Program Review Self-Study Template

Academic unit: Bioengineering

College: Engineering - Interdisciplinary

Date of last review 2012 ________

Date of last accreditation report (if relevant) ____________

List all degrees described in this report (add lines as necessary)

Degree: BS Bioengineering ______________________________ CIP* code: 14.0501_______

Degree: ____ CIP code:_______________

Degree: ____ CIP code:_______________

*To look up, go to: Classification of Instructional Programs Website, http://nces.ed.gov/ipeds/cipcode/Default.aspx?y=55

Faculty of the academic unit (add lines as necessary)

Name	Signature
Michael Jorgensen	________
Anil Mahapatro	________
Nils Hakansson	________
Kim Cluff	________
Marlon Thomas	________
Gary Brooking	________
	________
	________
	________
	________
	________

Submitted by: Michael Jorgensen, Chair, Biomedical Engineering __ Date _______________
(name and title)

In yellow highlighted areas, data will be provided

1. Departmental purpose and relationship to the University mission (refer to instructions in the WSU Program Review document for more information on completing this section).

a. University Mission:

The mission of Wichita State University is to be an essential educational, cultural, and economic driver for Kansas and the greater public good.

b. Program Mission (if more than one program, list each mission):

The mission of the Bioengineering program is to provide students a comprehensive education, including integration of the life sciences and engineering principles, to prepare the students to address health needs at the local, national and global levels.

c. The role of the program (s) and relationship to the University mission: Explain in 1-2 concise paragraphs.

The role of the Bioengineering program is to provide a comprehensive and interdisciplinary education to prepare students to pursue careers to address societal health needs that are becoming increasingly complex in nature, which also require interdisciplinary solutions. The Bioengineering program prepares students, through its integration of science and engineering principles, to understand and contribute to scholarship, both in the classroom as well as participation in research opportunities. Additionally, the Bioengineering program involves and contributes to the larger community, by its vision to integrate healthcare entities within its curricular offerings and research endeavors of its faculty and students.

d. Has the mission of the Program (s) changed since last review? ☐ Yes ☒ No

i. If yes, describe in 1-2 concise paragraphs. If no, is there a need to change?

The mission of the Bioengineering program has not changed since the program was created in 2009. However, there may be a need to revisit the mission given the mission of Wichita State University changed in 2013. This will be a program faculty decision on whether or not to revisit the Bioengineering program mission.

e. Provide an overall description of your program (s) including a list of the measurable goals and objectives of the <u>program</u> (s) (programmatic). Have they changed since the last review?

☒ Yes ☐ No

If yes, describe the changes in a concise manner.

Bioengineers are employed in industry, hospitals, research facilities, and government regulatory agencies. To address an increasing need for expertise and a skilled and knowledgeable workforce in bioengineering, the Bioengineering program began in the Fall 2009 semester, and offers a B.S. Bioengineering bachelor’s degree. The Bioengineering program requires 133 credit hours consisting of 53 hours of math and science (chemistry, biology, physics), 50 hours of engineering courses, 27 hours of general education and basic skills courses, and 3 hours of open electives. The Bioengineering faculty direct four laboratories that are utilized for both teaching and research purposes, consisting of the Biomaterials Lab, the Musculoskeletal Biomechanics and Design Lab, the Bioinstrumentation and

Bioimaging Lab, and the Microfluidics and Biosensors Lab. Each of these labs is equipped with equipment for experiential learning activities in the Bioengineering courses as well as undergraduate students participating in research with Bioengineering faculty.

Due to the interdisciplinary structure of the Bioengineering curriculum, graduates will have the ability to solve problems and design solutions that link engineering with physical and biological sciences, and pursue professional opportunities related to this ability. Thus, the Bioengineering program has three program educational objectives. Bioengineering alumni, within a few years of receiving their baccalaureate degree, will be successful professionals as evidenced by having:

1. Addressed problems at the interface of engineering, biology, and medicine;
2. Pursued professional development, including further study in graduate or professional schools;
3. Served in leadership roles in addressing societal needs at the local, national, and global levels.

These program educational objectives were developed by the Bioengineering faculty and approved by the Bioengineering Industrial Advisory Board. The appropriateness of the program educational objectives have been assessed for each of the past two years by surveying juniors in the Bioengineering program, where all three program objectives have been perceived as appropriate. Future plans for assessing progress toward achieving the program educational objectives include surveying Bioengineering program alumni within a few years of their graduation, and continuing to survey juniors and seniors in the Bioengineering program on the appropriateness of the program educational objectives.

2. Describe the quality of the program as assessed by the strengths, productivity, and qualifications of the faculty in terms of SCH, majors, graduates, and scholarly/creative activity (refer to instructions in the WSU Program Review document for more information on completing this section).

Complete the table below and utilize data tables 1-7 provided by the Office of Planning Analysis (covering SCH by FY and fall census day, instructional faculty; instructional FTE employed; program majors; and degree production).

Scholarly Productivity	Number Journal Articles		Number Presentations		Number Conference Proceedings		Performances			Number of Exhibits		Creative Work		No. Books	No. Book Chaps.	No. Grants Awarded or Submitted	$ Grant Value
	Ref	Non-Ref	Ref	Non-Ref	Ref	Non-Ref	*	**	***	Juried	****	Juried	Non-Juried				
Year 1 2012	1		3	1	3											5/10	148,848
Year 2 2013	6		3	6	13										1	5/14	1,965,699
Year 3 2014	6		14	3	15										1	3/13	1,480,804

* Winning by competitive audition. **Professional attainment (e.g., commercial recording). ***Principal role in a performance. ****Commissioned or included in a collection.

- Provide a brief assessment of the quality of the faculty/staff using the data from the table above and tables 1-7 from the Office of Planning Analysis as well as any additional relevant data. Programs should comment on details in regard to productivity of the faculty (i.e., some departments may have a few faculty producing the majority of the scholarship), efforts to recruit/retain faculty, departmental succession plans, course evaluation data, etc.

Provide assessment here:
As shown in Figure 2.1 below, the Bioengineering program undergraduate enrollment has grown steadily. At the end of the previous reporting period (2011) there were 63 students enrolled in the Bioengineering program, whereas it has grown to 138 students by 2013. Additionally, the Bioengineering program has realized its first graduates, seven in 2013 and 15 in 2014.

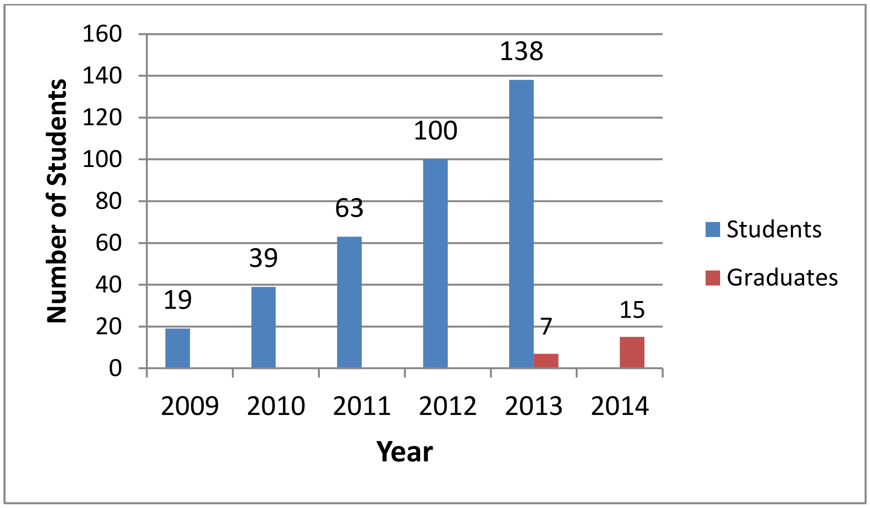

Figure 2.1 Number of Bioengineering students and graduates by year

The scholarly productivity data for Year 1 (2012) reflect the productivity of three faculty (Dr. Jorgensen, Coordinator of the Bioengineering program, Dr. Anil Mahapatro, and Dr. Nils Hakansson. Year 2 (2013) reflects the productivity of the above named faculty plus Dr. Kim Cluff (full year) and Dr. Marlon Thomas (August – December). The productivity reported in 2014 reflects Dr.'s Jorgensen, Mahapatro, Hakansson, Cluff and Thomas. From 2012 to 2014 the Bioengineering program faculty have shown steady productivity increases in scholarly research dissemination, and consistent productivity in submission of proposals for internal and external grant funding. Peer-reviewed journal article publications have increased from one in 2012 to six in 2014. Additionally, although not shown in the table above, at the end of 2014 the program faculty collectively had two peer-reviewed journal articles accepted but not yet published, and 11 in review. Conference publications have also shown a steady increase, from three in 2012 to 15 in 2014. Similarly, refereed and non-refereed presentations have increased, from four in 2012 to 17 in 2014. The number of grant proposals submitted has also increased from 10 in 2012 to 13 in 2014, with grant amounts for submissions increasing from $148,848 in 2012 to $1,480,804 in 2014. The Bioengineering program faculty place a priority on enhancing the research and dissemination activities with the undergraduate students in the program. Under their direction, bioengineering students have participated in 32 separate undergraduate research projects (5 in 2012, 8 in 2013 and 19 in 2014), which has resulted in 27 separate oral and poster presentations (2 in 2012, 8 in 2013 and 17 in 2014) of their research at various conferences and forums (locally, regionally and nationally).

Collectively, the faculty of the Bioengineering program demonstrated an acceptable level of scholarship productivity in terms of research dissemination through peer-reviewed journal articles and conference papers, grant proposal submissions, and directing undergraduate research projects and dissemination by students.

The Bioengineering program was significantly active in faculty recruitment during this review period (2012-2014), and has increased from two in the previous reporting period (2009-2011) to six by the end of this current reporting period (2014). Dr. Nils Hakansson (biomechanics and rehabilitation) joined the program in January 2012 as an Assistant Professor, Dr. Kim Cluff (bioinstrumentation and bio-imaging) joined the program in January 2013 as an Assistant Professor, and Dr. Marlon Thomas (microfluidics and biosensors) joined the program in August 2013 as an Assistant Professor. Finally, Dr. Gary Brooking joined the Bioengineering program in August 2014 as a non-tenure track Engineering Educator, with responsibility for developing and delivering courses related to bioengineering design and innovation.

The Bioengineering program retained all faculty who joined the Bioengineering program during this review period (2012-2014). The untenured faculty have participated in mentoring programs, and have attended faculty workshops for enhancement of teaching, as well as professional development seminars and workshops. A list of mentoring, faculty workshops and professional development activities engaged by the faculty of Bioengineering can be found in Appendix 1.

The Bioengineering program faculty have also shown a steady increase in the perceived course value for the specific Bioengineering courses they teach. The perceived course value is assessed by the Student Perception of Teaching Effectiveness (SPTE). The mean perceived course value, compared to all engineering courses were 25.4th percentile, 51.9th percentile and 65.8th percentile, for the years 2012, 2013, and 2014, respectively.

The Bioengineering program has shown steady growth in student enrollment since it started in 2009, with 138 students enrolled as of 2013, and realizing a total of 22 graduates from the program in 2013 and 2014. Collectively, during this current reporting period, the Bioengineering faculty has shown steady productivity increases in peer-reviewed journal article publications and submissions, conference papers and presentations, and course evaluations. The Bioengineering program has increased its faculty from two to six, retained all faculty who joined the program during this reporting period, and have been actively engaged in mentoring, faculty workshops and professional development activities. Finally, the faculty of the Bioengineering program have maintained a steady submission rate for internal and external grant funding.

3. **Academic Program: Analyze the quality of the program as assessed by its curriculum and impact on students for each program (if more than one). Attach updated program assessment plan (s) as an appendix (refer to instructions in the WSU Program Review document for more information).**

a. For undergraduate programs, compare ACT scores of the majors with the University as a whole. (Evaluate table 8 [ACT data] from the Office of Planning and Analysis). The mean composite ACT scores for WSU were 23.0 and 23.0 for 2012 and 2013, respectively. The mean composite ACT scores for Bioengineering students were 24.3 and 23.7 for 2012 and 2013, respectively. The 5-year average (2009-2013) composite ACT scores were 22.9 and 24.4 for WSU and Bioengineering program students, respectively. The Bioengineering student mean composite ACT scores were an average of 1.0 point higher than the University students as a whole for 2012 and 2013, whereas the 5-year average (2009-2013) mean composite ACT scores were 1.5 points higher than the University students as a whole.

b. For graduate programs, compare graduate GPAs of the majors with University graduate GPAs. (Evaluate table 9 [GPA data] from the Office of Planning and Analysis). N/A.

c. Identify the principal learning outcomes (i.e., what skills does your Program expect students to graduate with). Provide aggregate data on how students are meeting those outcomes in the table below. Data should relate to the goals and objectives of the program as listed in 1e. Provide an analysis and evaluation of the data by learner outcome with proposed actions based on the results.

In the following table provide program level information. You may add an appendix to provide more explanation/details. Definitions:
Learning Outcomes: Learning outcomes are statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program (e.g., graduates will demonstrate advanced writing ability).
Assessment Tool: One or more tools to identify, collect, and prepare data to evaluate the achievement of learning outcomes (e.g., a writing project evaluated by a rubric).
Criterion/Target: Percentage of program students expected to achieve the desired outcome for demonstrating program effectiveness (e.g., 90% of the students will demonstrate satisfactory performance on a writing project).
Result: Actual achievement on each learning outcome measurement (e.g., 95%).
Analysis: Determines the extent to which learning outcomes are being achieved and leads to decisions and actions to improve the program. The analysis and evaluation should align with specific learning outcome and consider whether the measurement and/or criteria/target remain a valid indicator of the learning outcome as well as whether the learning outcomes need to be revised.

Table 3.1 Learning Outcomes, Assessment, Target/Criteria, Results and Analysis (BIOE 452: Biomechanics; BIOE 462: Intro to Biofluids; BIOE 477: Intro to Biomaterials; BIOE 480: Bioinstrumentation; BIOE 482: Design of Biodevices; BIOE 585: Bioengineering Practicum; BIOE 595: Capstone Design).

Learning Outcomes (most programs will have multiple outcomes)	Assessment Tool (e.g., portfolios, rubrics, exams)	Target/Criteria (desired program level achievement)	Results	Analysis
1. Ability to apply knowledge of mathematics, science, and engineering	Courses: BIOE 452, 462 Assessment Tool: Questions on exams/quizzes	Mean of 70% across all students in courses assessed	2012: 74.3% 2013: 85.7% 2014: 82.1%	Learning outcome is being achieved, improved over time
2. Ability to design and conduct experiments, as well as to analyze and interpret data	Courses: BIOE 452, 477, 480, 595 Assessment Tool: Questions on exams/quizzes, criteria for term paper, lab report and poster	Mean of 70% across all students in courses assessed	2012: 88.6% 2013: 90.7% 2014: 89.7%	Learning outcome is being achieved
3. Ability to design a system, component or process to meet desired needs with realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	Courses: BIOE 482, 595 Assessment Tool: Questions on exams/quizzes, criteria for case study review	Mean of 70% across all students in courses assessed	2012: 90.0% 2013: 86.3% 2014: 91.8%	Learning outcome is being achieved

4. Ability to function on multidisciplinary teams	Courses: BIOE 585, 595 Assessment Tool: Peer evaluation metrics from CATME survey	Mean of 70% across all students in courses assessed	2012: N/A 2013: 90.3% 2014: 91.3%	Learning outcome is being achieved
5. Ability to identify, formulate and solve engineering problems	Courses: BIOE 462, 595 Assessment Tool: Questions on exams, design criteria rubric	Mean of 70% across all students in courses assessed	2012: 80.3% 2013: 90.9% 2014: 83.8%	Learning outcome is being achieved
6. Understanding of professional and ethical responsibility	Courses: : BIOE 477, 595 Assessment Tool: Questions on exams, report rubric	Mean of 70% across all students in courses assessed	2012: N/A 2013: 90.2% 2014: 94.5%	Learning outcome is being achieved
7. Ability to communicate effectively	Courses: BIOE 452, 482, 585, 595 Assessment Tool: Rubric for oral presentations, written reports	Mean of 70% across all students in courses assessed	2012: 89.7% 2013: 89.5% 2014: 88.8%	Learning outcome is being achieved
8. Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	Courses: BIOE 585, 595 Assessment Tool: Rubric for oral presentations, written reports	Mean of 70% across all students in courses assessed	2012: N/A 2013: 87.5% 2014: 82.5%	Learning outcome is being achieved
9. Recognition of the need for, and an ability to engage in life-long learning	Courses: BIOE 452, 480, 595 Assessment Tool: Questions on exams/quizzes, rubric for poster/presentation	Mean of 70% across all students in courses assessed	2012: 89.4% 2013: 88.7% 2014: 90.2%	Learning outcome is being achieved
10. Knowledge of contemporary issues	Courses: BIOE 585, 595 Assessment Tool: rubric for poster/presentation	Mean of 70% across all students in courses assessed	2012: N/A 2013: 95.1% 2014: 89.5%	Learning outcome is being achieved
11. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	Courses: BIOE 482, 585, 595 Assessment Tool: Questions on exams, rubric for paper/presentation	Mean of 70% across all students in courses assessed	2012: 88.7% 2013: 84.6% 2014: 90.2%	Learning outcome is being achieved
12. An understanding of biology and physiology	Courses: BIOE 462, 477, 480 Assessment Tool: Questions on exams	Mean of 70% across all students in courses assessed	2012: 87.6% 2013: 88.9% 2014: 90.9%	Learning outcome is being achieved
13. The capability to apply advanced mathematics to solve problems at the interface of engineering and biology	Courses: BIOE 452, 462, 480 Assessment Tool: Questions on exams	Mean of 70% across all students in courses assessed	2012: 79.0% 2013: 90.1% 2014: 86.1%	Learning outcome is being achieved, has improved over time
14. The ability to make measurements on and interpret data from living systems	Courses: BIOE 480 Assessment Tool: Questions on exams, rubric for term project, lab report	Mean of 70% across all students in courses assessed	2012: 92.9% 2013: 96.3% 2014: 94.9%	Learning outcome is being achieved

15. Address problems associated with the interaction between living and non-living materials and systems	Courses: BIOE 477, 482, 595 Assessment Tool: Questions on exams, rubric for project report	Mean of 70% across all students in courses assessed	2012: 82.3% 2013: 90.8% 2014: 92.3%	Learning outcome is being achieved, has improved over time

Results: The Bioengineering program assesses learning outcomes from the majority of its required courses in its curriculum. The Bioengineering program utilizes learning outcomes that are defined by ABET, the accrediting body for engineering programs. The faculty of the Bioengineering program have mapped specific learning outcomes from specific required BME courses to the ABET defined program outcomes, as shown in the Table 3.1 above. Not all learning outcomes are assessed in each required course, however, most of the learning outcomes are assessed in at least two of the courses. The Bioengineering faculty has also determined an acceptable threshold for each learning outcome is a mean attainment of 70% across all students for the metric being measured, across all courses assessed for each learning outcome. Metrics consist of specific exam/quiz questions, specific criteria from rubrics for oral presentations, lab reports or term projects, as well as specific criteria from the peer-evaluation for assessment of teamwork from CATME surveys. The overall collective results are shown in the table above, whereas the specific results for each learning outcome mapped to the specific courses they are assessed from 2012 to 2014 are shown in Appendix 2. As shown in the table above, the attainment threshold level of 70% is being met for all learning outcomes across 2012 to 2014. Many of the learning outcomes have shown consistent attainment levels, whereas two have shown increases from 2012 to 2014.

Analysis: Collectively, all learning outcomes are being met across the required courses in the Bioengineering curriculum. Given these are ABET defined learning outcomes, the learning outcomes in the table above will continue to be assessed. It is also envisioned that an additional required Bioengineering course, BIOE 335, Bioengineering Computer Applications, will be assessed for Learning Outcome #11 related to utilization of modern engineering tools.

d. Provide aggregate data on student majors satisfaction (e.g., exit surveys), capstone results, licensing or certification examination results (if applicable), employer surveys or other such data that indicate student satisfaction with the program and whether students are learning the curriculum (for learner outcomes, data should relate to the outcomes of the program as listed in 3c).

The Bioengineering program has surveyed the senior students in the BIOE 595 Capstone Design course in the Spring 2013 and Spring 2014 semesters (the first two years we had seniors and students graduate from the program). Perceived confidence in knowledge of various discipline areas, the perceived ability to perform satisfactorily, as well as perceived value of the required Bioengineering courses was surveyed. Additionally, students were requested to provide comments or improvement suggestions for the Bioengineering program. The Bioengineering faculty has determined a minimum threshold of 3.5 out of 5 as an acceptable level of attainment. In 2013, all 14 students in BME 595 completed the survey whereas 15 of 19 students completed the survey in 2014.

The specific categories of the student's perceived confidence in knowledge or understanding on the survey are shown below, with the results shown in Figure 3.1. The results indicated that the students perceived confidence in probability and statistics was slightly below the acceptable threshold. The Bioengineering program has now moved the required probability and statistics course from the Junior year to a Sophomore year placement in the curriculum, has made it a prerequisite to the Junior year Bioinstrumentation course (BIOE 480), and now requires students to utilize statistical procedures in at least two Bioengineering courses.

Survey: Confidence in knowledge or understanding (1 = no confidence to 5 = extremely confident):

- Basic sciences (e.g., physics, chemistry, biology)
- Mathematics (e.g., calculus, differential equations)
- Probability and Statistics
- Engineering sciences
- Engineering design principles
- Engineering professionalism and ethical standards
- Teamwork
- Socio-economic context in which engineering is practiced

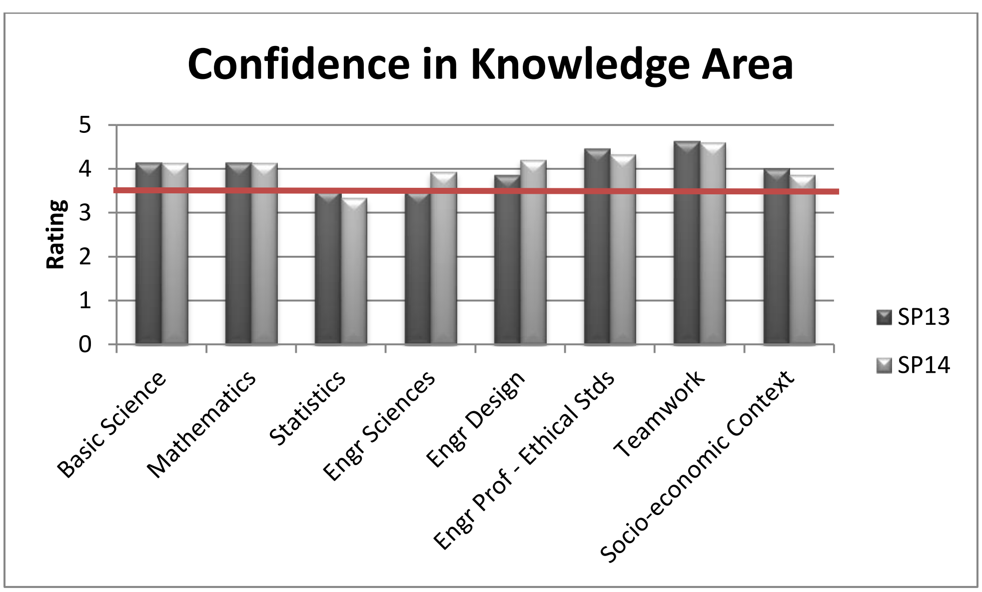

Figure 3.1 Senior exit survey results for 'Confidence in Knowledge Area' (1 = no confidence to 5 = extremely confident).

The specific categories of the student's perceived confidence in ability to perform satisfactorily on the survey are shown below, with the results shown in Figure 3.2. The Spring 2013 results indicated that the students perceived confidence in communicating with drawings and graphics was below the acceptable threshold. The Bioengineering program purchased site licenses for Solidworks (three-dimensional computer aided design software) and began teaching modules in required design courses, and also began teaching Solidworks in a new Bioengineering Computer Applications course (BIOE 497C, now BIOE 335). The Spring 2014 results showed the perceived confidence level for this category increased above the threshold.

Survey: Confidence in ability to perform satisfactorily (1 = no confidence to 5 = extremely confident):

- Integrate knowledge and information for engineering problem solving
- Communicate ideas and results verbally
- Communicate ideas and results in writing
- Communicate engineering ideas and results in drawings and graphic expressions
- Build teams and facilitate team processes/outcomes
- Locate needed knowledge and self-learn
- Work effectively in an international/global environment

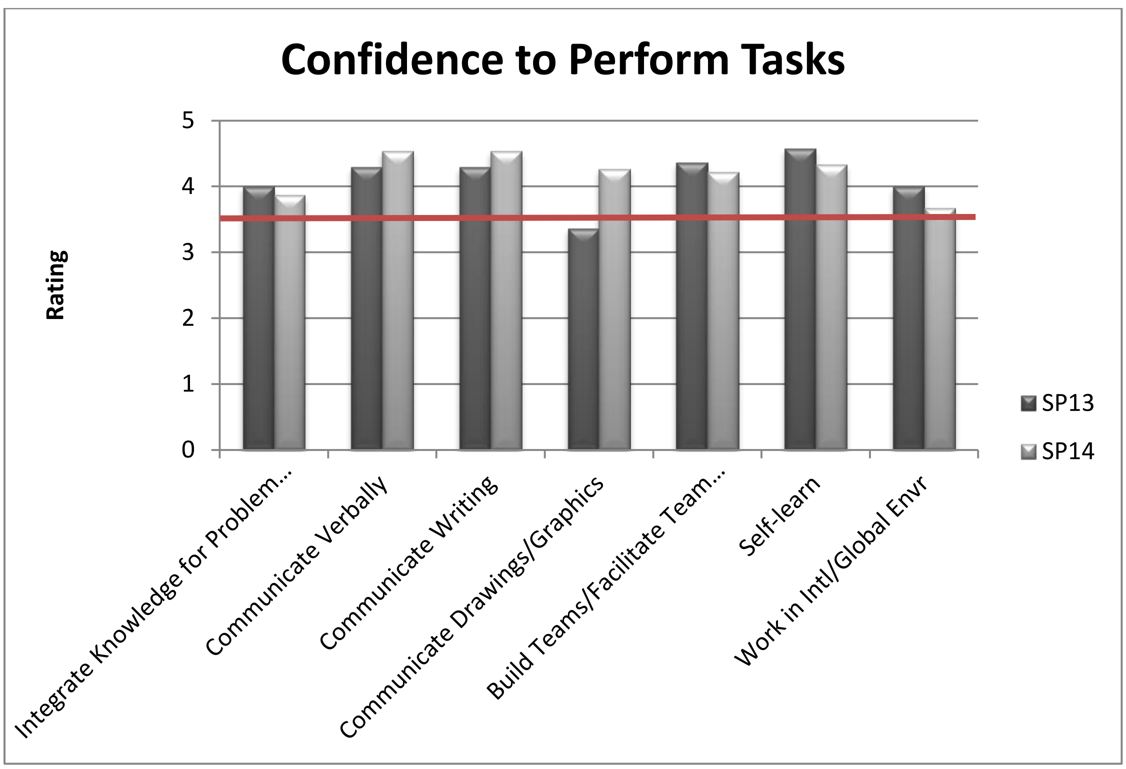

Figure 3.2 Senior exit survey results for 'Confidence to Perform Tasks (1 = no confidence to 5 = extremely confident).

The perceived value of required courses are also surveyed from the senior Bioengineering students. As shown in Figure 3.3, BIOE 462 (Intro to Biofluids) and BIOE 482 (Design of Biodevices) were below the acceptable threshold in the Spring 2013 assessment, but increased to acceptable levels by the Spring 2014 assessment. For BIOE 462, increased homework problems and practice problems prior to exams were given, new lectures were created to increase knowledge of the biological relevance of fluid dynamics in the body, and software was introduced to simulate and model blood flow in a human artery as well as create a 3D CAD drawing of a bifurcated human carotid artery. To address the below threshold perceived value of BIOE 482 (Design of Biodevices), case studies related to the design of biodevices were introduces, and lab modules utilizing design tools were introduced utilizing Solidworks and COMSOL software additional.

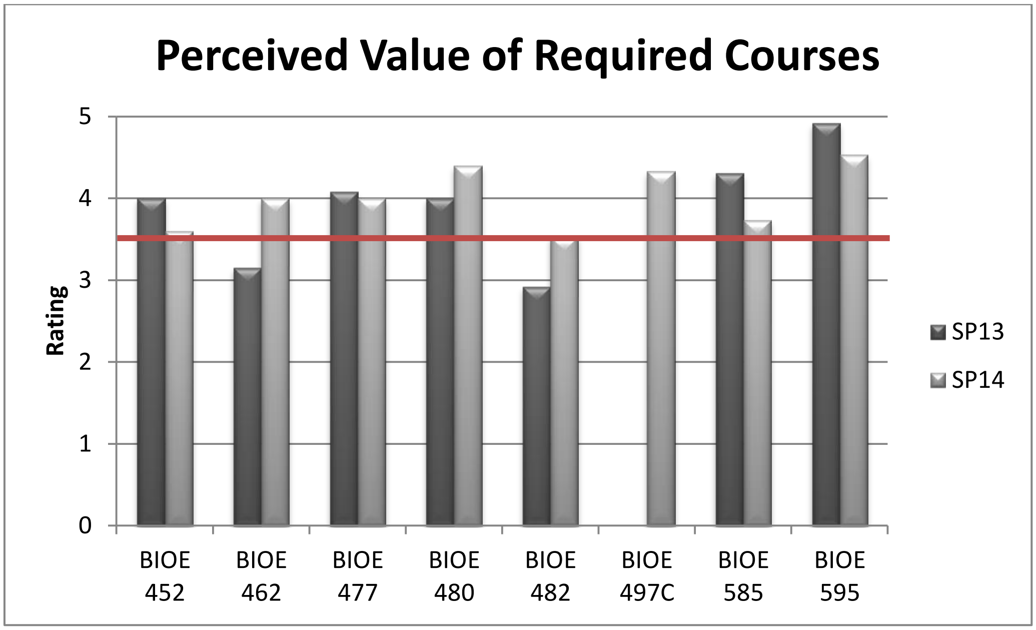

Figure 3.3 Senior exit survey results for ‘Perceived Value of Required Courses’ (1 = no value to 5 = very high value).

Table 3.2 below tabulates the results of ‘Satisfaction with Program’ from WSU senior exit surveys. For 2013 and 2014, the Bioengineering program students level of satisfaction were almost identical with the percent satisfied or very satisfied at the University undergraduate level as a whole, and consistently higher than the satisfaction level of the College of Engineering undergraduate students.

Table 3.2 Satisfaction of Program data from Table 10 from the Office of Planning and Analysis.

Student Level	2013	2014
University Undergraduate Level	82.9%	81.4%
College of Engineering Undergraduate Level	70.1%	75.0%
Bioengineering Program Level (percent satisfied or very satisfied)	83.3%	81.3%

e. Provide aggregate data on how the goals of the *WSU General Education Program* and *KBOR 2020 Foundation Skills* are assessed in undergraduate programs (optional for graduate programs).

Outcomes: ○ Have acquired knowledge in the arts, humanities, and natural and social sciences ○ Think critically and independently ○ Write and speak effectively ○ Employ analytical reasoning and problem solving techniques	Results	
	Majors	Non-Majors

Note: Not all programs evaluate every goal/skill. Programs may choose to use assessment rubrics for this purpose. Sample forms available at: http://www.aacu.org/value/rubrics/

f. For programs/departments with concurrent enrollment courses (per KBOR policy), provide the assessment of such courses over the last three years (disaggregated by each year) that assures grading standards (e.g., papers, portfolios, quizzes, labs, etc.) course management, instructional delivery, and content meet or exceed those in regular on-campus sections.
Provide information here: N/A

g. Indicate whether the program is accredited by a specialty accrediting body including the next review date and concerns from the last review.
Provide information here:

The Bioengineering undergraduate program received full accreditation by ABET after its 2013 accreditation visit. The next ABET accreditation visit is 2019.

h. Provide the process the department uses to assure assignment of credit hours (per WSU policy 2.18) to all courses has been reviewed over the last three years.
Provide information here:

All faculty utilize a standardized Wichita State University syllabus, and all syllabi contain the required language defining the definition of a credit hour appropriate the type of the course.

i. Provide a brief assessment of the overall quality of the academic program using the data from 3a – 3e and other information you may collect, including outstanding student work (e.g., outstanding scholarship, inductions into honor organizations, publications, special awards, academic scholarships, student recruitment and retention).
Provide assessment here:

The Bioengineering program has very capable and high quality students as demonstrated by the higher ACT composite scores compared to University students as a whole as well as other qualities and achievements. Bioengineering undergraduate students have been authors on conference papers/posters (3 in 2013, 22 in 2014), journal articles (1 in 2014, 1 in press, 3 in review), have performed undergraduate research projects (7 in 2012, 9 in 2013, 19 in 2014), presented their research in various forums (2 in 2012, 9 in 2013, 17 in 2014) and have won awards for their research (11 received 1st, 2nd or 3rd place for their presentations or posters at the various forums). Bioengineering students also consist of Wallace Scholars, Deans Scholars, the 2014 McGregor Scholar, several Honors College students, two Distinguished Scholarship Invitational finalists, one Gates Scholar, several K-INBRE scholarship awardees, and roughly 20% of Bioengineering students also identify themselves as Pre-med students. Assessment of learning outcomes has shown all have been met across 2012-2014, where surveys of students perceived capabilities and understanding resulted in changes to the curriculum with the addition of computer software design tools, additional experiential learning activities in the courses, and additional application of math and statistics in the courses.

j. Analyze the student need and employer demand for the program. Complete for each program if appropriate (refer to instructions in the WSU Program Review document for more information on completing this section).

a. Evaluate tables 11-15 from the Office of Planning Analysis for number of applicants, admits, and enrollments and percent URM students by student level and degrees conferred.

b. Utilize the table below to provide data that demonstrates student need and demand for the program.

Due to the small number of students who have graduated from this program we do not have a sufficient sample size to report this data.

Employment of Majors*							
	Average Salary	Employ-ment % In state	Employment % in the field	Employment: % related to the field	Employment: % outside the field	No. pursuing graduate or profes-sional educa-tion	Projected growth from BLS** Current year only.
Year 1							
Year 2							
Year 3							27% growth from 2012-2022

* May not be collected every year

** Go to the U.S. Bureau of Labor Statistics Website: http://www.bls.gov/oco/ and view job outlook data and salary information (if the Program has information available from professional associations or alumni surveys, enter that data)

a. Provide a brief assessment of student need and demand using the data from tables 11-15 from the Office of Planning and Analysis and from the table above. Include the most common types of positions, in terms of employment graduates can expect to find.

Provide assessment here:

As shown in Figure 4.1, the Bioengineering program has realized a steady increase in enrollment since the program began in 2009, and has also realized its first graduates during the current reporting period (seven in 2013 and 15 in 2014). Between 2012 and 2014 the program has seen a steady increase in applicants (41 to 65) and students admitted into the program (38 to 65), as well as those who matriculate into the program (22 to 41). In 2012 and 2013, underrepresented minorities represented approximately 15% of the Bioengineering student population, whereas underrepresented minorities made up 26.7% of the graduates in 2013 for the Bioengineering program. A collective assessment of this data suggest a healthy student demand for the Bioengineering program, with increasing demand through the years of existence. However, due to the small number of students who have graduated from this program we do not have a sufficient sample size to assess the employment demand.

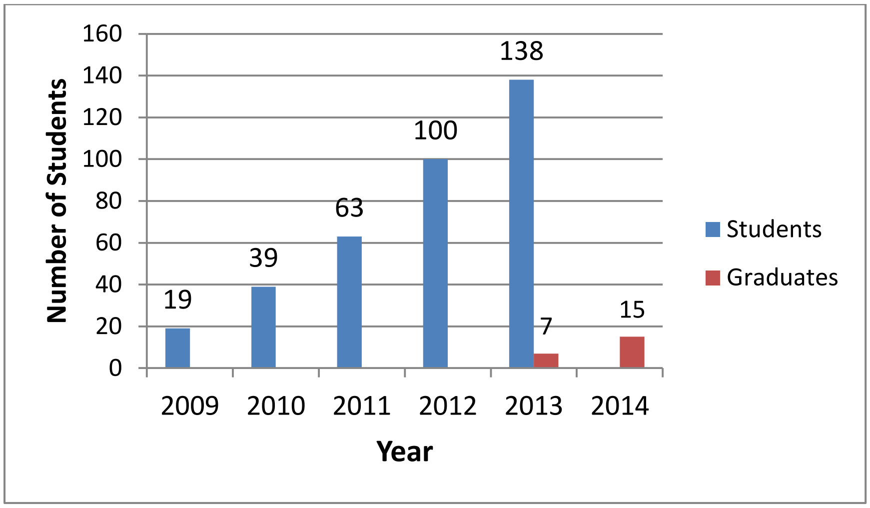

Figure 4.1 Total number of enrolled Bioengineering students and graduates by year

5. **Analyze the service the Program provides to the discipline, other programs at the University, and beyond. Complete for each program if appropriate (refer to instructions in the WSU Program Review document for more information on completing this section).**

Evaluate table 16 from the Office of Planning Analysis for SCH by student department affiliation on fall census day.

a. Provide a brief assessment of the service the Program provides. Comment on percentage of SCH taken by majors and non-majors, nature of Program in terms of the service it provides to other University programs, faculty service to the institution, and beyond.

Provide assessment here:

The percent of SCH taken by majors in the Bioengineering courses was 100% for 2012 and 2013. The faculty of the Bioengineering program provides service to the program, departments of the College of Engineering, the University, and outside the University. Dr. Jorgensen, who served as the Coordinator of the Bioengineering program, is also a tenured faculty in the IME Department in the College of Engineering teaches three IME courses and serves on various departmental committees. Within the Bioengineering program, Dr. Jorgensen directed the successful ABET accreditation process for the Bioengineering program, directs the faculty and staff recruitment and evaluation, advising of students, accreditation and assessment efforts for the program, and budgetary decisions and maintenance. Within the College of Engineering, Dr. Jorgensen sat on the College Assessment committee, the Strategic Planning committee, the Scholarship committee, the Curriculum committee, and has served on various search committees. At the University level, Dr. Jorgensen is the Chair of the Intercollegiate Athletic Advisory Board (ICAA), and has participated in the Coleman Foundation Fellowship Program with the

Center of Entrepreneurship. Outside the University, Dr. Jorgensen is on the Editorial Board of two peer-reviewed journals and consistently reviews manuscripts for many peer-reviewed journals.

Dr. Anil Mahapatro joined WSU in August 2011. Within the Bioengineering program, Dr. Mahapatro has served on faculty search committees, participated in ABET accreditation activities, has developed and improved several courses to support the program (i.e., Tissue Engineering, Design of Biodevices, Introduction to Biomaterials), and collaborates with faculty on research from several departments (e.g., Mechanical Engineering, Industrial Engineering, Biology, Chemistry, National Institute for Aviation Research). Outside the program, Dr. Mahapatro serves on the College of Engineering Strategic Planning committee. Outside the University, Dr. Mahapatro reviews manuscripts for several peer-reviewed journals, and has been appointed to the International Organization for Standardization and the American Society for Testing and Materials Working Groups for Absorbable Vascular Implants.

Dr. Nils Hakansson joined WSU in January 2012. Within the Bioengineering program, Dr. Hakansson has developed and improved several courses to support the program (e.g., Biomechanics, Clinical Biomechanics Instrumentation, Applied Human Biomechanics, Bioengineering Practicum, Capstone Design), has served on faculty search committees, participated in ABET accreditation activities, and collaborates with faculty on research from several departments (e.g., Mechanical Engineering, Electrical Engineering, Industrial Engineering, Exercise Science, Physical Therapy). Within the University, Dr. Hakansson serves on the ADA Review Committee for the Experiential Engineering building, and has guest lectured for Human Performance Studies and Physical Therapy courses. Outside the University, Dr. Hakansson has served on grant proposal review panels.

Dr. Kim Cluff joined WSU in January 2013. Within the Bioengineering program, Dr. Cluff has served on faculty and staff search committees, participated in ABET accreditation activities, has developed and improved several courses to support the program (i.e., Intro to Biofluids, Bioinstrumentation, Biomedical Imaging, Advanced Biocomputing), and collaborates with faculty on research from several departments (e.g., Mechanical Engineering, Biology, Exercise Science, Industrial Engineering). Outside the University, Dr. Cluff has served as a reviewer for a peer-reviewed journal and a judge for high school design projects.

Dr. Marlon Thomas joined WSU in August 2013. Within the Bioengineering program, Dr. Thomas has developed and improved several courses to support the program (e.g., Bioengineering Computer Applications, Biosensor Design, Biochemical Engineering), has served on faculty and staff search committees, participated in ABET accreditation activities, and collaborates with faculty on research from several departments (e.g., Biology, Chemistry), Within the University, Dr. Thomas serves on the College of Engineering's diversity committee and awards and scholarship committee.

Dr. Gary Brooking joined WSU in August 2014. Within the Bioengineering program Dr. Brooking has served on the ABET accreditation committee and has taught and enhanced the existing Bioengineering Practicum course (BIOE 585), and serves as the faculty advisor for student chapter of the Biomedical Engineering Society. Within the University, Dr. Brooking served as an observer for the Distinguished Scholarship Invitational.

Finally, consistent with the goals of WSU, the Bioengineering program offers a unique experiential learning opportunity to its undergraduate students. The faculty and students of the Bioengineering program are very active in undergraduate research activities. The faculty of the Bioengineering program has directed 36 individual undergraduate research projects between 2012 and 2014, which were funded from a variety of sources (e.g., start-up funds, internal and external research grants, McNair's scholarships) although some projects were unfunded but provided valuable experience to the students. Many of the undergraduate students have presented their research locally, regionally or nationally and have won awards for their research. The bioengineering faculty has also increased substantially the number of hands-on experiential learning activities in the specific Bioengineering coursework. These experiential learning activities have typically taken place in the various Bioengineering labs, but also occur in the classroom, may be research projects in the courses, presentations, and also include projects out in the community with community partners to address real community and unmet medical needs. To provide these experiential learning opportunities to the Bioengineering students, adequate resources are necessary to provide for equipment, supplies, graduate teaching assistants, travel, and the cost of time to perform these valuable activities for the students.

6. Report on the Program's goal (s) from the last review. List the goal (s), data that may have been collected to support the goal, and the outcome. Complete for each program if appropriate (refer to instructions in the WSU Program Review document for more information on completing this section).

(For Last 3 FYs)	Goal (s)	Assessment Data Analyzed	Outcome
	Recruitment and retention of Bioengineering faculty to bring the Bioengineering program to a level that allows coverage of required and elective courses in the Bioengineering program	Number of new faculty in the program vs. number of faculty that have left the program.	Increased the number of Bioengineering faculty from 2 to 6, with no turnover in faculty during this reporting period.
	Increase co-op and internship opportunities for Bioengineering students	Number of internships/co-ops documented in the Engineer of 2020 program	Have requested data, have not yet received the data.
	Increase undergraduate research opportunities through development of an undergraduate research program	Bioengineering program tracks each individual undergraduate research project directed by a faculty member	2009-2011: 3 2012-2014: 36
	Achieve ABET accreditation of the Bioengineering program	ABET report	Achieved full ABET accreditation in 2014
	Development of experience-based learning opportunities within the Bioengineering curriculum	Documented activities from Bioengineering faculty as part of ABET assessments	2009-2011: 10 2012: 5 2013: 29 2014: 61

7. Summary and Recommendations

a. Set forth a summary of the report including an overview evaluating the strengths and concerns. List recommendations for improvement of each Program (for departments with multiple programs) that have resulted from this report (relate recommendations back to information provided in any of the categories and to the goals and objectives of the program as listed in 1e). Identify three year goal (s) for the Program to be accomplished in time for the next review.

Provide assessment here:

The strengths of the Bioengineering program centers around the quality and diversity of its students, the increase in the number of experiential learning activities in the curriculum from the last reporting period, the involvement of students in research and dissemination of research, and the interdisciplinary activities of its faculty. First, this is still the only undergraduate Bioengineering program in the State of Kansas, which presents opportunities for growth and impact for WSU in this geographic region. Additionally, the Bioengineering program has now been transformed into the newest Department in the College of Engineering and also renamed Biomedical Engineering. The Bioengineering program has seen continued steady growth since the inception of the program (from 19 in 2009 to 138 in 2013), attracting students that have higher mean ACT scores than the overall University undergraduate student population, and possess ethnic as well as gender diversity (approximately 55% female). Several students in the program have been awarded scholarships that reflect academic achievement as well as leadership potential (e.g., Deans Scholars, Wallace Scholars, Gates Scholar, DSI Finalists, etc.). The caliber and quality of the students is also reflected in the proportion of students who are currently in the pre-med curriculum (~20%) and the numerous scholarly achievements of several students through participation in undergraduate research, research dissemination, and awards for recognition for their research. The Bioengineering faculty provide service to the program through their efforts in developing courses and assessing student learning outcomes, their efforts in preparing the program for accreditation, as well as their work and time committed to helping grow the program in terms of faculty and student recruitment and retention. Additionally, they are extremely active collectively with service to the College of Engineering, WSU, as well as the professional societies they belong to.

The concerns of the Bioengineering program include the lack of a graduate program, limited resources for the number of students who want to engage in undergraduate research, resource constraints for GTAs and additional equipment for experiential learning in the curriculum, and limited internship/co-op opportunities locally and regionally. These concerns may have an impact on the future success of the current Bioengineering faculty, recruitment of additional faculty to the program, and may impact student learning and development. Lab space, for both current and especially future Bioengineering faculty is also limited in quantity. This limitation may impact negatively on attracting future Bioengineering faculty to WSU and the program, and reduces the opportunities for experience-based learning and undergraduate research for Bioengineering students.

The three-year goals to be completed by the Bioengineering program by the next program review include 1) development of a graduate program; 2) increase co-op and internship placements for Bioengineering students; 3) increase undergraduate research for students in the growing Bioengineering program; 4) increase research dissemination of the program faculty; and 5) increase research expenditures.

Appendix 1. Bioengineering Faculty Mentoring, Workshops and Professional Development Activities

Dr. Michael Jorgensen, Associate Professor and Program Coordinator
Faculty Workshops: Learning Objectives (3/2012), BME Council of Chairs Industry/Academia Educational Workshop (10/2012)
Professional Development: Coleman Faculty Fellow in Entrepreneurship, College of Health Professions Leadership Academy, Capstone Design Conference (2012, 2014), Biomedical Engineering Council of Chairs bi-annual meetings

Dr. Anil Mahapatro, Assistant Professor (2011 to present):
Mentoring: WSU Pre-tenure club, CoE Faculty Mentoring Program
Faculty Workshops: Learning Objectives (3/2012), Flipped Approach to a Learner-Centered Class (2/2013), COMSOL Multiphysics workshop (3/2013), Introduction to Video Instruction (8/2013), Teaching about Plagiarism (10/2014)
Professional Development: Biomedical Engineering Entrepreneur Academy (7/2012), Kansas Regional Independent Inventors Conference (4/2013), ABET Fundamentals of Program Assessment (10/2013), NSF CAREER grant proposal writing workshop (10/2014)

Dr. Nils Hakansson, Assistant Professor (2012 to present):
Mentoring: WSU Pre-tenure club, CoE Faculty Mentoring Program
Faculty Workshops: Learning Objectives (3/2012)
Professional Development: Kansas Regional Independent Inventors Conference (4/2013), Writing Winning Grants Seminar (KUMC, 8/2013)

Dr. Kim Cluff, Assistant Professor (2013 to present):
Mentoring: WSU Pre-tenure club
Faculty Workshops: Web Development Tools workshop (8/2013)
Professional Development: Kansas Regional Independent Inventors Conference (4/2013), Writing Winning Grants Seminar (KUMC, 8/2013), COMSOL Multiphysics workshop (10/2013), Mouse Microsurgery and Echocardiography Workshop (3/2014), NIH Grant Writing Seminar (6/2014), COMSOL Multiphysics Workshop (7/2014), NSF CAREER grant proposal writing workshop (10/2014)

Dr. Marlon Thomas, Assistant Professor (2013 to present):
Faculty Workshops: participated in several faculty development workshops organized by the Office for Faculty…
Professional Development: National Effective Teaching Institute Conference (5/2014), NSF CAREER grant proposal writing workshop (10/2014)

Dr. Gary Brooking, Engineering Educator (2014 to present):
Mentoring: Dr. Jorgensen
Faculty Workshops: Office of Research and Technology Transfer Grant Budget workshop
Professional Development: Great Plains Capital Conference (9/2014), Center for Entrepreneurship Business Booster Seminars (attended 8 talks)

Appendix 2: Specific Learning Outcome and Results in each of the Bioengineering Courses, 2012 to 2014.

Learning Outcome	Bioengineering Courses*							
	BIOE 452	BIOE 462	BIOE 477	BIOE 480	BIOE 482	BIOE 585	BIOE 595	Overall
2. Ability to apply knowledge of mathematics, science, and engineering	72.5% 82.5% 82.5%	76.1% 88.9% 81.7%						74.3% 85.7% 82.1%
3. Ability to design and conduct experiments, as well as to analyze and interpret data	86.6% 94.9% 83.5%		N/A 84.4% 91.3%	90.6% 92.7% 94.4%			N/A 90.0% 90.7%	88.6% 90.7% 89.7%
4. Ability to design a system, component or process to meet desired needs with realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability					90.0% 85.0% 92.3%		N/A 87.5% 91.3%	90.0% 86.3% 91.8%
5. Ability to function on multidisciplinary teams						N/A 92.0% 88.4%	N/A 88.5% 94.2%	N/A 90.3% 91.3%
6. Ability to identify, formulate and solve engineering problems		80.3% 91.1% 79.3%					N/A 90.6% 88.3%	80.3% 90.9% 83.8%
7. Understanding of professional and ethical responsibility			89.2% 90.3% 97.7%				N/A 90.0% 91.3%	N/A 90.2% 94.5%
8. Ability to communicate effectively	87.0% 89.2% 81.5%				92.3% 95.5% 94.6%	N/A 85.7% 80.9%	N/A 87.5% 98.0%	89.7% 89.5% 88.8%
9. Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context						N/A 81.3% 70.0%	N/A 93.6% 94.9%	N/A 87.5% 82.5%
10. Recognition of the need for, and an ability to engage in life-long learning	88.7% 80.5% 86.5%			90.1% 94.0% 91.4%			N/A 91.6% 92.7%	89.4% 88.7% 90.2%
11. Knowledge of contemporary issues						N/A 96.9% 85.0%	N/A 93.3% 94.0%	N/A 95.1% 89.5%
12. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice					88.7% 82.4% 95.4%	N/A 80.0% 81.8%	N/A 91.3% 93.3%	88.7% 84.6% 90.2%
13. An understanding of biology and physiology		82.0% 94.5% 90.0%	88.0% 84.6% 93.2%	92.7% 87.7% 89.5%				87.6% 88.9% 90.9%
14. The capability to apply advanced mathematics to solve problems at the interface of engineering and biology	82.5% 94.3% 85.5%	65.1% 88.9% 85.0%		89.3% 87.0% 87.8%				79.0% 90.1% 86.1%
15. The ability to make measurements on and interpret data from living systems				92.9% 96.3% 94.9%				92.9% 96.3% 94.9%
16. Address problems associated with the interaction between living and non-living materials and systems			75.5% 94.6% 91.0%		90.0% 86.3% 92.0%		N/A 91.4% 94.0%	82.3% 90.8% 92.3%

*BIOE 452: Biomechanics; BIOE 462: Intro to Biofluids; BIOE 477: Intro to Biomaterials; BIOE 480: Bioinstrumentation; BIOE 482: Design of Biodevices; BIOE 585: Bioengineering Practicum; BIOE 595: Capstone Design.

Appendix 3. Rubrics for Learning Outcome Assessments.

BIOE 585 Bioengineering Practicum Final Project Presentation Rubric

Project Name ______________________________ Evaluator Name ______________________

Criterion				
Sponsor Description	Little described about sponsor and their services	Sponsor identified, services, mission, population minimally described	Sponsor identified, mission, services, population served, somewhat described	Clearly identified sponsor mission, services, population served, stakeholders
	0 1 2	3 4	5 6	7 8
Biodesign Process	Not identified, very little process discussed	Some steps in Biodeisgn process identified and discussed, but confusing	Some steps in Biodesign process identified, somewhat clear	Steps in Biodesign process clearly identified and discussed
	0 1 2	3 4	5 6	7 8
Clinical Observation Process	Minimal observation performed, minimal stakeholders involved	Some observation performed, limited to few stakeholders	Adequate observation performed, single or multiple sites, appropriate stakeholders involved	Significant observation performed, multiple sites, multiple and appropriate stakeholders
	0 1 2	3 4	5 6	7 8
Knowledge Acquisition	Minimal research performed, inadequate knowledge gained through research	Some research performed, but less than required for meaningful understanding of disease state, market, IP, etc.	Enough research performed to gain adequate knowledge of market, disease state, IP, etc.	Significant research performed, developed meaningful and relevant knowledge of disease state, market, IP, etc.
	0 1 2	3 4	5 6	7 8
Stakeholder Involvement	Minimal to no stakeholder involvement in Biodesign process	Few stakeholders involved in observation process, not involved in follow-up process	Multiple, appropriate stakeholders involved in observation process, little in follow-up process	Significant involvement of multiple stakeholders in Biodesign process, including observation and follow-up
	0 1 2	3 4	5 6	7 8
Needs Identification	No needs identified, very little described of the needs identification process	Some needs identified, needs identification process partially identified	Some needs identified, needs identification described	Multiple needs identified, including target populations
	0 1 2	3 4	5 6	7 8
Needs Statement Development	Developed, but not clear or concise, generally confusing	Developed, unclear of target population, outcome measures, solutions partially embedded	Developed, target population and outcome measures partially identified, no solutions embedded	Clear, concise, target population, outcome measure identified, no embedded solution
	0 1 2	3 4	5 6	7 8
Concept Generation Process	Described, but unclear and unorganized, one concept developed	Described, somewhat clear and organized, one concept developed	Described, somewhat clear and organized, need criteria and multiple concepts developed	Clearly described, need criteria identified, multiple concepts developed
	0 1 2	3 4	5 6	7 8
Oral Communication	Little in the oral presentation was clear, generally confusing	Some of the oral presentation was clear, but there were significant lapses	Most of the oral presentation was clear, added significant content	All of oral presentation was clear, added significant content
	0 1 2	3 4	5 6	7 8
Graphical Communication	Many slides, charts, graphs were not legible	Some slides, charts, graphics were clear, did not add significant content	All slides, charts and graphs were clear, did not add significant content	All slides, charts and graphs were clear, added significant content
	0 1 2	3 4	5 6	7 8

Appendix 3 (continued). Rubrics for Learning Outcome Assessments.

EVALUATION: Course Project ______ Writers: Group

Section Points		Criterion	0	0.25	0.5	0.75	1	Section Scores	Comment
			Poor				Excellent		
1		**Title Page**						1.00	
	1	Title, team member names, due date, breif summary of team members contributions					x	1.00	
17		**Introduction**						17.00	
	5	Successfully establishes the scientific concepts, provides background, and appropriate examples of the material					x	5.00	
	3	Effectively presents the hypothesis/objectvies					x	2.50	
	3	Effectively presents the rationale/purpose					x	2.50	
	7	Quality, readability, and flow					x	7.00	
17		**Methods**						17.00	
	8	Accurately, clearly and succinctly presents methods in paragraph form, and presents appropriate governing equations, physics, and figures					x	8.00	
	9	Quality, readablility, and flow					x	9.00	
15		**Results**						15.00	
	3	Opens with effective statement of overall findings					x	3.00	
	4	Presents visuals clearly and accurately					x	4.00	
	3	Presents findings as related to the hypothesis/objectives clearly and with sufficient support					x	3.00	
	5	Quality, successfully integrates verbal and visual representations					x	5.00	
19		**Discussion**						19.00	
	3	Opens with effective statement of support of the objectives/hypothesis					x	3.00	
	2	Backs up statement with reference to appropriate findings					x	2.00	
	3	Provides sufficient and logical explanation for statements					x	3.00	
	4	Sufficiently addresses other issues pertinent to the study					x	4.00	
	7	Quality, thoughtfulness, readability, and flow					x	7.00	
6		**Conclusion**						6.00	
	6	Convincingly describes what has been done and states perspectives and significance of overall findings					x	6.00	
16		**Presentation**						16.00	
	2	Citations and references adhere to proper format					x	2.00	
	3	Quality of citations used (i.e. from journal articles)					x	3.00	
	3	Format of tables, figures, equations, and report is correct					x	3.00	
	4	Report is written in scientific style: clear and to the point					x	4.00	
	4	Grammar and spelling are correct					x	4.00	
9		**Overall aims of the report:** *the student...*						9.00	
	3	Has successfully learned what the project is designed to teach					x	3.00	
	3	Demonstrates clear and thoughtful scientific inquiry					x	3.00	
	3	Accurately measures and analyzes data					x	3.00	
100							**Points Earned**	**100.00**	
							Total Possible Points	100	
							Percentage	**100%**	