BMEG 350 – Biomedical Engineering Laboratory

Student Outcome a: an ability to apply knowledge of mathematics, science, and engineering.

Performance Criterion #1: *Students can describe basic concepts of biomaterials preparation for a drug delivery vehicle. This will include determining impact of different variables on hydrogel properties and analyzing release data with respect to the material chemical and physical properties.*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Students explain how variables such as concentration and time impact the properties of the hydrogel	No mention or explanation given about variables changed when making the hydrogels.	Variables changed to modify hydrogel properties are mentioned, but explanation of how they impact the properties is missing	Correlation between variable and hydrogel properties are given.	Correlation between variable and hydrogel properties are given with detailed mathematical or theoretical basis.
Students analyze drug release data	Data are not given graphically to show the release profile of the vehicle	Data are plotted, but no analysis of the data are given to describe the release of drug from the hydrogel	Data are plotted and data are fit to enhance the description of the release profile	Data are plotted and data are fit to equations for a complete description of the release profile

Performance Criterion #2: *Students can describe and demonstrate understanding of basic concepts of biomechanics such as stress and strain and how the physical and chemical characteristics of a material influence its mechanics. For this, students will analyze the differentiate the mechanical properties of a non-living model system (e.g., pipettor tip) and a living system (e.g., chicken skin) in tensile stress (to support the mathematical aspect), how does plastic and elastic behaviors respectively can be identified based on the materials' characteristics, and what are the strain and Young's modulus of the model systems identified above (to support the*

science aspect). Further, students will learn the basic principles and operating procedures of an instrument that performs mechanical testing

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Students analyze and differentiate the mechanical properties of a non-living model system (e.g., pipettor tip) and a living system (e.g., chicken skin) in tensile stress	Does not analysis the data nor is able to formulate basic judgments on the properties of the materials being considered.	Uses the quantitative analysis as the basis for tentative, basic judgments on the properties of the materials however without drawing conclusions on the work performed.	Uses the quantitative analysis of data as the basis for competent judgments, drawing reasonable and appropriately qualified conclusions that permit material classification based on the different characteristics.	Uses the quantitative analysis as the basis for deep and thoughtful judgment drawing insightful and coherent conclusions that permit to identify the characteristics of the model systems as well as the differences there are between them.
Students understand what plastic and elastic behaviors are based on the materials' characteristics	Does not demonstrate accurate understanding of the concepts nor is able to identify based on the data collected.	Rarely demonstrates understanding of the concepts or ability to identify the different types of behavior based on the data collected.	Usually demonstrates understanding of the concepts as well as the ability to identify the different types of behavior based on the data collected.	Provides accurate concept analysis by identifying the different types of behavior based on the data collected.
Students can calculate what are the strain and Young's	Does not provide accurate explanations of information presented in	Rarely provides accurate explanations of information presented in mathematical	Provides somewhat accurate explanations of information presented in	Provides accurate explanations of information presented in

modulus of the model systems	mathematical forms. Does not consider any of the errors related to assumptions or units being used.	forms. Makes major errors related to assumptions or units.	mathematical forms, but occasionally makes minor errors related to assumptions or units.	mathematical forms. Makes appropriate inferences based on that information. Accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the data suggest.
Students learn and demonstrate the basic principles and operating procedures of an instrument that performs mechanical testing	Students do not understand how the instrument operates nor its purpose	Students do not understand how the instrument operates however have an understanding of its purpose for mechanical testing	Students demonstrate a general understanding of how the instrument operates as well as how it could be used for mechanical testing	Students insightfully discusses in relevant details how the instrument works, understand its purpose but also provide relevant information on its supported limitations and implications for mechanical testing

Performance Criterion #3: *Students can describe and demonstrate understanding of basic concepts of microfluidics such as laminar flows and diffusion. Students will understand the chemical reactions involved in the preparation of polydimethylsiloxane (PDMS) microchannels and the assembly of PDMS microfluidic chips. Students will operate the microfluidic experiment and correlate the processing parameters to the quantities that characterize the microfluidics. Further, students will learn how to calculate these quantities to analyze transport phenomena including momentum and mass transfer.*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Students understand the chemical reactions involved in the preparation of PDMS microchannels and the assembly of PDMS microfluidic chips	Does not analysis the physical or chemical changes during the preparation of PDMS microfluidic chips.	Understands chemical reactions involved in the PDMS microfluidic preparation, but cannot formulate the reactions.	Formulates the chemical reactions involved in the preparation of PDMS microfluidics.	Understands the chemical reactions involved and is able to analyze how alterations in ratio of PDMS resin to the curing agent affects the physical properties of PDMS substrates.
Students can correlate the processing parameters to the quantities that characterize the microfluidics	Does not have an understanding of correlations between the microfluidic processing parameters to the characteristics of the microfluidics.	Demonstrates qualitative but not quantitative understanding of correlations between the processing parameters and characteristics of the microfluidics.	Provides both qualitative and quantitative analysis of the characteristic of the microfluidics with the processing parameters.	Provides accurate quantitative calculation of microfluidic characteristics with the processing parameters and qualitative analysis how the parameters affects the microfluidic characteristics.
Students can calculate these quantities to analyze transport phenomena including momentum and mass transfer	Does not analyze the momentum and mass transfer involved in the microfluidics.	Rarely provides accurate calculation of momentum and mass transfer quantities under various processing conditions.	Provides accurate calculation of momentum and mass transfer quantities under various processing conditions.	Provides accurate calculation of momentum and mass transfer quantities under various processing conditions, and qualitative analysis of how the quantities are influenced

				by the processing parameters.

Performance Criterion #4: *Students can describe and demonstrate understanding of basic concepts of biomedical imaging*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Learn how to operate at a high-level language and interactive programming-based environment, such a MATLAB® for biomedical image processing testing	Does not understand or is able, without help, to launch Matlab, generate folders with data and basic programming code, nor is able to use the command line and execute basic image processing commands (e.g. read/write, process and/or plot an image)	- Able to launch and navigate within the Matlab programming environment with minor supervision. - Has a tentative, basic judgment on how to type, execute basic image processing commands and algorithms provided by the instructor, however without drawing conclusions on the work performed.	- Able not only to launch and navigate within the Matlab programming environment, but also to detect programming bugs. - Has a competent, judgment and draws reasonable conclusions after executing image processing commands and algorithms - Drawing superficial conclusions on the work performed.	- Proficiency in running Matlab experiments - Performing quantitative and error analysis as the basis for deep and thoughtful judgment drawing insightful and coherent conclusions that permit to identify the capabilities of different cell segmentation and detection algorithms and their sensitivity to noise factors and other pre-processing algorithms.
Students understand	Does not demonstrate	Rarely demonstrates	Usually demonstrates	Provides accurate

what the concepts of image segmentation and detection are, based on a set of experiments using cell images	accurate understanding of the concepts nor is able to identify the different image segmentation and detection methods based on the data used and the Matlab experiments performed.	understanding of the concepts or ability to identify the different image segmentation and detection methods based on the data used and the Matlab experiments performed.	understanding of the concepts as well as the ability to identify the different image segmentation and detection methods based on the data used and the Matlab experiments performed.	concept analysis by identifying the different image segmentation and detection methods based on the data used and the Matlab experiments performed.
Students can test the effect of spatial resolution, additive noise and photometric normalization to cell segmentation quality when using the Matlab programming environment	Does not provide accurate explanations of the information presented in algorithms / functions used to affect cell image quality. Does not consider any of the errors related to assumptions or types of algorithms / functions being used.	Rarely provides accurate explanations of the information presented in algorithms / functions used to affect cell image quality. Makes major errors related to assumptions or types of algorithms / functions being used.	Provides somewhat accurate explanations of the information presented in algorithms/functions used to affect cell image quality, but occasionally makes minor errors related to assumptions or types of algorithms / functions being used.	Provides accurate explanations of the information presented in algorithms / functions used to affect cell image quality. Makes Appropriate inferences based on that information. Accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the effect of the algorithms / functions being used on the data suggest.
Students learn the basic principles and	Students do not understand how to organize, run	Students do not understand how to organize, run	Students demonstrate a	Students insightfully discuss in

operating procedures of a complete experiment that studies the effect of the quality of a cell segmentation when using image downscaling, noise and photometric normalization algorithms	and complete a basic biomedical imaging experiment focused on cell detection and segmentation nor its purpose.	and complete a basic biomedical imaging experiment; however they have an understanding of its purpose for accurate detection and segmentation of human cells when they are fully or partially visible within the provided/input image.	general understanding of how to detect cells using image processing, and the effect of image quality on cell segmentation when using image downscaling, noise and photometric normalization.	relevant details on how to organize, run and complete a basic biomedical imaging experiment focused on cell segmentation, understand its purpose but also provide relevant information on its supported limitations and implications for testing under various noisy conditions that affect cell image quality.

Student Outcome b: an ability to design and conduct experiments, as well as to analyze and interpret data

Performance Criterion #1: *Students can design an experiment pertinent to the relevant modules identified above*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Students can design an experiment pertinent to the individual module	No work is being proposed and the student does not demonstrate an understanding of the experimental	Little work is accomplished or being proposed to design an experiment pertinent to the individual	Work proposed is somewhat comprehensive, and allows for the project data acquisition and analysis however	Work proposed is thorough, comprehensive, and allows for the project data acquisition and analysis

	design or set-up.	module and module objectives.	without considering interpretation of the data	

Performance Criterion #2: *Students can develop laboratory reports (pre and post lab reports) that follows the guidelines given in class and are pertinent to the individual lab module*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Students can provide and maintain all the lab reports on a specific module.	Lab report is not clear, incomplete, and is disorganized	Lab report is clear, but not complete or organized .	Lab report is mostly clear, complete, and somewhat organized	Lab report is all clear, complete, and organized

Performance Criterion #3: *Students can analyze and interpret data pertinent to the relevant modules*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Students can conduct an experiment that allow for collection of the data	The student does not conduct any individual experiments nor participate in the team data collection.	The student rarely conducts an individual experiment or participates in the team data collection.	The student usually conducts the experiments as assigned as well as participates in the team effort for data collection.	The student conducts the experiments, provides directions to the team members and is involved in all the team efforts for successful and comprehensive data collection.

Students analyze and differentiate the data based on the objectives of the individual module	Does not analyze the data nor is able to formulate basic judgments on the properties as related to the data that was collected.	Uses the quantitative analysis as the basis for tentative, basic judgments on the module objectives.	Uses the quantitative analysis of data as the basis for competent judgments drawing reasonable and appropriately qualified conclusions about the individual modules outcomes.	Uses the quantitative analysis as the basis complete judgments drawing insightful and coherent conclusions that permit to identify the specific outcomes of the module as well as the importance of the problem being studies.
Students can calculate and interpret the collected data	Does not provide accurate explanations or is able to present information in mathematical forms. Does not consider any of the errors related to assumptions or units being used.	Rarely provides accurate explanations of information presented in mathematical forms. Makes major errors related to assumptions or units.	Provides somewhat accurate explanations of information presented in mathematical forms, but occasionally makes minor errors related to assumptions or units.	Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information. Accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the data suggest.

Student Outcome d: an ability to function on multi-disciplinary teams.

Performance Criterion #1: *Student contributes to conduction of the individual lab modules*

Peer Review Scoring Rubric

ASPECT	**1-Not proficient** (no involvement with the modules)	**2-Progressing to proficiency** (1-2 of the modules)	**3-Proficient** (3 of the modules)	**4-Superior proficiency** (all of the modules)
Research and information gathering as related to the particular module	Does not collect any information that relates to the topic	Collects very little information; some of it related to the topic	Collects some basic information as related to the topic	Collects a great deal of information- i.e., all information is clear and correct and contains referenced resources- as related to the topic
Fulfill team's duties and the assigned role	Does not perform any of the assigned duties	Performs very little of the assigned duties	Performs nearly all the duties as assigned	Performs all the experiments and the duties being assigned
Share work in the team	Always relies on others to do the work assigned to the team	Rarely does and gets involved with the assigned work	Usually does and gets involved with the team for the assigned work	Always does the assigned work (all the modules)
Listen to the other teammates	Is always talking and never contributing to the project	Usually doing most of the talking	Usually listens to the other teammates	Always listens to the other teammates
Performed experiments and contributed to the data analysis	Did not perform any experiment nor contributed to the data analysis	Perform little of the experiment and data analysis	Usually performs the experiments and data analysis as	Always performs the experiments and data analysis as related to the topic

			related to the topic	
Contributed to the post-lab report	Did not contribute to the post-lab report	Contributes little to the post-lab report	Usually contributes to the post-lab report	Always contributes to the post-lab report

Instructor Scoring Rubric

ASPECT	**1-Not proficient** (no involvement with the modules)	**2-Progressing to proficiency** (1-2 of the modules)	**3-Proficient** (3 of the modules)	**4-Superior proficiency** (all of the modules)
Summary of Goals	Does not summarizes any goals that relates to the topic/module	Summarizes very little of the goals with some of them being related to the topic	Summarizes the goals as related to the topic	Summarizes the goals as related to the topic and talks about the importance of achieving them
Approach to achieve goals explained	Does not explain the approach	Explains very little of the approach	Explains nearly all the approach	Explains all the approach
Outline of the experiment	Does not outline the experimental steps	Rarely outlines the experimental steps	Usually outlines the experimental steps	Always outlines the experimental steps
Identification of possible challenges	Does not identify any of the challenges related to the module/experiment	Rarely outlines the challenges as related to the module/experiment	Usually outlines the challenges as related to the module/experiment	Always outlines the challenges as related to the module/experiment
Summary of safety concerns	Does not summarizes the safety concerns nor proposes means to	Rarely summarizes the safety concerns and proposes	Usually summarizes the safety concerns	Always summarizes the safety concerns and

	circumvent any safety issues	means to circumvent the safety issues	and proposes means to circumvent any safety issues that might occur	proposes means to circumvent any safety issues that might occur
Data analysis considered	Does not analyze the collected data	Rarely analyze the collected data	Usually analyze the collected data	Always analyze the collected data
Quality of data assessment	The data assessment is never considered critically, stated clearly or described comprehensively. The student does not consider all relevant information necessary for full understanding of the results	The data assessment is rarely considered critically, stated clearly or described comprehensively. The student fails to deliver all relevant information necessary for full understanding of the results	The data assessment is usually considered critically, stated clearly and described comprehensively, delivering all relevant information necessary for full understanding of the results	The data assessment is always considered critically, stated clearly and described comprehensively, delivering all relevant information necessary for full understanding of the results
Consideration of error	There is no consideration of the error or sources of errors	There is little consideration of the error or sources of errors	Usually there is consideration of the error or sources of errors	Always there is consideration of the error or sources of errors
Format/ Grammar and punctuation/ Tense and voice followed	There is no consideration for the introduced format. The student does not follow the rules	Rarely there is consideration for the introduced format The student rarely follows	Usually there is consideration for the introduced format	Always there is consideration for the introduced format

	of standard English.	the rules of standard English.	The student usually follows the rules of standard English.	The student always follows the rules of standard English.

Student Outcome i: A recognition of the need for, and an ability to engage in life-long learning.

Performance Criterion #1: *Students perform a literature search pertinent to the individual lab module and subject being addressed*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Students demonstrate the ability to effectively conduct internet or library searches as related to the individual topic of the module	Demonstrates no ability to search the internet or library resources	Demonstrates limited ability to search the internet or library resources and distinguish quality resources from useless ones	Demonstrates an ability to search the internet or library resources and distinguish quality resources from useless ones	Demonstrates extensive ability to search the internet or library resources and distinguish quality resources
Students demonstrate the ability to find, evaluate and use information independently to analyze the data collected for the individual modules	Students demonstrate no ability to find or utilize information independently	Students seek information from outside sources when necessary, but use few sources and primarily nontechnical ones	Students seek information from multiple sources, including technical reports and papers	Students seek information from a variety of sources and show discernment in the use of information by selecting relevant one

Ability to apply module concepts in an independent manner	Cannot connect module content to project in meaningful way	Makes some connection of module content to project, but makes errors in application of concepts	Connects module content to project but makes minimal or superficial meaning of the applied concepts	Connects module content to project and makes appropriate applications with meaningful outcomes