SAINT LOUIS UNIVERSITY

Program-Level Assessment: Annual Report

Program Name (no acronyms): Biomedical Engineering	Department: Engineering
Degree or Certificate Level: B.S.	College/School: Parks College
Date (Month/Year): September 2021	Assessment Contact: Scott Sell
In what year was the data upon which this report is based collected? AY 2020 - 2021	
In what year was the program's assessment plan most recently reviewed/updated? 2021	

1. Student Learning Outcomes

Which of the program's student learning outcomes were assessed in this annual assessment cycle? (Please list the full, complete learning outcome statements and not just numbers, e.g., Outcomes 1 and 2.)

In this annual cycle we assessed all five of our stated HLC student learning outcomes. Because our ABET accreditation cycle requires outcomes to be assigned to courses, each year of a 3 year cycle (2 cycles per ABET review) we look at a different set of courses each year. This year the courses that were common to both the ABET and University assessment processes were BME 3100, BME 4400, BME 4410, BME 3840, BME 4130, BME 4200, and BME 4430

2. Assessment Methods: Artifacts of Student Learning

Which artifacts of student learning were used to determine if students achieved the outcome(s)? Please describe and identify the course(s) in which these artifacts were collected. Clarify if any such courses were offered a) online, b) at the Madrid campus, or c) at any other off-campus location.

BME artifacts include specific homework, quiz and exam questions, specific sections of reports from projects, oral presentations, poster presentations and prototypes of student's designs. We also have extensive student survey data, but survey data is not included in this report. For AY 2020 - 2021 we collected artifacts from the following courses: BME 3100, BME 4400, BME 4410, BME 3840, BME 4130, BME 4200, and BME 4430

None of the artifacts were collected from the Madrid campus, or other off-campus locations. Several courses were delivered in an online / hybrid format (BME 4400, BME 4430).

3. Assessment Methods: Evaluation Process

What process was used to evaluate the artifacts of student learning, and by whom? Please identify the tools(s) (e.g., a rubric) used in the process and **include them in/with this report document** (do not just refer to the assessment plan).

Faculty review the artifacts and assign scores, generally 0-100 and reflecting the degree to which each artifact corresponds to the desired response. Artifact scores are converted to the letters A, B and C according to our rubric, where an A corresponds to greater than 80% of the artifacts received a passing score (>70%), B corresponds to greater than 60% of the artifacts received a passing score, and C corresponds to less than 60% of the artifacts received a passing score.

4. Data/Results

What were the results of the assessment of the learning outcome(s)? Please be specific. Does achievement differ by teaching modality (e.g., online vs. face-to-face) or on-ground location (e.g., STL campus, Madrid campus, other off-campus site)?

SLO 1: Graduates will be able to apply knowledge of i) math, ii) science, iii) engineering and iv) empirical data to solve engineering problems. This outcome was assessed through artifact collection in three courses across junior, and senior level courses. In each of these courses the outcome was assessed to be at Level-A achievement (>80% of the artifacts received passing scores).

SLO 2: Graduates will be able to function on multi-disciplinary teams. This outcome was assessed through artifact collection in three courses representing junior and senior levels. In each of these courses the outcome was assessed to be at Level-A achievement (>80% of the artifacts received passing scores).

SLO 3: Graduates will demonstrate an understanding of professional and ethical responsibility. This outcome was assessed through artifact collection in three courses representing junior and senior levels. In each of these courses the outcome was assessed to be at Level-A achievement (>80% of the artifacts received passing scores).

SLO 4: Graduates will be able to communicate effectively. This outcome was assessed through artifact collection in three courses representing junior, and senior levels. In each of these courses the outcome was assessed to be at Level-A achievement (>80% of the artifacts received passing scores).

SLO 5: Graduates will be able to solve problems in biological systems using i) engineering skills and tools, and ii) empirical measurements and data from living and nonliving systems. This outcome was assessed through artifact collection in three courses representing junior, and senior levels. In each of these courses the outcome was assessed to be at Level-A achievement (>80% of the artifacts received passing scores).

5. Findings: Interpretations & Conclusions

What have you learned from these results? What does the data tell you?

Our data suggests that the students are achieving the desired level of performance with respect to each of our assessed outcomes.

6. Closing the Loop: Dissemination and Use of Current Assessment Findings

A. When and how did your program faculty share and discuss these results and findings from this cycle of assessment?

Our faculty keep a Google folder of all our assessments and artifacts. We have a program meeting each semester to view and discuss the assessments of our courses (exemplar artifacts viewed as needed). This allows all faculty to observe assessment techniques and opportunities while providing feedback and allowing for continuous improvement.

B. How specifically have you decided to use these findings to improve teaching and learning in your program? For example, perhaps you've initiated one or more of the following:

Changes to the Curriculum or Pedagogies

- Course content
- Teaching techniques
- Improvements in technology
- Prerequisites
- Course sequence
- New courses
- Deletion of courses
- Changes in frequency or scheduling of course offerings

Changes to the Assessment Plan	• Student learning outcomes • Artifacts of student learning • Evaluation process	• Evaluation tools (e.g., rubrics) • Data collection methods • Frequency of data collection

Please describe the actions you are taking as a result of these findings.

Based upon high student achievement of outcomes (with all being achieved at Level A) we are not planning for changes to curriculum. However we have generated draft versions of performance indicators and official scoring rubrics for each outcome and associated areas of focus. We have also voted to change outcomes in alignment with a change implemented by ABET, which will begin a new assessment cycle in Fall 2021.

If no changes are being made, please explain why.

N/A

7. Closing the Loop: Review of Previous Assessment Findings and Changes

A. What is at least one change your program has implemented in recent years as a result of assessment data?

In recent years we have eliminated the use of student self-evaluations and survey data from our assessments. We have also voted to generate draft performance indicators and scoring rubrics. These are currently in revision with a final program vote planned for late Fall 2021.

B. How has this change/have these changes been assessed?

The elimination of student self-evaluations has put the focus for assessment entirely on student generated artifacts and we plan to integrate our scoring rubrics to make that assessment of outcomes more uniform and less dependent upon individual grades.

C. What were the findings of the assessment?

In the past we had found that there was little value in the student evaluations of our outcomes, which was supported by ABET, and that it was much more meaningful to evaluate the student generated artifacts rather than have them comment on how well they felt outcomes were achieved. We also found that having uniform performance indicators and scoring rubrics allowed faculty to focus on outcome achievement and less on assignment grades.

D. How do you plan to (continue to) use this information moving forward?

We continue to focus on student generated content, but less so on grades. This will put more emphasis on the performance indicators and scoring rubrics rather than just assignment grades for determining outcome achievement.

IMPORTANT: Please submit any assessment tools (e.g., rubrics) with this report as separate attachments or copied and pasted into this Word document. Please do not just refer to the assessment plan; the report should serve as a stand-alone document.

BME Form 3.5 Faculty Course Evaluation

Course Number: **BME3100**
Course Title: **Signals and Systems**
Semester: **Fall 2020**
Instructor: **Dr. Hall**
Date : **08/01/2021** **Department Review Date:**________

Course Grade Distribution

Grade	F	D	C-	C	C+	B-	B	B+	A-	A
Number of Students	0	0	0	6	4	2	6	1	9	19

Assessment of Student Outcomes

For each student outcome indicate the *Phase-I* assessment methods (1-7) used or NA if the outcome is not reflected in this particular course. For each method listed please provide a more specific description of the assessment method, rank the achievement level, and provide quantitative evidence to support the achievement level.

(a): This course contributes to our students' ability to apply knowledge of mathematics, science, and engineering.

Methods: 1

- Homework, quizzes and exams - applying and solving mathematical expressions in engineering problems related to signals and signal processing in the time and frequency domains, in both continuous and discrete time, and including the Fourier transform, Laplace Transform and Z-transform.
  Assessment Outcome - Exam 2 – 43/47 >70%: Level A
  Assessment Outcome - Exam 3 – 43/47 >70%: Level A
  Assessment Outcome – Quiz 9 – 40/47 >70%: Level A

(c): This course contributes to our students' ability to identify, formulate, and solve engineering problems.

Methods: 1, 2

- Homework, quizzes, and exams – solving an array of engineering problems related to continuous time and discrete signal characterization and signal processing.
  Assessment Outcome - Exam 2 – 43/47 >70%: Level A
  Assessment Outcome - Exam 3 – 43/47 >70%: Level A

- Computer assignments and projects – completing Matlab based signal processing assignments, for example, frequency analysis of audio signals and digital signal filtering.
  Assessment Outcome – Matlab 3: Filter Implementation – 46/47 >70%: Level A

(k): This course contributes to our students' ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Methods: 1,2

- Homework, quizzes, and exams – solving an array of engineering problems related to continuous time and discrete signal characterization and signal processing.
  Assessment Outcome - Exam 2 – 43/47 >70%: Level A
  Assessment Outcome - Exam 3 – 43/47 >70%: Level A

- Computer assignments and projects – completing several MATLAB based signal processing assignments, for example, frequency analysis of audio signals and digital signal filtering.
  Assessment Outcome – Matlab 3: Filter Implementation – 46/47 >70%: Level A
  Assessment Outcome – Matlab 6: Audio FFT – 44/47 >70%: Level A

(l): This course contributes to our students' understanding of biology and physiology, and the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.
Methods: 2

- Computer assignments and projects – physiologic signals were processed.
  Assessment Outcome – Matlab 6: Audio FFT – 44/47 >70%: Level A

Faculty Self-Assessment:
Teaching this class remotely, with its heavy mathematics component, was much more of a challenge than the other courses I taught remotely this year. I held class in person three times per week, with a third of the students attending each class period (so each student was in class once per week). I was hoping that this in-person time would enhance the video lectures. While this was accomplished for some, for others it was a source of confusion and anxiety. The in-person class period was designed as an enrichment and help session, so each class session was a bit different, based on the questions asked. When students from different in-person sessions spoke, and realized different topics were covered, that was unsettling to some.

I will be teaching the course in person this fall. My goal for the coming semester is to add more physiologic signal processing and also to help students develop more intuition about the effect of filtering on a signal…to move students further up the pyramid of Bloom's Taxonomy.

BME Form 3.5 Faculty Course Evaluation

Course Number: **BME 4400**
Course Title: **Biomaterials**
Semester: **Fall 2020**
Instructor: **Silviya Zustiak**
Date : 1/19/21 **Department Review Date:** ________________

Course Grade Distribution

Grade	F	D	C-	C	C+	B-	B	B+	A-	A
Number of Students	0	0	1	1	1	2	7	9	16	10

Assessment of Student Outcomes

For each student outcome indicate the *Phase-I* assessment methods (1-7) used or NA if the outcome is not reflected in this particular course. For each method listed please provide a more specific description of the assessment method, rank the achievement level, and provide quantitative evidence to support the achievement level.

(b): **The course contributed to your ability to design and conduct experiments, as well as to analyze and interpret data.**
Methods: 1:

- Homework #1 – students were given a real data set and tasked with building a stress-strain curve and determining several materials properties: 94%; 47/47 > 70% (Level A)
- Exam #1 – students had to interpret data from recent relevant research papers: 83.4%; 43/47 >70% (Level A)
- Quizzes (average of 9 assignments + 2 practice ungraded assignments) – students were often given data from current literature and asked to explain why a certain phenomenon was observed: 81.3%; 44/47 >70% (Level A)

(e): **This course contributes to our students' ability to identify, formulate, and solve engineering problems.**
Methods: 1, 2, and 5

- Homework #2 – The students were tasked with solving problems related to polymers. They were given structures of polymers/materials un-known to them and asked to identify properties based on known common principles and concepts: 93.2%, 47/47 > 70%; (Level A)
- Group project on device development: 96.9%; 47/47 > 70% (Level A)

(i): **This course contributed to your recognition of the need for, and an ability to, engage in life-long learning**.
Methods: 4 and 5

- Group Project – The project included 3 phases where the students had to submit 3 written project reports (1 – Background; 2 – Proposed Design and Rationale;

and 3 – Cost and Targeted Market): 96.9%; 47/47 > 70% (Level A)

- Homework #3 – The students were supposed to work with their group and prepare a written 3-6 page report and a short presentation (3 min elevator pitch) to educate the class on a specific class of biomaterials not covered in lectures (e.g. pyrolytic carbon). The presentations were conducted as an in-class activity, where students were separated into groups of "presenters", "judges", "audience charged with asking questions". An "award of 5 bonus points" was given to the best presentations – 99.5%; 47/47 >70% (Level A)

(k): This course contributed to your ability to use techniques, skills, and modern engineering tools needed for engineering practices.

Methods: 1 and 2

- Exams, homework, and quizzes – the students were examined or quizzed on the material learned in class, which covered novel materials, current technology, and current challenges in the field.
    - Homework assignments (3 assignments): 95.6%; 47/47 > 70% (Level A)
    - Exams (3 assignments): 86.7%; 46/47 >70% (Level A)
    - Quizzes (9 graded assignments): 81.3%; 44/47 >70% (Level A)

(l): This course contributed to your understanding of biology and physiology, and the capability to apply advanced mathematics (includes differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.

Methods: 1 and 2

- Exams, homework, and quizzes – the students were examined or quizzed on the material learned in class, which routinely covered host-material interactions.
    - Homework assignments (3 assignments): 95.6%; 47/47 > 70% (Level A)
    - Exams (3 assignments): 86.7%; 46/47 >70% (Level A)
    - Quizzes (9 graded assignments): 81.3%; 44/47 >70% (Level A)
- Group Project: The students were supposed to design a biomedical device while focusing on the biomaterial aspect (e.g. islet encapsulation). They had to take specific host-material interaction into consideration in their design (e.g. Would you expect cell infiltration? What would the consequences be? Would you expect systemic toxicity and/or hypersensitivity and why or why not?)
    - The project included 3 phases where the students had to submit 3 written project reports (1 – Background; 2 – Proposed Design and Rationale; and 3 – Cost and Targeted Market): 96.9%; 47/47 > 70% (Level A)

(m): This course contributed to your ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems.

Methods: 1 and 2

- Exams, homework, and quizzes – the students were examined or quizzed on the material learned in class, which routinely covered host-material interactions.
    - Homework assignments (3 assignments): 95.6%; 47/47 > 70% (Level A)

- Exams (3 assignments): 86.7%; 46/47 >70% (Level A)
    - Quizzes (9 graded assignments): 81.3%; 44/47 >70% (Level A)
- Group Project: The students were supposed to design a biomedical device while focusing on the biomaterial aspect (e.g. islet encapsulation). They had to take specific host-material interaction into consideration in their design (e.g. Would you expect cell infiltration? What would the consequences be? Would you expect systemic toxicity and/or hypersensitivity and why or why not?)
    - The project included 3 phases where the students had to submit 3 written project reports (1 – Background; 2 – Proposed Design and Rationale; and 3 – Cost and Targeted Market): 96.9%; 47/47 > 70% (Level A)

Table F3.5-1: Summary of Student and Faculty Evaluation

Summarize the phase-1 measures and, based on that data, determine the overall level of achievement. Discuss the basis for that determination in the faculty assessment section below. Please also provide your overall class assessment and, if necessary, an action plan to address concerns.

	Student (N/A)				Faculty	
Outcome	**Average (1-5)**	**%A or SA**	**%NA**	**Level**	**Phase-1 Level**	**Overall Level**
b					**A**	**A**
e					**A**	**A**
i					**A**	**A**
k					**A**	**A**
l					**A**	**A**
m					**A**	**A**

Faculty Assessment:

The course objectives include:

- Outline mechanical, physical, biological, and biochemical material properties as well as techniques/instrumentation by which these properties are measured.
- List important and widely used naturally-derived and synthetic biomaterials, including ceramics, glasses, metals, polymers, and hydrogels, and give examples for their application.
- Give real life example of biomaterial usage.
- Outline methods of biomaterial degradation, such as hydrolytic or enzymatic, and describe the chemical or biological basis for the degradation as well as the underlying mechanisms.
- Describe key features of the extracellular matrix (ECM) and how biomaterials can be designed to mimic these features.

- Identify design criteria for biomaterials for a specific application.
- Identify design criteria to improve biocompatibility of biomaterials for specific applications.
- Explain potential problems associated with a specific biomaterial implantation.
- List main reasons for implant and biomaterial failure and devise possible solutions to address these problems.

The objectives of this course were met as 47 out of 47 students demonstrated good knowledge and showed much interest in the material. The students regularly participated in discussions via Zoom polling and chat features and whole class activities. I also implemented some group quizzes where two students had to discuss and agree on their answers. The students appreciated this format as it helped them think about the material and remember it better. Students were given additional practice quizzes and homework to practice applying concepts they learned in class, to solving biomaterial problems. Overall, the students complained that the quizzes were hard, that there was a large amount of reading, and that they wanted more practice material that would not be graded. I routinely self-evaluate and poll students to get timely feedback during the semester. As a response to students requests, I have scaled back on the reading materials since my first year teaching the class and have given then an additional ungraded homework prior to exam 3 and 1 un-graded quiz each prior to Exam 2 and 3. I also routinely polish both my quizzes and the lecture material to address concepts that students seem to struggle with. Students also appreciated the continuous feedback on their project and the multiple reports format. The students also liked learning about a new material on their own and were eager to share what they learned with their peers. Lastly, I encourage the students to attend 2 BME seminars a semester, for which I give them modest extra credit. The students appreciate hearing from experts in their field.

BME Form 3.5 Faculty Course Evaluation

Course Number: BME4410
Course Title: Tissue Engineering
Semester: Fall 2020
Instructor: Dr. Sell
Date: 06/29/21 Department Review Date: ____________

Course Grade Distribution

Grade	F	D	C-	C	C+	B-	B	B+	A-	A
Number of Students	0	0	0	0	0	0	0	1	5	34

Assessment of Student Outcomes

For each student outcome indicate the *Phase-I* assessment methods (1-7) used or NA if the outcome is not reflected in this particular course. For each method listed please provide a more specific description of the assessment method, rank the achievement level, and provide quantitative evidence to support the achievement level.

(b): This course contributes to our students' ability to design and conduct experiments, as well as to analyze and interpret data.
Methods: 3, 4, 5, 6, 7

The course is run as a semester long group project to simulate a tissue engineering startup company. One of the 3 major components of this project is to determine and develop a testing regime for a tissue engineered product. Students work as groups to review literature on a specific tissue and they formulate a testing regime for that tissue. They then present their testing regime to the class as an oral presentation and provide a written document to the instructor. The class provides critical reviews and discussion on the chosen testing methods.

Testing Regime Video Average: 94%; 40/40 > 70% (Level A)
Testing Regime Written Paper Average: 92%; 40/40 > 70% (Level A)

(e): This course contributes to our students' ability to identify, formulate, and solve engineering problems.
Methods: 1, 5, 6, 7

An example of this outcome being assessed is through an investigation into appropriate tissue engineering scaffold fabrication techniques. Student groups were presented with the problem of "How would you design a scaffold appropriate for your tissue?" Various engineering techniques were discussed in class lectures, which students were quizzed on. The students then had to think as a group in class, and perform a literature review, about which scaffold fabrication techniques would be appropriate for their specific tissues;

identifying what sort of properties would be important for their tissue (i.e. mechanical strength, degradation rate, porosity, viscoelasticity, etc.), formulating a plan for creating an ideal scaffold, and then providing a written report that included the rationale (using the key engineering parameters discussed in class) for two techniques that would be appropriate and two techniques that would not be appropriate for use. Similar approaches were utilized for the design of an appropriate bioreactor system.

Final Design Video Average: 95%; 40/40 > 70% (Level A)
Final Design Written Paper Average: 91%; 40/40 > 70% (Level A)

(i): This course contributes to our students' recognition of the need for, and an ability to engage in life-long learning.
Methods: 1, 6, 7

Throughout the semester the students and instructor engaged in 3 lectures that were entirely discussion based, and were intended to stimulate student curiosity about the course material. These included assigned readings, homeworks, and discussions based upon 3 unique case reports: "The state of the market"; "Ethics in TE: The HeLa Story"; and "Dermagraft: Why did a great product fail". These homework/reading/discussions all promote student engagement and curiosity by providing them modern examples of tissue engineering in the marketplace. The students can see clearly how the concepts taught in the class have translated to modern engineering use; furthermore, they can see how the missteps of others in the field have had massive implications. This piques interest in the field as a whole and promotes student learning and engagement.

Ethics HW Average: 98%; 21/25 > 70% (Level A)
Dermagraft HW Average: 99%; 40/40 > 70% (Level A)

(k): This course contributes to our students' ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
Methods: 3, 4, 5, 6, 7

Again, the semester long project design of this course provides students with ample opportunity to utilize their engineering skills. The final component of their semester long project involves the theoretical design of a novel tissue engineering product. Students do an extensive literature review, present an oral presentation to the class, and provide a written document to the instructor. This is then followed by class discussion and feedback in the form of a "Painstorming" session that encourages the students to look critically at all of the novel products presented and think of ways to improve upon those products. In their final presentation students must not only address their novel engineering design, but must also discuss how this design will be tested, how it will be manufactured, and how it will be implemented.

Final Design Video Average: 95%; 40/40 > 70% (Level A)
Final Design Written Paper Average: 91%; 40/40 > 70% (Level A)
Painstorming HW Average: 98%; 40/40 > 70% (Level A)

(l): This course contributes to our students' understanding of biology and physiology, and the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.
Methods: 1, 3, 4, 5, 6, 7

While much of the student work performed throughout the semester focuses on engineering and design, many of the lectures provided (especially during the first half of the semester) focus on the biology and physiology background needed to be a successful tissue engineering (i.e. cell biology, biochemistry, stem cell biology, extracellular matrix physiology, etc.). The students then pull these concepts together through their semester long project. They are required to determine the key components of their tissue's unique physiology that make it a challenge to engineer as they begin work on their novel product design.

Final Design Video Average: 95%; 40/40 > 70% (Level A)
Final Design Written Paper Average: 91%; 40/40 > 70% (Level A)
Quiz Average (9 Quizzes): 94%; 40/40 > 70% (Level A)

(m): This course contributes to our students' ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems.
Methods: 3, 4, 5, 6, 7

See description for (b) above. Students must perform a literature review to develop a testing regime for their native tissue. This is then expanded upon in the final component of the semester long project, where students must address implementation and success. They have to formulate a method for determining whether their novel product has been successful (i.e. appropriate testing outcomes from animal models, translational outcomes, etc.).

Testing Regime Video Average: 94%; 40/40 > 70% (Level A)
Testing Regime Written Paper Average: 92%; 40/40 > 70% (Level A)
Final Design Video Average: 95%; 40/40 > 70% (Level A)
Final Design Written Paper Average: 91%; 40/40 > 70% (Level A)

Table F3.5-1: Summary of Student and Faculty Evaluation
Summarize the phase-1 measures and, based on that data, determine the overall level of achievement. Discuss the basis for that determination in the faculty assessment section below. Please also provide your overall class assessment and, if necessary, an action plan to address concerns.

	Faculty	
Outcome	**Phase-1 Level**	**Overall Level**
b	**A**	**A**

e	**A**	**A**
i	**A**	**A**
k	**A**	**A**
l	**A**	**A**
m	**A**	**A**

Faculty Assessment:

The content and topic schedule for Tissue Engineering has undergone a continuous progression since I created this course in the Spring 2014. Having now taught this course for 6 consecutive years, I am extremely comfortable with the material and have found a style that the students seem to enjoy and learn from. Student assessments all came back extremely positive.

Changes: Due to the pandemic this course was delivered in a hybrid (virtual and face-to-face) format. To do this I utilized a flipped classroom format: all of my lectures were recorded ahead of time, which students watched outside of the classroom. Then they took a quiz online thorough Blackboard. In class time was dedicated to active learning activities, group discussions, and team design project work.

Exam Performance: Exams were eliminated from the course this semester and replaced with a series of weekly quizzes. Questions were taken from previous exams and presented in the form of 10 quizzes spread throughout the semester. The students preferred this method of assessment, as was indicated by their comments on the end of semester evaluation. They felt that there was less pressure to perform on the quizzes compared to exams (i.e. Mid-term and Final), and that they learned more by not having to ‘cram’ for an exam.

Presentation Performance: Presentations play a major role in my assessment of student performance. This semester, because of the hybrid nature of the course, presentations were not live but were done as pre-recorded videos. Students presented as teams at least 3 times throughout the course: 1) Determination of the market for their specific tissue; 2) Design of a testing regime appropriate for their tissue product; 3) Presentation of their novel product and a plan for implementing said product.

BME Form 3.5 Faculty Course Evaluation
Course Number: BME3840
Course Title: Junior Lab
Semester: Spring 2021
Instructor: Dr.Cooperstein
Date: 07/08/2021 Department Review Date: ______________

Course Grade Distribution

Grade	F	D	C-	C	C+	B-	B	B+	A-	A
Number of Students	0	0	0	1	0	0	4	2	6	35

Assessment of Program Outcomes

For each program outcome indicate the *Phase-I* assessment methods (1-7) used or NA if the outcome is not reflected in this particular course. For each method listed please provide a more specific description of the assessment method, rank the achievement level, and provide quantitative evidence to support the achievement level.

(a): This course contributes to our students' ability to apply knowledge of mathematics, science, and engineering.

Methods: (1, 3, 5, 7) Students had to use their knowledge of mathematics, science and engineering to complete pre-lab exercises, prepare themselves for and complete the laboratory experiments, as well as analyze and compile written reports.

- Pre-lab average: 88.7%; 48/48 >70% (Level A)
- Written reports average: 92.6%; 48/48 > 70% (Level A)

(b): This course contributes to our students' ability to design and conduct experiments, as well as to analyze and interpret data.

Methods: (2, 3, 5, 7) Students had to prepare themselves for the experiment by writing detailed experimental protocols for each experiment; they had to perform the experiments and troubleshoot any issues when necessary; as well as obtain data using the provided equipment/software, and analyze that data

- Pre-lab average: 88.7%; 48/48 >70% (Level A)
- Lab work: 100%, 48/48 >70% (Level A)
- Written reports average: 92.6%; 48/48 > 70% (Level A)

(e): This course contributes to our students' ability to identify, formulate, and solve engineering problems.

Methods: (2, 3, 5, 7) Students had to identify, formulate, and solve engineering problems in their pre-labs as well as while performing their experiments

- Pre-lab average: 88.7%; 48/48 >70% (Level A)
- Lab work: 100%, 48/48 >70% (Level A)

(l): **This course contributes to our students' understanding of biology and physiology, and the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.**
Methods: (1, 2, 3, 5, 7) Students were tasked with applying and solving equations relating to human systems; they had to learn about human anatomy and physiology and apply their knowledge during pre-lab exercises, while performing experiments and while writing written reports

- Volumetric Flow Rates pre-lab average: 88.6%; 47/48 >70% (Level A)
- Muscle and kinematics pre-lab average: 86.2%; 46/48 >70% (Level A)
- Written report 2 average: 92.7%; 48/48 >70% (Level A)

(m): **This course contributes to our students' ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems.**
Methods: (2, 3, 5, 7) Student performed 2 experiments that specifically required them to obtain data (ECG, heart sounds, blood pressure) from human subjects and analyze that data. They also had to identify any limitations of the devices used with respect to being able to obtain desired/accurate data.

- Muscle and kinematics pre-lab average: 86.2%; 46/48 >70% (Level A)
- EEG and EOG pre-lab average: 90.9%; 48/48 >70% (Level A)
- Written report 3 average: 92.8%; 48/48 >70% (Level A)

Table F3.5-1: Summary of Student and Faculty Evaluation
Summarize the phase-1 measures and, based on that data, determine the overall level of achievement. Discuss the basis for that determination in the faculty assessment section below. Please also provide your overall class assessment and, if necessary, an action plan to address concerns.

	Student (N/A)				Faculty	
Outcome	**Average (1-5)**	**%A or SA**	**%NA**	**Level**	**Phase-1 Level**	**Overall Level**
a					**A**	**A**
b					**A**	**A**
e					**A**	**A**
l					**A**	**A**
m					**A**	**A**

Faculty Assessment:

This course consists of several laboratory experiments for which students had to come prepared: they had to complete pre-lab exercises, compile detailed protocols, obtain data and process analyze it. The experiments required the students to apply knowledge obtained in other BME classes. The final product of these experiments were laboratory reports, on which the students had to work in groups. The students remained engaged in the course throughout the semester, worked hard on all the assignments, and, overall, performed very well. I continue working on each of the experiments presented to the students, to make sure that it is clear what the students are asked to do and how to achieve it (especially for materials that they might not have encountered before, like gait analysis for example).

BME Form 3.5 Faculty Course Evaluation

Course Number: **BME4130**
Course Title: **Medical Imaging**
Semester: **Spring 2021**
Instructor: **Dr. Hall**
Date : **08/03/2021** **Department Review Date:** ____________

Course Grade Distribution

Grade	F	D	C-	C	C+	B-	B	B+	A-	A
Number of Students	1	1	2	1	1	0	2	4	7	7

Assessment of Student Outcomes

For each student outcome indicate the *Phase-I* assessment methods (1-7) used or NA if the outcome is not reflected in this particular course. For each method listed please provide a more specific description of the assessment method, rank the achievement level, and provide quantitative evidence to support the achievement level.

(b): This course contributes to our students' ability to design and conduct experiments, as well as to analyze and interpret data.
Methods: 1, 2

- Homework and exams - This course introduced the physics, signals-and-systems, and image processing components of 4 widely used medical imaging technologies; X-ray and angiography, computed tomography, magnetic resonance, and ultrasound. Parts of the homework and exams involved the quantitative analysis of medical image systems and data.
  Assessment Outcome - Exam 1 – 23/26 >70%: Level A
  Assessment Outcome - Exam 3 – 22/26 >70%: Level A

- Computer assignments - MATLAB based assignments including determining the spatial resolution of a cell phone camera.
  Assessment Outcome – HW 1 - Spatial Resolution – 19/26>70%: Level B

(e): This course contributes to our students' ability to identify, formulate, and solve engineering problems.
Methods: 1, 2

- Homework assignments & exams – solving engineering problems related to the mathematics, physics and engineering of medical imaging systems.
  Assessment Outcome - Exam 1 – 23/26 >70%: Level A
  Assessment Outcome - Exam 3 – 22/26 >70%: Level A

- Computer assignments - MATLAB based assignments including determining the spatial resolution of a cell phone camera and the computing the radon transform.
  Assessment Outcome – HW 1 - Spatial Resolution – 19/26 >70%: Level B
  Assessment Outcome – HW 5 - Radon Transform – 23/25 >70%: Level A

(i): This course contributes to our students' recognition of the need for, and an ability to engage in life-long learning.
Methods: 2

- Computer assignments - MATLAB based assignments including determining the spatial resolution of a cell phone camera and medical image analysis.
  Assessment Outcome – HW 1 - Spatial Resolution – 19/26 >70%: Level B
  Assessment Outcome – HW 6 – Medical Image Analysis – 23/25 >70%: Level A

  The assessment outcomes listed here are good examples of the recognition for life-long learning. For the spatial resolution experiment, each student used their own cell phone, and therefore was required to figure out the process of the image extraction and processing on their own. For medical image analysis, they used a program (3D Slicer) that they had to download and install and figure out how to use with minimal training from the instructor.

(k): This course contributes to our students' ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
Methods: 2

- Computer assignments - MATLAB based assignments including medical image analysis and processing a simulated ultrasound signal return.
  Assessment Outcome – HW 6 – Medical Image Analysis – 23/25 >70%: Level A
  Assessment Outcome – HW 8 - Ultrasound Signal Proc. – 20/24 >70%: Level A

(l): This course contributes to our students' understanding of biology and physiology, and the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.
Methods: 1, 2

- Homework assignments & exams – solving engineering problems related to the mathematics, physics and engineering of medical imaging systems. A significant amount of the lecture material dealt with how imaging systems interact with tissues, including the x-ray linear attenuation coefficient, acoustic impedance and the principles nuclear magnetic resonance.
  Assessment Outcome - Exam 1 – 23/26 >70%: Level A
  Assessment Outcome - Exam 3 – 22/26 >70%: Level A

- Computer assignments and projects- MATLAB based assignments including computing the radon transform (used in CT imaging) and processing simulated ultrasound signal returns.
  Assessment Outcome – HW 5 - Radon Transform – 23/25 >70%: Level A
  Assessment Outcome – HW 8 - Ultrasound Signal Proc. – 20/24 >70%: Level A

(m): This course contributes to our students' ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems.
Methods: 1, 2

- Homework assignments & exams – solving engineering problems related to the mathematics, physics and engineering of medical imaging systems. Essentially the entire course focused on making measurements on living systems. We also examined image artifacts, for example produced by implants.
  Assessment Outcome - Exam 1 – 23/26 >70%: Level A
  Assessment Outcome - Exam 3 – 22/26 >70%: Level A

- Computer Assignments and Projects – students used a medical image visualization platform to make specific renderings and measurements on human cardiac and abdominal CT data. This included ability to use multi-planar image reformatting to locate specific views of the heart, and use of volume rendering techniques to image the abdominal vascular anatomy in a CT angiography image. These are standard tools used daily by radiologists.
  Assessment Outcome – HW 6 – Medical Image Analysis – 23/25 >70%: Level A

Faculty Assessment:
This is the sixth time I have taught the course, and it was taught virtually over Zoom. The lectures were given live over Zoom (rather than prerecorded) and the lecture was recorded. The slides used in the lecture were also posted for students. I believe this was a better format than I used for BME 3100 the prior fall (pre-recorded lectures with in-person help sessions). I did not make significant improvements to the course, as I was focused on making the on-line presentation as effective as possible. I did add several additional explanatory slides to make up for the lack of in-person instruction. My major disappointment was that we were unable to tour the hospital to see the imaging systems in person. We were, however, able to have all of our clinical guest lectures, given over Zoom by physicians at SLU Hospital. My goal for the coming year is to reintroduce group projects.

There was one cited assignment that achieved only a Level B outcome, determining the spatial resolution of the student's cell phone camera. This is the very first assignment in the class, and requires students to do more independent work than they might be used to. It is typically the lowest homework score. But the students quickly adjust.

BME Form 3.5 Faculty Course Evaluation

Course Number: **BME 4200**
Course Title: **Biomechanics**
Semester: **Spring 2021**
Instructor: **Dr. Cooperstein**
Date: 07/08/2021 **Department Review Date: ________**

Course Grade Distribution

Grade	F	D	C-	C	C+	B-	B	B+	A-	A
Number of Students	0	1	0	0	0	0	4	2	6	24

Assessment of Student Outcomes
For each student outcome indicate the *Phase-I* assessment methods (1-7) used or NA if the outcome is not reflected in this particular course. For each method listed please provide a more specific description of the assessment method, rank the achievement level, and provide quantitative evidence to support the achievement level.

(b): This course contributes to our students' ability to design and conduct experiments, as well as to analyze and interpret data.
Methods: (1, 4, 5, 7) Students had several homework, reading assignments, and in-class activities that required them to analyze and interpret biomechanical data (such as gait analysis, or reading and interpreting stress-strain diagrams). Their final project tasked them with researching a problem in biomechanics research (the effects of microgravity on astronauts muscular and skeletal systems), summarizing the current state of knowledge and proposing a study to analyze the effects of exercise on astronaut's condition.

- Group project 3 average: 98.7%; 37/37 > 70% (Level A)
- Individual project 4 average: 94.9%; 37/37 > 70% (Level A)
- In-class activities average: 97.6%, 35/37 > 70% (Level A)

(e): This course contributes to our students' ability to identify, formulate, and solve engineering problems.
Methods: (1, 4, 5, 7) Project 4 involved researching a problem in biomechanics research (the effects of microgravity on astronauts muscular and skeletal systems), summarizing the current state of knowledge and proposing a study to analyze the effects of exercise on astronaut's condition. Additionally, several homework assignments and in-class activities tasked the students with formulating and solving engineering problems.

- Individual project 4 average: 94.9%; 37/37 > 70% (Level A)
- Homework average: 84.9%, 34/37 > 70% (Level A)
- In-class activities average: 97.6%, 35/37 > 70% (Level A)

(i): **This course contributes to our students' recognition of the need for, and an ability to engage in life-long learning.**

Methods: (1, 2, 4, 5, 7) In this course students were able to use the knowledge from their other classes to solve problems, complete reading assignments, homework assignments, and projects. Through these assignments, they were introduced to new techniques and new knowledge. They had to use external resources to complete most of the assignments, and develop valuable skills, such as performing literature search or critiquing/analyzing research articles.

- Group project 1 average: 93.7%; 37/37 > 70% (Level A)
- Individual project 2 average: 96.8%; 37/37 >70% (Level A)
- Reading assignments average: 85.3%, 36/37 > 70% (Level A)

(k): **This course contributes to our students' ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.**

Methods: (1, 4, 5, 7) The students had to use different types of resources to complete this class. They obtained the required knowledge form textbooks, journal articles, videos; they gave oral presentations using software like PowerPoint or Prezi, working together and individually. They were tasked with solving problems that required computer software (such as Excel, Matlab, Wolfram Alpha etc).

- Group project 1 average: 93.7%; 37/37 > 70% (Level A)
- Individual project 2 average: 96.8%; 37/37 >70% (Level A)
- Homework average: 84.9%, 34/37 > 70% (Level A)

(l): **This course contributes to our students' understanding of biology and physiology, and the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.**

Methods: (1, 2, 4, 5, 7) Most of this course's in-class assignments and homework assignments required from the students to learn human biology and physiology, and apply this knowledge as well as their knowledge of advanced mathematics (such as integral calculus, differential equations) in solving problems involving biomechanics of human body.

- Homework average: 84.9%, 34/37 > 70% (Level A)
- In-class activities average: 97.6%, 35/37 > 70% (Level A)

(m): **This course contributes to our students' ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems.**

Methods: (1, 7) While the students didn't directly obtain laboratory data in this course, they analyzed real data provided to them in homework assignments, in-class assignments, as well as in Group Project 3, which involved finding a peer -reviewed research article in the assigned field of biomechanics, analyze and interpret the presented data, and determine the study strengths and weaknesses.

- Homework average: 84.9%, 34/37 > 70% (Level A)
- In-class activities average: 97.6%, 35/37 > 70% (Level A)
- Group project 3 average: 98.7%; 37/37 > 70% (Level A)

Table F3.5-1: Summary of Student and Faculty Evaluation

Summarize the phase-1 measures and, based on that data, determine the overall level of achievement. Discuss the basis for that determination in the faculty assessment section below. Please also provide your overall class assessment and, if necessary, an action plan to address concerns.

BME 4200	Student (N/A)				Faculty	
Outcome	**Average (1-5)**	**%A or SA**	**%NA**	**Level**	**Phase-1 Level**	**Overall Level**
b					**A**	**A**
e					**A**	**A**
i					**A**	**A**
k					**A**	**A**
l					**A**	**A**
m					**A**	**A**

Faculty Assessment: In this course students actively participate in in-class activities every class meeting. They are required to come prepared for each class, and they put a lot of effort in all of the assignments employed in this course (homework assignments, reading assignments, individual and group presentations, individual and group written reports etc.). I believe that the students achieved all six outcomes for this course at high level. I continue on introducing new material, focusing on the newest developments in the field of biomechanics and develop new activities that engage the students and expose them to the field.

BME Form 3.5 Faculty Course Evaluation

Course Number: BME4430
Course Title: Regenerative Engineering
Semester: Spring 2021
Instructor: Koyal Garg
Date : 06/15/2021 **Department Review Date:** ________________

Course Grade Distribution

Grade	F	D	C-	C	C+	B-	B	B+	A-	A
Number of Students								2	4	10

Assessment of Student Outcomes

For each student outcome indicate the *Phase-I* assessment methods (1-7) used or NA if the outcome is not reflected in this particular course. For each method listed please provide a more specific description of the assessment method, rank the achievement level, and provide quantitative evidence to support the achievement level.

(a) **This course contributes to our students' ability to apply knowledge of mathematics, science, and engineering.**

Methods: 1, 2, 5, 4, 6

This course discusses the development, applications, challenges, and techniques for improvement of stem cell therapies. We discuss the application of biomaterials, mechanical and electrical stimulation in conjunction with stem cell therapeutics.

- Homework 1 and 2 (Level A)
- Exams (Level A)
- Class Activities (Level A)
- Article Presentation (Level A)
- Final Project (Level A)

(b) **This course contributes to our students' ability to design and conduct experiments, as well as to analyze and interpret data.**

Methods: 3, 6

Students design a stem-cell based therapy to help cure or treat a specific medical condition. They are expected to submit an experimental plan and define expected outcomes as well the clinical challenges and risks associated with their therapy. Students also present a peer-reviewed journal article relevant to the material covered in class. Students are expected to present the data in the article, independently verify the analysis and interpretation included in the article, highlight any discrepancies, and provide a critique of the article. Students design microenvironments for stem cell expansion, differentiation, and engraftment post transplantation as part of their class activities.

- Class Activities (Level A)

- Final Project (Level A)
- Article Presentation (Level A)

(c) **This course contributes to our students' ability to design a system, component, or process to meet desired needs.**

Methods: 1**,** 3, 5

Students design microenvironments for stem cell expansion, differentiation, and engraftment post transplantation as part of their class activities. Students design a stem-cell based therapy to help cure or treat a specific medical condition. They are expected to submit an experimental plan and define expected outcomes as well the clinical challenges and risks associated with their therapy.

- Homework (Level A)
- Class Activities (Level A)
- Final Project (Level A)

(d) **This course contributes to our students' ability to function on multi-disciplinary teams.**

Methods: 3, 5, 7

In this course, students are expected to work in groups for the class activities, final project, and also for journal article presentations. An oral PowerPoint presentation is assessed for the journal article presentation and a written report is assessed for the class activity and the final project.

- Class Activities (Level A)
- Final Project (Level A)
- Article Presentation (Level A)

(e) **This course contributes to our students' ability to identify, formulate, and solve engineering problems.**

Methods: 1, 3

Students work individually and also in groups to identify challenges associated with large scale expansion of stem cells, to identify areas of improvement in existing cell-based therapeutics used clinically and discussing the application of bioengineering tools to improve upon them.

- Homework (Level A)
- Class Activities (Level A)
- Final Project (Level A)

(f) **This course contributes to our students' understanding of professional and ethical responsibility.**

Methods: 3, 6

We discuss ethical controversy associated with embryonic stem cells. Students are asked to discuss regulatory aspects associated with stem cell and biomaterial based therapies. Students are encouraged to identify clinical challenges and risks associated with stem cell therapies. Through journal article presentations, students are exposed to proper conduct of research and detailed reporting of results. Students are encouraged to highlight any discrepancies and provide a critique of the article.

- Final Project (Level A)
- Class Activities (Level A)
- Article Presentation (Level A)

(g) **This course contributes to our students' ability to communicate effectively.**

Methods: 4, 5

An oral PowerPoint presentation is assessed for the journal article presentation and a written report is assessed for the class activity and the final project. A Q&A session and class discussion after the journal article presentation provides a chance to communicate thoughts and ideas clearly.

- Article Presentation (Level A)
- Final Project (Level A)

(h) **This course contributes to the broad education necessary for students to understand the impact of engineering solutions in a global and societal context.**

Methods: 1**,** 4, 3

This course allows students to discover the significance of high-impact journal articles on the field of science, medicine, and health care. Students research incurable medical conditions and emerging technologies for their management. Guest lecturers are invited to describe how emerging stem cell and biomaterial technologies are being used to treat patient.

- Quiz (Level A)
- Article Presentation (Level A)
- Class Activities (Level A)
- Final Project (Level A)

(i) **This course contributes to our students' recognition of the need for, and an ability to engage in life-long learning.**

Methods: 3

We discuss stem cell and biomaterial-based therapeutics currently being researched and developed for a variety of medical conditions. We also discuss examples of how our understanding of stem cell biology has been challenged and ultimately refined by new research and data.

- Class Activities (Level A)
- Final Project (Level A)

(j) **This course contributes to our students' understanding of biology and physiology, and the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology.**

Methods: 1, 3, 4, 6

We discuss the application of technologies such as biomaterials, mechanical and electrical stimulation to improve the efficacy of cell-based therapeutics. We also take a quantitative approach to understand the mechanobiology of stem cells.

- Homework (Level A)
- Exams (Level A)
- Class Activities (Level A)
- Article Presentation (Level A)
- Final Project (Level A)

(k) **This course contributes to our students' ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems.**

Methods: 3, 4, 5, 6

Students interpret data from peer-reviewed journal articles and also collect data/information associated with stem cell properties, tissue composition, and medical conditions for a particular application.

- Class Activities (Level A)
- Article Presentation (Level A)
- Final Project (Level A)

Table F3.5-1: Summary of Student and Faculty Evaluation

Summarize the phase-1 measures and, based on that data, determine the overall level of achievement. Discuss the basis for that determination in the faculty assessment section below. Please also provide your overall class assessment and, if necessary, an action plan to address concerns.

	Student (N/A)				Faculty	
Outcome	**Average (1-5)**	**%A or SA**	**%NA**	**Level**	**Phase-1 Level**	**Overall Level**

Faculty Assessment: