UC San Diego - WASC Exhibit 7.1
Inventory of Educational Effectiveness Indicators

Academic Program	(2a) What are these learning outcomes?	(3) Other than GPA, what data/evidence are used to determine that graduates have achieved stated outcomes for the degree?	(4) Who interprets the evidence? What is the process?	(5) How are the findings used?
Department: *Bioengineering* **Major:** *B.S. in Bioengineering: Bioengineering* *B.S. in Bioengineering Biotechnology* *B.S. in Bioengineering Bioinformatics* *B.S. in Bioengineering BioSystems* **(1) Have formal learning outcomes been developed?** *Yes* **(6) Date of last Academic Senate Review?** *20013-2014* October 2018	**Students graduating with a degree should be able to:** **Written Communication** *ABET Learning Outcome (3): An ability to communicate effectively (written and oral) with a range of audiences.*	**Written Communication** *1) Direct Assessment Measures in* ***Class assignments and the Senior Project Capstone course:*** *A matrix has been generated that describes the mapping of student outcomes to individual BE courses (see attachment).* *For each outcome, a direct assessment tool, in form of a rubric, has been developed, using several performance indicators, which evaluate individual traits of an outcome based on four achievement levels. Selected exams, homework assignments, and project reports are used to assess written communication.* *2) Indirect Assessment Measures via* ***Stakeholder feedback****:* *Student surveys are used to assess learning outcomes through annual* ***senior student exit surveys*** *and* ***biannual alumni surveys****, conducted by the Jacobs School of Engineering.* *Assessment of program objectives and student learning outcomes are performed through* ***employer feedback*** *and surveys, collected in quarterly* ***Industrial Advisory Board*** *meetings.* *3) Additional measures and enrichment options for student learning outcomes via* ***Co-curricular activities****:* • ***Bioengineering Day (BE Day)****: The Capstone Senior Student Design projects consist of teams from all Bioengineering programs. The design topics are chosen in close relation with local industry. Students are required to communicate all aspects of the design problem and must make presentations, interact with people in different disciplines, e.g. medical school and the IT sector, and must explain their results to the public. Design project results are presented at the Bioengineering (BE) Day. BE Day is an annual event organized entirely by students. At the BE Day, the final design projects are publicly presented to local bioengineering and biotechnology industry. Industry representatives get involved with students, offering their point of view, which sometimes leads to a long lasting industry liaison. Some of these design project cooperation lead to patents with applications of bioengineering solutions in public domains and for the benefit of health care. The success of the BE day and the positive feedback of industry reflect additional evidence that student learning outcomes have been met. Feedback is documented in industry questionnaires at the end of BE Day. Satisfaction with the skills and training in Bioengineering programs are reflected upon the fulfillment of industry needs.* • ***Internship Program and Research Activities****: Students are encouraged to participate in industrial internships to gain real-world experiences. Technical elective credit can be granted for approved internships (BENG 196). Feedback is collected from the industrial supervisors. Furthermore, Bioengineering students are encouraged to engage in UCSD undergraduate research activities in research labs of teaching faculty.* • ***Student Organizations****: Students can join engineering student organizations for extra-curricular experiences in communication and leadership. The Biomedical Engineering Society (BMES) student organization has a very active chapter, which has consistently been ranked high among the top universities in the nation.*	**Written Communication** *The* ***Undergraduate Student Affairs Committee*** *and the* ***ABET Committee*** *regularly review student learning outcome assessment and curriculum adjustments.* *The* ***Industrial Advisory Board*** *is convened periodically to provide input on various aspects of program assessment results (objectives, outcomes).* *Collected evidence in column (3) is analyzed and graphically presented to the faculty in the* ***annual faculty retreat****. Faculty discusses and evaluates the findings of the assessment for each outcome within each Bioengineering program. Discussion results and suggestions for program improvement are documented in faculty questionnaires.* ***Process:*** *An action plan is developed by the ABET committee, based on the measures of outcome assessment and faculty evaluations. If, as a result, changes to courses are proposed for continuous program improvement, these suggestions are presented to and evaluated by the Undergraduate Affairs Committee for possibly implementation.* *Re-assessment of the outcomes in the following academic year will provide evaluation of the success rate of curriculum changes.*	**Written Communication** ***Faculty*** *assesses the coverage of topics and learning outcomes in consequential courses in the annual faculty retreat. Faculties is prompted to self-evaluate and discuss courses and learning outcomes with colleagues. A topic group leader documents discussion results in questionnaires for each program. This enables continuously improvement in each program on the course level.* *The* ***Undergraduate Affairs Committee*** *Committee reviews more complex suggestions for curriculum change, suggested from assessment measures and faculty feedback, and develops a plan for program improvement.* *The* ***Undergraduate Student Council (UGSC)*** *decides on curriculum changes before being forwarded to the* ***Academic Senate*** *for final approval and implementation.* *The assessment and evaluation cycle of student learning outcomes are repeated annually for continuous program improvement.*

	Oral Communication *ABET Learning Outcome (3): An ability to communicate effectively (written and oral) with a range of audiences.*	**Oral Communication** *1) Direct Assessment Measures in* ***Class assignments and the Senior Project Capstone course:*** *Mapping: see attached matrix for student outcomes vs BE courses. For each outcome, a direct assessment tool, in form of a rubric, has been developed, using several performance indicators, which evaluate individual traits of an outcome based on four achievement levels. Selected class presentations and project talks are used to assess oral communication.* *2) Indirect Assessment Measures via* ***Stakeholder feedback****:* • ***BE Day****: Stakeholders are able to assess poster presentations of the Capstone Senior Design projects while talking to the students and completing a questionnaire.* • ***Internship Program:*** *Internship projects are presented at the annual Internship Symposium and assessed by faculty, industry representatives, and graduate students.* *3) Additional measures and enrichment options for student learning outcomes via* ***Co-curricular activities****:* • ***Student Organizations****: Students can join engineering student organizations for extra-curricular experiences in communication and leadership. The Biomedical Engineering Society (BMES) student organization has a very active chapter, which has consistently been ranked high among the top universities in the nation.*	**Oral Communication** *SEE ABOVE*	**Oral Communication** *SEE ABOVE*
	Quantitative Reasoning: *ABET Learning Outcome (1): An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.* *ABET Learning Outcome (6): An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions*	**Quantitative Reasoning** *1) Direct Assessment Measures in* ***Class assignments and the Senior Project Capstone course:*** *Mapping: see attached matrix for student outcomes vs BE courses. For each outcome, a direct assessment tool, in form of a rubric, has been developed, using several performance indicators, which evaluate individual traits of an outcome based on four achievement levels. Selected exams, homework assignments, and project reports are used to assess quantitative reasoning.* *Design projects are used to ensure that all students have quantitative reasoning skills necessary for successful professional practice, engineering modeling and design. Group design projects are introduced every year of the bioengineering program, beginning in the freshman year and leading up to the program's "masterpiece" in the Capstone senior student design project. The Capstone design projects are assessed by an independent evaluator from industry as well as during the BE Day presentations.* *2) Indirect Assessment Measures via* ***Stakeholder feedback****:* *SEE ABOVE* *3) Additional measures and enrichment options for student learning outcomes via* ***Co-curricular activities****:* *SEE ABOVE*	**Quantitative Reasoning** *SEE ABOVE*	**Quantitative Reasoning** *SEE ABOVE*

	Information Literacy *ABET Learning Outcome (7): An ability to acquire and apply new knowledge as needed, using appropriate learning strategies and literature research (including verifying the source of data information).*	**Information Literacy** *1) Direct Assessment Measures in* ***Class assignments and the Senior Project Capstone course:*** *Mapping: see attached matrix for student outcomes vs BE courses. For each outcome, a direct assessment tool, in form of a rubric, has been developed, using several performance indicators, which evaluate individual traits of an outcome based on four achievement levels. Selected exams, homework assignments, and backgrounds for project reports are used to assess information literacy.* *To ensure that all students have the skills necessary for successful professional practice and design in a social context, literature review is conducted for each design project. Group design projects are introduced every year of the bioengineering program, beginning in the freshman year and leading up to the program's "masterpiece" in the Capstone senior student design project. The Capstone design projects are assessed by an independent evaluator from industry as well as during the BE Day presentations.* *2) Indirect Assessment Measures via* ***Stakeholder feedback****:* *SEE ABOVE* *3) Additional measures and enrichment options for student learning outcomes via* ***Co-curricular activities****:* *SEE ABOVE*	**Information Literacy** *SEE ABOVE*	**Information Literacy** *SEE ABOVE*
	Critical Thinking *ABET Learning Outcome (2): An ability to apply engineering design to produce solutions that meet specified needs with standards and constraints.* *ABET Learning Outcome (4): An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which mush consider the impact of engineering solutions in global, economic, environmental, and societal contexts.*	**Critical Thinking** *1) Direct Assessment Measures in* ***Class assignments and the Senior Project Capstone course:*** *Mapping: see attached matrix for student outcomes vs BE courses. Courses that are taught at the mastering level (labeled "3") apply the highest level of critical thinking via critique, synthesis, or creation of the subject matter (according to Bloom's taxonomy).* *For each outcome, a direct assessment tool, in form of a rubric, has been developed, using several performance indicators, which evaluate individual traits of an outcome based on four achievement levels. Selected exams, homework assignments, and project reports are used to assess critical thinking.* *The Senior Project Capstone design sequence course (4 quarters) provides several experiences that require student teams to design, build, solve, and propose solutions to Bioengineering real life problems. Economics, environmental, sustainability, and ethical, social, health and safety related, and political considerations are incorporated.* *To ensure that all students have the skills necessary for successful professional practice and design, group design projects are introduced every year of the bioengineering program, beginning in the freshman year and leading up to the program's "masterpiece" in the Capstone senior student design project. The Capstone design projects are assessed by an independent evaluator from industry as well as during the BE Day presentations.* *2) Indirect Assessment Measures via* ***Stakeholder feedback****:* *SEE ABOVE* *3) Additional measures and enrichment options for student learning outcomes via* ***Co-curricular activities****:* *SEE ABOVE*	**Critical Thinking** *SEE ABOVE*	**Critical Thinking** *SEE ABOVE*

	Additional Learning Outcomes *ABET Learning Outcome (5): An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment (inclusion of diversity), establish goals, plan tasks, and meet objectives.* *ABET Learning Outcome (8): An ability to identify needs for new engineering solutions in the world or society, and to develop innovative thinking to solve bioengineering problems with creativity and entrepreneurship.*	(All other items not color coded) *1) Direct Assessment Measures in* ***Class assignments and the Senior Project Capstone course:*** *Mapping: see attached matrix for student outcomes vs BE courses. Courses that are taught at the mastering level (labeled "3") apply the highest level of critical thinking via critique, synthesis, or creation of the subject matter (according to Bloom's taxonomy).* *For each outcome, an additional evaluation tool in form of a rubric with several performance indicators has been created to evaluate individual traits of an outcome based on four achievement levels.* *Student knowledge and skills are evaluated and monitored annually, according to the developed rubrics for each outcome, through direct assessments of selected exams, group projects, homework assignments, reports and presentations.* A *Capstone design sequence course (4 quarters) provides several experiences that require student teams to design, build, solve, and propose solutions to Bioengineering real life problems. Economics, environmental, sustainability, and ethical, social, health and safety related, and political considerations are incorporated.* *To ensure that all students have the skills necessary for successful professional practice (team participation and communication in inclusive multidisciplinary teams, as well as innovative leadership skills), group design projects are introduced every year of the bioengineering program, beginning in the freshman year and leading up to the program's "masterpiece" in the Capstone senior student design project. The Capstone design projects are assessed by an independent evaluator from industry as well as during the BE Day presentations.* *2) Indirect Assessment Measures via* ***Stakeholder feedback****:* *SEE ABOVE* *3) Additional measures and enrichment options for student learning outcomes via* ***Co-curricular activities****:* *SEE ABOVE*	(All other items not color coded) *SEE ABOVE*	(All other items not color coded) *SEE ABOVE*
	(2b) **Where are the learning outcomes published? Please provide your department/program website address.** • Course syllabi • Bioengineering Website: *http://be.ucsd.edu/undergraduate* http://be.ucsd.edu/undergrad-degree-programs • Posters published in the Bioengineering building hallway and Undergraduate Student Affairs office. • UC San Diego General Catalog: https://ucsd.edu/catalog/curric/SOE.html		**ABET ACCREDITATION** *The Bioengineering: Bioengineering and Bioengineering: Biotechnology programs received a full 6-year accreditation by the Accreditation Board of Engineering and Technology (ABET) in 2014. Learning outcomes are compared with national standards. The new Bioengineering: BioSystems program received ABET accreditation retroactive for 2016, since accreditation can only be obtained after the first group of students graduated in 2017. All 3 programs are up for accreditation renewal in 2019/2020.*	**Repetition of Assessment and Evaluation cycle:** With a continuous process of outcome assessment, evaluation, and feedback from all stakeholders, the educational teaching effectiveness is improving. Assessment results are **published** on ABET and internal Bioengineering webpages for review by the program stakeholders (students, alumni, industry representatives, and faculty).

Contribution of required courses to program Student Learning Outcomes (1-8) for all accredited Bioengineering majors*

Course ID	Outcomes								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
BENG 1. Intro to Bioengineering	1	2	2	1	1	2	2	2	(1): Identify, formulate, solve complex eng. problems by applying princpls of **engineering, science, math**
BENG 2. Intro Computer Programming/Matlab	1	0	0	0	0	1	1	2	
BENG 100. Statist. Reasoning for Bioeng Appl.	3	2	2	2	1	3	2	0	
BENG 102. Molec. Compontents of Living Syst	2	2	2	1	0	0	3	1	
BENG 103B. Bioengineering Mass Transfer	2	2	0	1	0	0	2	0	(2): Apply **eng. design** to produce solutions that meet specific needs with **standards and constraints** due to: public health, safety, welfare and global, cultural, social, environmtl, economic factors
BENG 110. Foundation of Biomechanics	3	2	2	2	0	2	3	0	
BENG 112A. Tissue Biomechanics	3	2	2	2	2	2	3	0	
BENG 112B. Fluid and Cell Biomechanics	3	2	2	0	2	2	3	2	
BENG 120 .Org. Chem. Struct. & Design Princpl	3	1	1	1	1	1	2	1	
BENG 122A. Biosystems and Control	3	3	3	3	3	3	3	2	
BENG 123. Dynamic Simulation in Bioengineering	3	0	2	0	0	2	0	1	(3): **Communicate** effectively (written and oral) with a range of audiences
BENG 125. Modelg & Computation in Bioeng	3	0	3	0	0	0	3	3	
BENG 130. Biotech Thermodynamics and Kinetics	2	2	2	2	0	0	2	0	
BENG 133. Num. Analysis & Computational Eng.	2	1	2	1	3	3	1	1	(4): Recognize **ethical and professional** responsibilities in eng. situations and make informed judgements with the impact of eng. solutions in global, economic, environmental and societal contexts
BENG 134. Measmnts, Statistics & Probability	3	2	2	2	2	3	3	1	
BENG 135. Biomed. Signals and Systems	3	1	1	1	3	3	2	0	
BENG 140A. Bioeng Physiology I	2	1	2	2	1	1	2	0	
BENG 140B. Bioeng Physiology II	2	0	2	2	0	0	2	0	
BENG 141. Biomed. Optics and Imaging	3	2	3	1	1	1	1	1	
BENG 152. Biosystems Engineering Lab	2	2	2	0	0	3	3	3	(5): Function effectively on **a team** whose members together provide **leadership**, create a **collaborative** and inclusive environment, (**inclusion of diversity**) and establish goals, plan tasks, and meet objectives
BENG 160. Chem. and Molecular Bioeng Techniques	2	1	2	1	2	3	2	1	
BENG 161A. Bioreactor Engineering	3	2	0	1	0	0	2	1	
BENG 161B. Biochemical Engineering	3	2	0	2	0	0	2	1	
BENG 162. Biotechnology Laboratory	2	1	2	1	3	3	1	1	
BENG 166A. Cell and Tissue Engineering	2	2	3	2	0	2	2	1	
BENG 168. Biomolecular Engineering	1	2	2	2	1	2	3	1	(6): Develop and conduct appropriate **experimentation, analyze data**, and use eng. judgement to **draw conclusions**
BENG 172. Bioengineering Laboratory	3	2	3	1	3	3	3	0	
BENG 186A. Princpls of Biomaterials Design	3	2	2	1	2	2	2	1	
BENG 186B. Princpls of Bioinstrumentation Design	3	3	1	1	1	3	3	1	
BENG 187A. Bioeng Design: Planning	3	3	3	3	3	3	3	3	(7): Acquire and apply **new knowledge** as needed, using appropriate learning strategies (**life-long learning**)
BENG 187B. Bioeng Design: Development	3	3	3	3	3	3	3	3	
BENG 187C. Bioeng Design: Implementation	3	3	3	3	3	3	3	3	
BENG 187D. Bioeng Design: Presentation	3	3	3	3	3	3	3	3	
BENG 189. Physiological Systems Eng.	3	1	3	3	2	2	3	3	(8): Identify needs for new eng. solutions in society and develop **innovative thinking** to solve bioeng problems with creativity and **entrepreneurship**
BENG 191. Professional Issues in Bioeng	1	2	2	3	1	0	2	3	
BENG 193. Clinical Bioengineering	3	3	3	2	2	1	3	3	
BENG 196. Bioengineering Industrial Internship	3	3	3	3	3	3	3	3	
*updated August 2018 Total of '3's:	23	8	12	8	10	15	18	10	

1= Introduction (knowledge level) 2= Developing skill (analysis, application) 3= Mastering (create, synthesize, critique) 0= Not addressed in this class

Five Core Competencies according to WASC

Written communication
Communication by means of written language for informational, persuasive, and expressive purposes. Written communication may appear in many forms, or genres. Successful written communication depends on mastery of the conventions of the written language, facility with culturally accepted structures for presentation and argument, awareness of audience, and other situation-specific factors.

Oral communication
Communication by means of spoken language for informational, persuasive, and expressive purposes. In addition to speech, oral communication may employ visual aids, body language, intonation, and other non-verbal elements to support the conveyance of meaning and connection with the audience. Oral communication may include speeches, presentations, discussions, dialogue, and other forms of interpersonal communication, either delivered face to face or mediated technologically.

Quantitative reasoning
The ability to apply mathematical concepts to the interpretation and analysis of quantitative information in order to solve a wide range of problems, from those arising in pure and applied research to everyday issues and questions. It may include such dimensions as ability to apply math skills, judge reasonableness, communicate quantitative information, and recognize the limits of mathematical or statistical methods.

Information literacy
According the Association of College and Research Libraries, the ability to "recognize when information is needed and have the ability to locate, evaluate, and use the needed information" for a wide range of purposes. An information-literate individual is able to determine the extent of information needed, access it, evaluate it and its sources, use the information effectively, and do so ethically and legally.

Critical thinking
The ability to think in a way that is clear, reasoned, reflective, informed by evidence, and aimed at deciding what to believe or do. Dispositions supporting critical thinking include open-mindedness and motivation to seek the truth.