to conduct experiments	5.55	5.53	5.67	5.71	6.43	6.25	na	
	b	Ability to analyze data	5.91	5.82	6.08	6.14	6.29	6.40	na	
	b	Ability to interpret data	na	na	na	6.14	6.29	6.16	na	
	c	Ability to design a system, component or process	5.82	5.94	5.50	5.87	6.00	6.05	na	
	d	Ability to function on multidisciplinary teams	5.82	5.88	5.42	6.40	6.57	6.20	na	
	e	Ability to identify engineering problems	5.82	6.12	5.82	6.00	6.57	6.20	na	
	e	Ability to formulate engineering problems	5.55	5.88	5.75	5.90	6.43	5.75	na	
	e	Ability to solve engineering problems	5.91	5.88	6.17	5.93	6.43	6.20	na	
	f	Understand professional responsibility	5.91	6.24	6.17	6.29	6.29	6.50	na	
	f	Understand ethical responsibilities	5.55	6.00	5.92	6.23	6.14	6.50	na	
	g	Communicate effectively	6.00	6.35	6.58	6.29	6.29	6.05	na	
	g	Communicate (written progress reports)	5.82	6.29	6.33	na	na	na	na	
	h	Understand impact …….global context	5.64	5.35	5.75	5.93	6.14	6.00	na	
	h	Understand impact …….economic context	5.27	5.18	5.00	5.80	6.14	5.75	na	
	h	Understand impact ….environmental context	6.18	6.18	6.33	6.33	6.57	6.30	na	
	h	Understand impact ……societal context	na	na	na	5.93	6.29	5.95	na	
	i	Recognize need for lifelong learning	6.09	6.47	5.92	6.15	6.57	6.10	na	
	j	Understand contemporary issues	5.18	6.06	5.33	5.87	6.57	6.00	na	
	k	Ability to use modern engineering tools	5.64	5.82	5.17	5.71	6.43	5.90	na	

10. Communicating Results

At least, two of the monthly faculty meetings in an academic year include discussion of assessment data. Two faculty retreats are also held every year (one in spring, one in fall) during which assessment results are shared and discussed. During the retreats, a significant amount of time is devoted to assessment data and program improvement.

Assessment results are also made available on a shared drive for all faculty to access.

Many of the details regarding assessment and how to use the results for program improvement are discussed at the faculty meetings/ retreats. In addition to these, the department maintains a Curriculum and Assessment Committee, which is chaired by the Undergraduate Program Coordinator. This committee is composed of the department chair and four faculty members. The committee meets monthly all year round to discuss program improvements, and the assessment data is regularly used at these meetings.

Use of Results

11. Purposeful Reflection and Action Plan

The actions that will be taken for the outcomes that appear problematic are summarized in the Interpretation column of Table 8.

Assessment results have been used to guide faculty discussion about BSEN courses. The purpose of the discussion is to review the learning outcomes, subjects and skill taught, and alignment with educational objectives of all BSEN courses (85% of the courses have been reviewed in the last one year). The four questions listed below are used as starting point for discussion of each course. Notes from each faculty meeting are shared among all faculty, and faculty who need to do more detailed work on their course content meet later on an individual basis.

1) What are the topics/skillsets that you expect students to know in preparation for your course?
2) What are the topics/skillsets that you cover so that students are prepared for the next course?
3) Are the prereqs for your course adequate?
4) Do you have learning outcomes for the course? If yes, what are they?

So far this has resulted in a much better alignment of course content among faculty, helping to eliminate redundancy in topic coverage. We have also noticed many faculty are updating their syllabi and adding the official ABET learning outcomes covered for each course, as well as a “desired outcomes” of workplace competencies/ skills if not already present.

One of the feedback from last year’s assessment report was the need to better define lifelong learning (outcome i) and assess this learning outcome. Based on this feedback and starting Fall 2018, we will be modifying the approach we have used to expose BSEN students to lifelong learning. BSEN students will now be required to participate in on-campus (and if appropriate off-campus) activities (e.g. seminars, thesis/dissertation presentations, graduate students poster sessions, conferences York lecture series etc.) that cover issues of globalization, society, environment, ethics, professionalism, life-long learning but are related to the biosystems engineering profession. The students will be required to attend one of these

activities in fall of sophomore (BSEN 2210), fall of junior (BSEN 3310), spring of junior (BSEN 3230) and fall of senior (BSEN 4300). For each course, students will submit a one page summary write up that contains the following sections: Title of Presentation/Activity, Presenters, Date, Location, Importance or Focus of Activity paragraph and Reflection paragraph (that should contain relevance of activity to BSEN, surprise take away for the student, what the student learnt etc.). Table 11 summarizes the rubric that will be used to assess the lifelong learning SLO. Student will be required to upload these graded assignment on their ePortfolio sites (note that BSEN students are required to start building ePortfolio as from Fall of Sophomore) as additional evidence of their understanding of the need for lifelong learning.

Another benefit of this approach is that students have more exposure to and have better awareness of contemporary issues such as societal, cultural, ethical and global issues that many of the employers have BSEN graduates have communicated to the department that they place value on. Finally, this new approach is similar to how practicing engineers are required to develop Continuing Professional Development hours i.e. the new approach will have another benefit of preparing graduates for the methodology used by practicing engineers to ensure that they continue to be competent, and that their capabilities, skills and knowledge are current and in pace with current practices and standards in the engineering profession.

Table 11: Proposed rubric for outcome I, lifelong learning

	Exceptional (95-100%)	**Effective (80-95%)**	**Acceptable (65-80%)**	**Unsatisfactory (<65%)**
Visuals **(20 pts max)**	Visually pleasing and easy to read; good use of white space	Adequate layout, but with some fonts, colors, backgrounds difficult to read	Difficult to read, cluttered appearance	Confusing layout, text extremely difficult to read
Organization **(20 pts max)**	Presented in logical sequence; introduction and background give proper content; key points and conclusions are clear and well developed	Most information presented in illogical sequence; clear introduction, adequate background; some relevant information	Some problems with sequencing; lacks clear transitions; incomplete or overly detailed introduction; emphasis given to less important information	Little or no organization, difficult to follow; missing or ineffective introduction; confusing or no background; key points unclear
Grammar **(20 pts max)**	Consistently follows the rules for standard English, several grammar, free of grammar, spelling and punctuation errors	Generally follow the rules of standard English, some grammar, spelling very few punctuation errors	Generally does not follow the rules of standard English, some grammar, spelling and punctuation errors	Does not follow the rules of standard English, several grammar, spelling and punctuation errors
Reflection analysis **(40 pts max)**	The reflection is an in-depth analysis of the learning process, the value of the derived learning to self or others, enhances the student's appreciation of the topic/discipline, and articulates multiple connections between this learning experience, and other past learning experiences/future goals	The reflection is an analysis of the learning experience, the value of the derived learning to self or others, and the connections to other past learning experiences and/or future goals	The reflection attempts to analyze the learning experience and articulate connections to other learning experiences but the value of the learning to the student or others, and the connection is vague and/or unclear	The reflection does not move beyond or description of the learning experience, and does not articulate any connection to other learning or experiences