

BMEG 455 and 456 – Senior Design Capstone

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

Performance Criterion #1: *Demonstrate the ability to apply scientific principles and engineering skills to solve problems at the interface of medicine and biology.*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Apply engineering skills				
apply the design process to a biomedical engineering problem	design process not used	aspects of the design process missing	four stages of design process used, but some incorrectly or inefficiently	design process followed completely
perform an optimization during the design process	no optimization completed	parameters identified but not optimized or incorrect	correct parameters identified with optimization attempted	correct parameters used for optimization

Performance Criterion #2: *Apply knowledge from human physiology, thermodynamics, transport in biological systems, math, chemistry, physics, biomedical instrumentation, biomechanics, etc. to complex, open-ended biomedical engineering problems*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Apply knowledge of life sciences, physical sciences, and biomedical engineering				
Apply human physiology principles	inability to apply principles	a few basic principles applied	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to complete design

Apply chemistry principles	inability to apply principles	a few basic principles applied	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to complete design
Apply physics principles	inability to apply principles	a few basic principles applied	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to complete design
Apply biomedical engineering principles	inability to apply principles	a few basic principles applied	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to complete design

Student Outcome c: an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

Performance Criterion #1: *Formulate strategies to solve an open-ended design problem related to biomedical engineering*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Create a need statement that identifies the problem, target population and an outcome	not developed	Statement has imbedded solution, is too broad, or is too general	Statement does not have one of three main components, problem, population, or outcome.	Statement clearly identifies the problem, population, and outcome
Define a project in a	not given	definition is vague with a lot	definition is clear, but a few	definition is clear and

clear and concise fashion		of non-pertinent information given	instances of superfluous information	concise
Identify the project significance	not given	significance is not well established and does not discuss the current solutions, data, or future impact	significance is stated but missing discussion of the current solution shortcomings	significance is clearly stated and the context for the project is detailed with current solutions, data, and impact on uses
Perform cost analysis	not performed	performed, but key considerations missing	performed, most key considerations used	performed, complete with good detail

Performance Criterion #2: *Address safety issues associated with the biomedical engineering problem being solved*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Inclusion of safety-related content	total ignorance of safety-related issues	reluctantly recognizes and includes relevant safety-related design issues	usually recognizes and includes relevant safety-related design issues	always recognizes, anticipates, and includes relevant safety-related design issues

Performance Criterion #3: *Address social, ethical, regulatory and economic issues, including industry and government standards for experimentation and design*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency

Inclusion of content on societal impact	total ignorance of societal issues	reluctantly recognizes and includes relevant societal issues in the design	usually recognizes and includes relevant societal issues in the design	always recognizes, anticipates, and includes relevant societal issues
Consider ethics in design	ethics not considered	ethics considered are minimal	ethics are considered for most aspects of the design	ethics considered in all aspects of the design
Identify legal issues associated with design	neither synthesizes nor demonstrates understanding of legal issues	occasionally synthesizes and demonstrates understanding of legal issues	usually synthesizes and demonstrates understanding of legal issues	always synthesizes and demonstrates understanding of legal issues
Develop a path to regulatory approval	mention of regulatory approval need, but no specifics on which pathway to use or incorrect pathway chosen	pathway given, but does not identify key aspects required such as FDA division to target, clinical trials, quality documentation, similarity to other products,	pathway given includes which FDA division is targeted, need for clinical trials, required documentation, and product review, or explanation of why regulation not required	pathway given with specific timelines, documents/forms
Identify players and modes for reimbursement	more than three players not/incorrectly identified	players identified correctly, but no indication of the different options for how to get reimbursed	players identified correctly, explanation for using current code or needing a new code given	players identified correctly, explanation for using current code or needing a new code given with detail of specific code numbers

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

Performance Criterion #1: *Student contributes to group project*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Even division of effort	product apparently due to one person's contribution	one person dominates or one person's contribution not apparent	uneven distribution apparent, but within acceptable deviations	apparent even division of effort
All members of group understand solution	clearly at least one or more members totally unaware of solution/strategy	not clear that all members understand solution and methodology	most members apparently understand complete solution or methodology	all members understand complete solution and methodology

Performance Criterion #2: *Student works effectively as a team member.*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Interact with team members in effective and professional fashion	it is clear that solution did not result from good team interaction	poor interaction between team members apparent	teamwork apparent, undesired interactions were quickly eliminated	team functioned appropriately

Performance Criterion #3: *Student works on multidisciplinary team*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Works effectively with people	does not work with the group	work is not effectively completed	work is completed effectively	multidisciplinary nature enhances the final product

from different disciplines				of the work
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Student Outcome e: an ability to identify, formulate, and solve engineering problems.

Performance Criterion #1: *Demonstrate the ability to apply scientific principles and engineering skills to solve problems at the interface of medicine and biology.*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Identify problem	cannot identify problem	problem identified but not clearly and/or incorrectly	problem identified	problem identified and details given enhance to problem statement
Formulate problem	cannot formulate problem	problem formulated but not clearly and/or incorrectly	problem formulated correctly	problem formulated and details given enhance to project
Solve problem	Solution not given	Solution is given with major errors	Solution is given with minor errors	Solution addresses the problem

Student Outcome f: an understanding of professional and ethical responsibility.

Performance Criterion #1: *Address professional and ethical issues associated with the biomedical engineering problem being solved*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency

Identify ethical issues	total ignorance of ethical issues	insufficient ethical issues identified	nearly all ethical issues identified	identified ethical issues are correct, complete, and relevant
Address ethical issues	total ignorance of ethical issues	ethical issues not discussed within context of design	ethical issues addressed in most aspects of the design	ethical issues addressed clearly and completely for all aspect of the design

Student Outcome g: an ability to communicate effectively.

Performance Criterion #1: *Present technical material in a written or oral format as well as develop the ability to communicate effectively, in writing, conversation and graphic.*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Effective use of visual aids				
Overall clarity	not clear or readable	difficulty reading	clear and readable	superior clarity and readability
Layout of VA	VA unreadable because too crowded	layout detracts from impact of VA	VA appropriately laid out	VAs very well laid out – enhances presentation
Readability	slides unreadable	slides consistently too small	most fonts readable	font readable
Wording	slides full of text, full sentences used	slides too wordy, full sentences used frequently	no more than 2 slides too wordy, bullets used instead of sentences	slides appropriate, worded well
Appropriate amount of	so much information per VA or so much	too much information per VA, missing	appropriate level of information per	appropriate level of information per

information per VA	missing information to make VAs useless	information such as size of total pie	VA, not always consistent with what is spoken	VA, consistent with what is spoken
Logical order of topics	totally disjointed, no organization	multiple items presented out of order	organization as per guidelines but improvement possible	organization logical and as per guidelines
Delivery	no delivery or delivery with no relevant content	difficult to understand, voice consistently hard to hear, voice trails off often, spoke too slow or too fast, overuse of slang and/or jargon, presentation full of hesitations, ums, ahs, etc.	voice clearly heard, words clearly enunciated, did not speak too slowly or too rapidly clear, continuous presentation, perhaps a few ums, ahs, etc.	voice projected very well, clear enunciation, did not speak too slowly or rapidly superior presentation, free of ums, ahs, etc.
Mannerisms	presentation has so many distracting mannerisms as to render presentation completely ineffective	presentation has distracting mannerisms (such as giggling or fidgeting)	no distracting mannerisms	presentation mannerisms enhance clarity and delivery
Composure	clearly unsure, nervous, confused	at times appears unsure, nervous, confused throughout presentation	composed at all times	exudes/conveys confidence

Student Outcome h: the broad education necessary to understand the impact of engineering solutions in a global and societal context.

Performance Criterion #1: *Address ethical, societal, health and safety issues as associated with the biomedical engineering problem being solved*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Consider ethics in design	ethics not considered	ethics considered are minimal	ethics are considered for most aspects of the design	ethics considered in all aspects of the design
Inclusion of content on societal impact	total ignorance of societal issues	reluctantly recognizes and includes relevant societal issues in the design	usually recognizes and includes relevant societal issues in the design	always recognizes and includes relevant societal issues
Inclusion of safety-related content	Lack of including any safety-related issues	recognizes and includes basic safety-related design issues	recognizes and includes relevant safety-related design issues	always recognizes, anticipates, and includes relevant safety-related design issues
Understanding of legal issues associated with design	neither synthesizes nor demonstrates understanding of legal issues	occasionally synthesizes and demonstrates understanding of legal issues	usually synthesizes and demonstrates understanding of legal issues	always synthesizes and demonstrates understanding of legal issues

Student Outcome j: A knowledge of contemporary issues.

Performance Criterion #1: *Improving human healthcare through possible clinical applications*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency

Identify problems in a given area of biomedical engineering	problems not identified	problems identified but not correct or too basic	Problems identified are good and have potential for design	Problems identified are numerous and have strong potential for design
Explain the process of regulation for new biomedical engineering products	no explanation given	paths to regulation process are given with no detailed requirements	paths to regulatory approval are detailed with specific requirements	paths to approval are detailed with requirements, hurdles, and timelines
Describe reimbursement pathway for a new product	no description given	reimbursement process is described with no details of requirements	reimbursement process is described with detailed requirements	reimbursement process is described with detailed requirements, cycle of care, and examples of codes

Student Outcome k: an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Performance Criterion #1: *Demonstrate the ability to use relevant software tools beyond Microsoft Office programs to create prototypes and supporting items including flowcharts, 3-d models, and computational models*

Scoring Rubric:

Aspect	1: Not proficient	2: Progressing to proficiency	3: Proficient	4: Superior proficiency
Use software during the design process to create a final prototype	Software use was limited to Microsoft Office programs	Software was utilized but incorrectly or poorly	Software implemented was relevant and used correctly	Software implemented was used correctly and in a fashion that enhanced the design