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**ABET SELF-STUDY**

**QUESTIONNAIRE:**

**TEMPLATE FOR A   
SELF-STUDY REPORT**

2021-2022 Review Cycle

**ENGINEERING ACCREDITATION COMMISSION**

**ABET**

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# Introduction

The Self-Study Report is expected to be a quantitative and qualitative assessment of the strengths and limitations of the program being submitted for review.

The Self-Study Report will provide information critical to a thorough on-site review of the program. Therefore, the Report will address the extent to which the program meets applicable ABET Criteria and policies. In so doing, it is necessary that the Report address all methods of instructional delivery used for the program, all possible paths that students may take to completion of the degree, and all remote offerings available to students in the program.

Each Commission of ABET provides a ***Self-Study Questionnaire*** to assist the program in completing the Self-Study Report.

# Requirements and Preparation

The program name used on the cover of the Self-Study Report **must** be identical to that used in the institutional publications, on the ABET Request for Evaluation (RFE), and on the transcripts of graduates. This will ensure that the program is correctly identified in ABET records and that graduates can be correctly identified as graduating from an accredited program.

Normally, each program requires a Self-Study Report.

While the *Questionnaire* focuses primarily on accreditation criteria, it also includes questions related to certain sections of the ABET *Accreditation Policy and Procedure Manual* (APPM).

While it is important that the overall structure in the *Questionnaire* be retained, it is not necessary to preserve notes or pages of instructions about preparing the Self-Study Report.

A program may use terminology different from that used in the *Questionnaire*. If different terminology is used, it is important that the Self-Study Report provide notes of explanation to clearly link the terminology in the Report to terminology used in the *Questionnaire*.

Tables in the *Questionnaire* may be modified in format to more clearly present the information for the program. When this is done, it is suggested that a brief explanatory footnote be included about why the table was modified. Rows may be added to or deleted from tables to better accommodate program information.

The **educational unit** is the administrative unit having academic responsibility for the program(s) being reviewed by a given Commission of ABET. For example, if a single program is being reviewed, the educational unit may be the department. If more than one program is being reviewed, the educational unit is the administrative unit responsible for the collective group of programs being reviewed by that Commission. For example, if multiple programs are reviewed, the educational unit may be the college.

# Supplemental Materials

The following materials are to be supplied in addition to the Self-Study Report:

* The general institution catalog covering course details and other institutional information applicable at the time of the review.
* Promotional brochures or literature describing program offerings of the institution.
* Official academic transcripts of recent graduates. The **official academic transcript** contains a listing of all the courses taken by a graduate, year/semester courses were taken, the grades earned, and degree(s) earned. The Team Chair will request a specific sampling size of transcripts for each program and will provide a timeframe in which they should be provided to program evaluators. Each academic transcript is to be accompanied by the program requirements for the graduate and by worksheets that the program uses to show how the graduate has fulfilled program requirements. It is not required to remove names and other personal identifying information from transcripts and associated student records before providing them to the Evaluation Team. However, if desired, personal identifying information may be replaced with a simple alphanumeric code by which the documents may be referred to during the evaluation.

# Submission and Distribution of Self-Study Report

**NOTE: No email submission is permitted. No hard copy submission will be accepted. No submission on a data stick is permitted. The submission cannot be a combination of hard copy and electronic file.**

The Self-Study Report and Supplemental Material should be uploaded section by section or as a single upload option as **pdf files on your institution’s page in the ABET Administration Management System.**

Catalogs that are available only electronically must be submitted in a pdf format. The catalog must be the version available at the time the Self-Study Report is prepared. Web-based versions may not be submitted.

* **To ABET Headquarters via upload by July 1** of the calendar year of the review:
  + Upload **one** Self-Study Report section by section or as a single document upload option, including all appendices for **each** program
  + Upload **one** set of the supplemental materials (**without the academic transcripts)**:
* The Team Chair and Program Evaluators will be able to access the Self-Study Report through the ABET Accreditation Management System. There will be no need to transmit these materials to the team.
* The institution’s primary contact will need to coordinate with the Team Chair to confirm where to send a set of transcripts for each program.
* Please send an e-mail to [accreditation@abet.org](mailto:accreditation@abet.org) if there are any questions.

# Confidentiality

All information supplied is for the confidential use of ABET and its authorized agents. It will not be disclosed without authorization of the institution concerned, except for summary data not identifiable to a specific institution or documents in the public domain.

# Template

The template for the Self-Study Report begins on the next page.

**ABET**

**Self-Study Report**

**for the**

**Biomedical Engineering**

**at**

**Florida International University**

**Modesto Maidique Campus**

**College of Engineering and Computing**

**10555 West Flagler Street**

**EC - 2600**

**Miami, FL 33174**

**04 June 2022**

**CONFIDENTIAL**

The information supplied in this Self-Study Report is for the confidential use of ABET and its authorized agents and will not be disclosed without authorization of the institution concerned, except for summary data not identifiable to a specific institution.

**Program Self-Study Report**

**for  
EAC of ABET  
Accreditation or Reaccreditation**

# BACKGROUND INFORMATION

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## *Program History*

Include the year implemented and the date of the last general review. Summarize major program changes with an emphasis on changes occurring since the last general review.

**B.1 History of BME at FIU**

The establishment of the Biomedical Engineering (BME) Department in 2003 was a culmination of an effort that was initiated by former Dean Gordon Hopkins and a group of faculty in the electrical and mechanical engineering programs in the mid 1990’s. At that time, BME was a major area of emphasis within each of those programs.

In the Fall of 1997, the University President, Modesto Maidique, earmarked approximately $1 million in funds to establish a Cardiovascular Engineering Center (CVEC) in the College of Engineering, through an in-house Quality Improvement Program (QIP) designed to enhance the academic excellence, external support and community impact of Florida International University (FIU). Faculty and partners in CVEC conduct research in both basic and applied areas of cardiovascular engineering.

In November 1998, FIU was awarded a $1 million Special Opportunity Award from The Whitaker Foundation to implement the MS program in biomedical engineering along with an undergraduate minor in biomedical engineering and to establish the Biomedical Engineering Institute in which the programs and faculty were initially housed.

In June of 2000, FIU received a $5 million dollar grant from the Wallace H. Coulter Foundation, to accelerate the growth of the biomedical engineering education and research programs. These funds were matched by the State for a total of $10 million in endowment for Biomedical Engineering.

Former Dean Vish Prasad, upon beginning his tenure at FIU in Fall 2001, immediately recognized the potential of the program and accelerated the planned growth of the programs. The BS program was implemented in 2002 and the PhD program was initiated in 2004. In between, in 2003, the Department of Biomedical Engineering was established to house the faculty and its programs. Under the next former Dean, Amir Mirmiran, the department added a new Chair in 2011 and two new faculty members in 2012-2013. Between 2014 and 2019, the department added five more new faculty to the program. The current Dean, John Volakis (whose tenure began in Fall 2017) focused on expanding the College of Engineering and Computing space via a new building in the Modesto Maidique Campus (MMC). The BME department is committed to have significant space in this new building. In Dec 2021, a new Interim Chair was appointed for our department and the department is growing with two new potential hires in 2022.

The program received its third accreditation in 2014. The Biomedical Engineering program at FIU is the first with masters and doctoral degrees as well as accredited bachelor degree among all of the public universities in the State of Florida and amongst the Hispanic and Minority serving universities in the nation.

**B.2 Academic Programs**

The Department of Biomedical Engineering houses the BS, MS and PhD degree programs in Biomedical Engineering. It also offers an undergraduate minor in biomedical engineering. Students who major in biomedical engineering, mechanical engineering, or electrical engineering may also enter the combined accelerated BS/MS program. This five-year program seamlessly combines the baccalaureate degree with the Master’s in biomedical engineering.

As of Fall 2021, the baccalaureate program had 333 students enrolled. In Fall 2021, the demographics for domestic students were as follows: 52.0% female, 7.2% African American, 4.2% Asian, 63.7% Hispanic and 7.5% White. 961 students have completed their BS degree and graduated from the program. The program also boasts five active student chapters including the Biomedical Engineering Society (BMES), the Alpha Eta Mu Beta Biomedical Engineering Honor Society (AEMB), IEEE-EMBS (Engineering in Medicine and Biology Society), IEEE-EPS (Electronic Packaging Society) and SPIE (Society of Photo-Optical Instrumentation Engineers).

As of Fall 2021, the graduate program had 44 students enrolled in the doctoral program and 24 in the MS program. Almost all of the doctoral students are on fully funded assistantships with either research assistantships or others funded through academic excellence fellowships or teaching assistantships offered through FIU. 51 students have completed their PhD with an average 6 years to graduation. Students in the MS program are now primarily self-funded. 117 students have completed their MS.

**B.3 Major Changes since the Last General Review**

Since the last re-accreditation, one major change has been the ability of admitting freshmen students who are calculus ready. This has allowed us to improve the quality of incoming students into our undergraduate engineering programs. Working with the department of mathematics, calculus courses modified to be geared towards engineering students via 3-sequence “Calculus for Engineers” courses. Students are provided with an interactive flowchart of their 4-year curriculum to better plan their courses by meeting the required pre- and co-reqs. A university wide effort on ‘early alerts’ has been put in place to track students underperforming in the courses. If a student is not meeting expected performance, ‘early alerts’ are initiated by instructors teaching the courses and brought to the attention of the undergraduate advisor(s).

The Senior capstone design projects are predominantly industry/clinic sponsored, and students receive advice and mentoring from department faculty, apart from the course instructor and the sponsor. Students are trained in medical device design and development while taking into consideration engineering standards, market and regulatory, in particular FDA, needs. In 2016, we initiated a Coulter Undergraduate Research Experience (CURE) program to promote and encourage undergraduates to participate in research. In recent years, we have embarked on several hybrid courses (50% online and 50% in-person) apart from our in-person and complete online course offerings. With new faculty hires, we have developed new BME undergraduate electives to expand on the breadth of biomedical engineering specialization areas to our students.

**B.4 BME Research Programs**

The research program in the Department of Biomedical Engineering prepares graduates for academic, clinical or industrial research and development in one, or more, of three cluster areas of specialization:

* Basic Research in Engineered Tissue Model Systems
* Diagnostic Bioimaging and Sensor Systems
* Therapeutic and Reparative Neurotechnology

These three areas are served by technological advancements in:

* Bio-imaging, bio-signal processing and computational modeling
* Bio-instrumentation, devices and sensors
* Biomaterials and bio-nano technology
* Cellular and tissue engineering

One of the missions of our doctoral program is to recruit, retain, graduate and serve an ethnically-diverse population of students to increase the flow of traditionally-underrepresented ethnic and gender groups in science, technology, engineering and mathematics (STEM) into the Biomedical Engineering area. To accomplish this mission, our BME program strives to create strong incentives for highly-qualified baccalaureate students underrepresented in STEM to join our and other Ph.D. programs. One approach is to foster a real individual connection between BME faculty and FIU’s minority and Hispanic students by exposing them to various research laboratories early in their undergraduate studies. We hence offer the students in the baccalaureate program multiple opportunities for conducting internships and research in the laboratories of the faculty of the department. Some of the students are also enrolled in the Honors College at FIU where the curriculum includes an “Advanced Research and Creativity” program. In 2011, we initiated an annual BME undergraduate research day and a graduate research day. These research days as well as those held by the Honors program and at the University level allow both undergraduate and graduate students to showcase their research projects and learn critical communication skills.

**B.5 Endowments Supporting the BME Program**

The BME Department is recipient of two endowments that directly impact the operations of the department and its ability to offer a quality educational program.

The Wallace H. Coulter Foundation Endowment supports the following:

* Faculty and Researcher Recruitment.
* Graduate Fellowships – to provide stipend support for outstanding graduate students.
* Undergraduate Scholarships – to recruit and retain up to five outstanding undergraduate students each year.
* Lecture Series – to support invited lectures by national and international academic, industrial and clinical experts.
* Research Initiation and Entrepreneurship- to support seed funding for translational research.
* Departmental operations – to support departmental operations and outreach, including travel support to students for conferences and workshops, student societies and support for faculty development and matching funds.
* Eminent Scholars Chair and Distinguished Professorship

The department also offers a Norman R Weldon Undergraduate Summer Research Internship to typically 2-4 students for 12 weeks each summer, and also research experience via our 3-tier CURE program (as CURE trainees, researchers, and fellows) each semester.

**B.6 Role of BME within FIU and the State University System**

The Department of Biomedical Engineering is a very high priority for the University. The establishment of the biomedical engineering programs at FIU was in response to the needs of the local industry, as well as a concerted effort University-wide to establish new and enhance existing, health-related programs. In the mid-90’s, the University added Health to its list of strategic themes. With this strategic focus came new programs University wide related to health and enhancement of existing programs towards biomedical education and research. Currently, the University’s focus is to build and enhance its research competitiveness in the biomedical sciences and engineering. A new Medical School was inaugurated in 2006 and received full accreditation in February 2013. One of the strengths of the growing BME Department is its enhanced alignment with the Herbert Wertheim College of Medicine, the Nicole Wertheim College of Nursing and Health Sciences, the College of Arts, Sciences and Education, and the most recently created Robert Stempel College of Public Health and Social Work. The vision and diligence of the founding members, investments made by the University and the development of strategic relationships have fueled the advancement of the Department.

As an illustration of FIU’s commitment to expanding biomedical research and education, since the last accreditation review research laboratory space has been allocated to the Department of Biomedical Engineering at MMC thereby further embedding Biomedical Engineering students and faculty into the Academic Health Center (constructed in the early 2010s). The university is currently in the process of constructing a new Engineering Building that will allow the expansion of the College of Engineering and Computing. Biomedical Engineering is expected to have significant space in this new building on the MMC campus.

## *Options*

List and describe any options, tracks, concentrations, etc. included in the program.

While there are no specific tracks or options, the BS BME program provides strong interdisciplinary training that integrates life sciences, physical sciences, mathematics, and multidisciplinary engineering fundamentals. These focus areas provide the foundation for three different concentration areas within the field of Biomedical Engineering; they are **Biosignals and Systems, Biomechanics and Biomaterials, and Tissue Engineering/Pre-medical**. Students select and enroll in courses within their chosen concentration area at the advanced stages of the curriculum.

## *Program Delivery Modes*

Describe the delivery modes used by this program, e.g., days, evenings, weekends, cooperative education, traditional lecture/laboratory, off-campus, distance education, web-based, etc.

Courses are offered during the day or evening primarily on-campus. The courses are mostly delivered in a face-to-face lecture mode, with a few courses offered as completely online or hybrid (50% face-to-face and 50% online). All the courses are web-assisted using the Canvas portal. Some courses have a laboratory component apart from the face-to-face lecture or online lecture format. More recently, courses are adopting the ‘active learning’ teaching involving learning assistant for classroom interactions and learning. A few courses have incorporated project-based learning in conjunction to their face-to-face lectures.

## *Program Locations*

Include all locations where the program or a portion of the program is regularly offered (this would also include dual degrees, international partnerships, etc.).

The common pre-requisite science courses are offered at the Modesto Maidique campus (MMC) and the program specific engineering courses are offered primarily at the Engineering Center (EC). With increased class sizes, we have been offering some of our large sized undergraduate engineering classes at MMC. The MMC occupies 332 acres and is home to the college of Arts and Sciences the EC 40 acres. There is a regular shuttle bus between MMC and EC.

## *Public Disclosure*

Provide information concerning all the places where the Program Education Objectives (PEOs), Student Outcomes (SOs), annual student enrollment, and graduation data specific to the program is posted or made accessible to the public. If this information is posted to the Web, please provide the URLs.

The Program Education Objectives (PEOs), Student Learning Outcomes (SLOs), annual student enrollment, and graduate data specific to our BS BME program is provided in our BME website link: <https://bme.fiu.edu/academics/degrees/>

## *Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them*

Summarize the Deficiencies, Weaknesses, or Concerns remaining from the most recent ABET Final Statement. Describe the actions taken to address them, including effective dates of actions, if applicable. If this is an initial accreditation, it should be so indicated.

A summary of the weaknesses and concerns raised from the ABET final statement in 2014 and our action items to address them along with the specifics is described below.

**G.1 Program Weakness#1:**

**Criterion 5. Curriculum** (Preparing students for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate **engineering standards** and multiple realistic constraints)

**Action Items:**

* Introduced engineering standards related lectures in BME 4800C (Design of Biomedical Systems and Devices), the first of the two-part senior design courses. The final presentation and the report submitted in this course mandated a thorough research, description, and presentation of the engineering standards. – Since Spring 2015
* Emphasis in final senior design project report in BME 4908 (Senior Design project) via a separate section on engineering standards (including regulatory standards, design standards, testing standards, and safety standards). The Faculty Evaluation rubric was also modified to explicitly score this subsection. All this was implemented since 2015-2016. We also developed a senior design handbook with guidelines and specifics of the requirements to be met by undergraduates towards their capstone senior design project (since Fall 2018).
* Availability of appropriate engineering standards for students via library, online resources etc.

**G.2 Program Concern#1:**

**Criterion 1: Students (students be advised regarding curriculum and career matters)**

We will take the following actions to address the concern regarding wait times and delays in students meeting with the advisors and the high student to advisor ratio.

**Action Items:**

* Addressed the wait times: Students make use of the Panther Success Network (PSN) to self-book appointments with their assigned advisor or may call the Advising Office Front Desk for assistance. The incorporation of virtual advising has helped increase advisor availability and reduced appointment no show rates while eliminating long wait times as advisors need to adhere to an orderly and timely schedule and pace. The College of Engineering advising staff has grown from 12 in 2015 to 19 in 2022. The Director of the Office of Undergraduate Advising (Mario Sanchez) is cross-trained on all of the engineering disciplines in the college to be able to handle cases during advisor absences.
* Management of student enrollment- In 2015-2016, the university implemented a new admission requirement for all engineering and computer science students deemed ‘Calculus I ready’ (i.e., having completed all pre-requisites for Calculus I, the gateway math course for all engineering majors). This decreased the total number of BME students requiring more intensive advising and improved the advisor to student ratio. It must be noted that many of the students entering the program that were not “Calculus I Ready” were ultimately unsuccessful and therefore the change largely benefited the students themselves. The intent was never to reduce access and students may transfer into the program once they become “Calculus I Ready”.
* Interactive curriculum flow charts (since 2017) - We developed an interactive course curriculum map for BS BME students so that they can better plan their courses for the semester(s) with interactive checks on the pre-reqs and co-reqs of each course and to recognize the optimal course sequence for timely graduation.

**G.3 Program Concern#2:**

**Criterion 6: Faculty (sufficient faculty to maintain adequate coverage of all curricular areas and meet the non-instructional requirements)**

**Action Items:**

* New faculty hires. Since 2014, we have hired 5 new faculty (one left). Currently we are in the process of hiring two more faculty members to the department. The department is requesting more faculty lines in the upcoming academic year 2022-2023 to make up for the lost faculty.
* Management of student enrollment – as discussed in concern#1. In 2015-2016, the university has implemented a new admission requirement for all engineering and computer science students deemed ‘Calculus I ready’ (i.e., having completed all pre-requisites for Calculus I, the gateway math course for all engineering majors). This decreased the total number of BME students and improved the advisor to student ratio. However, the BME program is committed to providing access and a high-quality education to all qualified students.

**GENERAL CRITERIA**

# CRITERION 1. STUDENTS

The Florida International University (FIU) Biomedical Engineering (BME) department’s vision is fully aligned with the vision of the university, stating: “the Biomedical Engineering Department will be nationally recognized for research excellence and innovation in clinical medicine and biomedical industry applications and lead education, research, and technology development in Florida”. In accordance with this vision, the Bachelor of Science in Biomedical Engineering (BSBME) program produces graduates who are prepared to work in the BME industry, prepared for graduate study in BME or related areas, and prepared for admission to U.S. and international medical schools. The BSBME program outcomes and program objectives define program exit and long-term quality metrics for BME graduates respectively.

The present section describes and delineates how the BME department, in conjunction with other entities and stakeholders at FIU, assures that entering students meet program acceptance criteria, how it monitors and evaluates students’ academic performance and progress; how it guides students through their academic curriculum and career choices; and how it assures that they meet program graduation requirements.

The program is governed through program requirements and procedures which are made available to the university, as well as the public at large, and are enforced at the university, college, and department levels.

Three primary entities share the responsibility for supporting admissions and advising services for students in the BME department at FIU:

1. The FIU Division of Academic and Career Success

2. The College of Engineering and Computing

3. The BME department.

1. ***Student Admissions***

Summarize the requirements and process for accepting new students into the program.

***FIU Admissions Requirements for First-Year Applicants***

FIU follows the minimum admissions eligibility requirements set forth in the State University System of Florida Board of Governors’ Regulation 6.002 Admission of Undergraduate First-Time-in-College, Degree-Seeking Freshmen; eligibility requirements are listed online, and in the FIU Undergraduate Catalog. First-time-in-college (FTIC) freshmen are those applicants who have earned the standard high school diploma from a Florida public or regionally accredited high school (or its equivalent), and who have earned fewer than 12 semester hours of transferable college credit. The minimum admissions eligibility requirements for undergraduate admission include one of the following:

1. A student may be admitted if he or she earns a 2.50 to 2.99 high school grade point average (GPA) on a 4.00 scale as calculated by the university, submits an official SAT and/or ACT score, and satisfies the requirements for college-level placement and high school credits (noted in the paragraph below).
2. A student may be admitted if he or she earns a 3.00 or higher high school GPA on a 4.00 scale as calculated by the university, submits an official SAT and/or ACT score, and satisfies the requirements for high school credits (noted in the paragraph below).

Eighteen academic units in college preparatory high school courses are required: four credits of English or language arts, four credits of mathematics, three credits of natural science, three credits of social science, two credits of the same foreign language, and two credits of academic electives from the fields of English, mathematics, natural sciences, social sciences, or foreign language. FIU calculates the high school GPA based only on the units listed here. Additional weight is given to honors, International Baccalaureate (IB), Association of International Credential Evaluators Inc., dual enrollment, and advanced placement courses.

These admissions criteria are the minimum requirements for eligibility. However, admission to the university is selective, and meeting minimum requirements does not guarantee admission. Available space is a consideration in admissions decisions.

FIU accepts each first-year student based on a “pathway” designed to fit his or her academic history (e.g., high school GPA) and goals. Each pathway maximizes student success based on quantitative factors (e.g., high school academic course rigor, grades, and sequence). Standardized assessment scores provide a benchmark of college readiness in math, reading, and college-level writing, and act as an assessment of skills acquired in high school and skills required to succeed in college.

First-year pathways include:

**FALL**

***Four-Year Fall***

This pathway is for high-achieving first-year students who intend to graduate from FIU in 48 months. This is the most selective of the pathways at FIU.

***Fall Supported Transition to Excellence Program (STEP) for Engineering, STEM, and Business***

FIU will admit students who demonstrate a capacity to be successful in college-level coursework to the Fall term; the pathway is designed for students who are not ready for calculus or must complete College Algebra. This will have term limits until the major advisor determines the student is ready for calculus.

**EARLY FALL**

***Early Fall Direct***

Students begin this pathway in the early Fall (i.e., Summer) term as full-time students. After successful completion of the Summer term, these students progress to the Fall term as full-time students.

***Early Fall STEP***

To provide incoming FTIC students with the best opportunity for success during the early Fall semester, we admit selected students to our Early Fall STEP pathway. Students begin this pathway in the Summer term as part-time students; if they complete the Summer successfully, then they progress to the Fall term as part-time. This pathway has term limits until the Spring term. The student will participate in out-of-class activities to supplement traditional classroom instruction. Students in engineering programs are required to enroll in a 0-credit enrichment lab, which exposes them to their engineering discipline of choice through activities and presentations.

***Top 10% Access to FIU***

FIU admits selected students to the Early Fall STEP, Early Fall, or Fall Direct pathway who are in the top 10% of their high school graduating class and are graduating from a Florida high school. Students begin this pathway in the Summer term; if they complete the Summer successfully, then they progress to the Fall term as full-time.

**SPRING**

***Spring Direct***

FIU designed the “Spring Direct” pathway to meet the needs of FTIC students who may benefit from taking two or three courses at a state college in the summer/fall prior to entering FIU. It is recommended that these students take ENC 1101 Writing and Rhetoric I, MAC 1147 Precalculus Algebra and Trigonometry, or any other general education courses they may need prior to starting FIU. The recommended number of credit hours is 11. It is not recommended they enroll at FIU as non-degree-seeking students; these students tend to have lower grades in core courses and should focus on time management and study skills at the state college prior to enrolling at FIU. They should also be aware of the excess credit policy (Florida Legislature Section 1009.286) and repeat course (Florida Statute 240.124 and Florida Administrative Code Rule 6C-7.001) rules as established by the State University System of Florida Board of Governors.

**CONNECT FOR SUCCESS**

Students participating in the Connect for Success program are admitted FIU as well as a Florida state college. While earning their Associate in Arts or select Associate of Science degree at a state college; these students work with bridge advisors as they prepare for formal admission to an FIU major. Upon completion of their AA degrees, these students begin pursuing their coursework at FIU.

**HOME EDUCATION, GED, AND OTHER NON-TRADITIONAL HIGH SCHOOL PROGRAMS**

FIU provides alternative admissions standards for applicants who have participated in home education or who have received a GED; minimum criteria are set forth and documented in Board of Governors’ regulations 6.002(2)(a)3 and 6.002(2)(a)4.

Applicants presenting a GED must present official GED results and official transcripts or any partial high school completion. Applicants with a GED from any state must achieve a total battery score of 600, with no sub score lower than 150 and a minimum test score of 1090 on the SAT after March 2016 (1490 on the SAT prior to March 2016) or a minimum composite score of 21 on the ACT. GED recipients with no college-level work meeting the minimum criteria are only considered for direct entry for the Early Fall STEP Pathway.

A student applying for admission who has participated in a non-traditional high school program must present credentials determined to be equivalent to a standard high school diploma and high school transcript. An applicant whose high school educational program is not measured in Carnegie Units must present a combined test score of a minimum of 1140 on the SAT after March 2016 or (1070 on the SAT prior to March 2016) or a minimum composite score of 23 on the ACT to be considered for admission to FIU.

***Minimum state requirements for college placement***

Minimum college-readiness benchmark scores are not required for admission but are required for college placement. The minimums are established by the Florida Department of Education and are outlined on their website, <http://www.fldoe.org/schools/higher-ed/fl-college-system/common-placement-testing.stml>, and in **Table 1.1** below.

An applicant may be admitted but required to take a PERT or ACCUPLACER placement test. Admitted students may take the PERT through FIU with approval (information is available at <https://testing.fiu.edu/>). PERT is a Florida placement test and may be offered through the public-school system or state college system. Accuplacer is a national placement exam offered through the College Board (additional information available at <https://accuplacer.collegeboard.org/>).

***Table 1.1 Standard Scores Approved by the State Board of Education***

|  |  |  |
| --- | --- | --- |
| **SAT** | **ACT** | **PERT** |
| Reading = 24 | Reading = 19 | Reading = 106 |
| Writing and Language = 25 | English = 17 | Writing = 103 |
| Math = 24 | Math = 19 | Math = 114 |

1. ***Evaluating Student Performance***

Summarize the process by which student performance is evaluated and student progress is monitored. Include information on how the program ensures and documents that students are meeting prerequisites and how it handles and documents situations when a prerequisite has not been met.

Student performance and progress are monitored through careful academic advising. Every student is assigned an academic advisor that is knowledgeable about University, College, and Departmental academic requirements for degree completion and graduation. Academic advising occurs throughout the student’s academic career. The first advising occurs after the student has been admitted to the program prior to the start of classes in an event named **Freshman Orientation** (or **Transfer Orientation** for new transfer students).

All new students who are admitted to the BME department are required to meet with an academic advisor for a college orientation and academic planning session. During such meeting the advisor may discuss transfer credit, the program curriculum including the advising flowchart, degree audit, etc. and include a 1-3 semester study plan, list to-do items for the student and include any other relevant information such as resources, FIU offices that the student may need to contact for assistance, etc. At the end of every meeting an advising report is created and saved in the Panther Success Network (PSN), viewable by both the student and advisor.

Students are encouraged to meet with their assigned academic advisor at least once a year or as frequently as needed. Regular advising sessions are strongly recommended to take place every term to reinforce important academic information, monitor and discuss the student’s academic progress, review and revise the enrollment plan as necessary, identify areas of concern, discuss academic success strategies and career, academic, and research opportunities among other topics.

PSN includes several functionalities which enables students to connect with their academic advisor, success coaches, career coaches, and tutors and stores all advising records for the student. The tool also enables advisors to search and identify students who may be performing poorly or at risk and/or in need of support. Advisors can reach out to the student and ask him/her to have a conversation about their performance. During the meeting the advisor may recommend a referral to one of the University student success partner offices (such as College Life Coaching, Tutoring, Counseling and Psychological Services, etc.) if he/she deems that a student may benefit from such a consultation.

Additionally, course instructors may issue progress alerts to students who are not performing in their courses – i.e. not submitting assignments, missing class, not doing well in exams, showing poor engagement in the course, etc. The assigned advisor is notified of the progress alert and contacts the student to let him/her know the instructor of the course has expressed concern about their performance and reminds the student to reach out to the instructor to get additional help / and contact other FIU success team offices for support.

Students who have a GPA below 2.0 are issued an advising and low GPA holds that prevent future registration activity. Such holds are removed once the student has met with his/her assigned advisor and agreed on a sound plan to raise the GPA.

**Corrective Action for Low Academic Performance**

FIU’s policy - *Undergraduate Academic Status # 340.020* explains how Undergraduate students are enter different academic statuses based on cumulative FIU GPA.

(a) Warning: A student whose cumulative GPA falls below a 2.0, indicating academic difficulty.

(b) Probation: A student on WARNING whose cumulative GPA remains below 2.0 at the end of the second consecutive semester will be placed on PROBATION, indicating serious academic difficulty. The College/School of the student on PROBATION may communicate in writing conditions which must be met in order to continue to enroll. A student who maintains a term/semester GPA of 2.0 while on PROBATION will remain on PROBATION while the cumulative GPA is below 2.0, but he/she will not be dismissed from the university.

(c) Dismissal: A student on PROBATION who receives a term/semester GPA below a 2.0 will be automatically dismissed from his/her program and the University for one academic year. An undergraduate student will not be dismissed prior to attempting a minimum of 20 semester hours of coursework. Transcripts will include a notation of the academic dismissal.

**Advising Process for students with Low Academic Performance**

**Figure 1.1** illustrates the advising process for students displaying poor academic performance. The BME department reviews all dismissal appeals filed by BME students. A determination on whether to recommend reinstatement after a first dismissal is determined by the BME Undergraduate Program Committee. The committee comprises faculty members and includes two undergraduate academic advisors and the Undergraduate Program Director. If reinstatement is recommended, the student is allowed to enroll in courses under probation status and agrees to pursue an academic plan as prescribed by the advisor who may recommend other University resources to help the student’s academic progression and success.

If the committee affirms the dismissal, the student is advised about alternate academic and career pathways, including the possibility of reapplying to the department in the future if applicable. After a minimum of one year, a student who has been dismissed from FIU or who has left voluntarily with an earned GPA of less than 2.0 may apply for readmission to the university, into the same program he or she was dismissed from or any other program.

Only students who have completed the AA degree from a Florida academic institution post-dismissal or have completed the BME pre-core courses and have met the admission requirements for transfer students for the BME program, are considered. Upon readmission, the previously dismissed student is automatically placed on academic probation. Readmitted students who have earned the AA degree subsequent to their dismissal from FIU may apply for readmission under FIU’s Academic Salvage as stated in *Re-Admission policy #340.230* (see document policy attached) whereby, if approved, the student’s FIU GPA is reset to 0.0. Students who did not enroll in any university or college for a period of at least five calendar years may apply for readmission under FIU’s *Undergraduate Academic Amnesty policy # 340.300*. If approved, the student will resume studies at FIU with a GPA of 0.0. Readmitted students may apply previously earned college-level credits toward the BSBME degree, provided that grades of C or better were earned.

For continuing students, the FIU registration system will permit students to pre-register in a course for the subsequent term if they are presently enrolled in its prerequisite. The academic advisor is alerted through a query report at the end of the current term if the student fails to complete the prerequisite. These students are notified by email to contact their advisor as soon as possible to review their course registration. The advisor then works with the student to adjust his/her course enrollment. Failure to comply with the prerequisite rule will result in the student being dropped from the course.

***Figure 1.1 Advising Process for Biomedical Engineering Majors with Low Academic Performance***



**Meeting of Course Pre-Requisites**

Course pre-requisite information is listed and stored in the University Catalog and Panthersoft Information System. A student currently enrolled in a course A that is a pre-requisite for a course B may pre-enroll in course B in the following semester (course pre-registration). Once term grades are posted, the Office of the Registrar runs a process named PERC (Post Enrollment Requirement Checking) which flags potential pre-requisite violations. The advisor then promptly reviews the PERC report for the different courses in the curriculum and checks if the system found any pre-requisite violations. The advisor then confirms if the student has successfully completed the pre-requisite(s) and if not, leaves the appropriate system option unselected and the student is administratively dropped by the system 24-48 hours later before the start of the next term. If the course pre-requisite has been transferred in or is an approved substitute pre-requisite course that has been successfully completed, the advisor may pre-assign a course pre-enrollment permission to allow the student to enroll. The advisor reconfirms that the course pre-requisite has been satisfied and clicks the option to keep the student enrolled in the course.

In rare instances where it is noticed that a student has enrolled in a course for which he/she has not met the proper pre-requisite(s) after the academic semester has begun, the advisor will reach out to the student to alert him/her of the situation and writes a memorandum addressed to the Office of the Registrar requesting to administratively drop the student. If system issues are found to be the cause of the pre-requisite violation, they are brought to the attention of the Office of the Registrar and investigated in order to identify and implement a solution.

1. ***Transfer Students and Transfer Courses***

Summarize the requirements and process for accepting transfer students and transfer credit. Include any state-mandated articulation requirements that impact the program.

**State Requirements and Process for Accepting Transfer Students**

FIU assumes responsibility for the academic quality of any credit or coursework recorded on its transcripts, whether earned at FIU or by transfer. The process for evaluating, awarding, and accepting credit not originating from FIU is guided by state law, regulations set forth by the State University System of Florida Board of Governors, and university policies and procedures. FIU follows the minimum admissions eligibility requirements set forth in Board of Governors’ Regulation 6.004 Admission of Undergraduate, Degree-Seeking Transfer Students. These requirements are listed online, and in the FIU Undergraduate Catalog.

A transfer student is a student who has earned 12 or more hours of transferable college credit since receiving a standard high school diploma or its equivalent. Eligibility for admission to FIU as a transfer student does not guarantee admission into the specific degree program to which admission is sought.

Each transfer applicant must provide official transcripts from each college or university attended since leaving high school. Transcripts must list all courses in which the student was enrolled each term, the status of each course at the end of the term, and all grades and credits awarded. For consideration for admission to FIU, a transfer applicant must have at least a 2.0 GPA.

Per Florida Statute 1007.23, applicants who receive an AA degree from a Florida state college or university are considered for admission without restriction, except for published limited-access programs or programs with prerequisites not met at the state college. Some degree programs have higher required benchmarks for admission and may require additional information or exams. An applicant transferring to FIU without an AA degree from a Florida state college or university must satisfy one of the following conditions:

1. Satisfy first-time-in-college admissions requirements with a 2.0 GPA in transfer course work, and be in good academic standing at prior institution; or
2. Have completed 30 transferable credit hours and earned at least a C or better in a college-level English class and a college-level math class, have a 2.0 GPA in transfer course work, and be in good academic standing at prior institution; or
3. Have completed 60 or more transferable credit hours, have a 2.0 GPA in transfer course work, and be in good academic standing at their prior institution.

**State Requirements and Process for Accepting Transfer Credit**

The Florida Department of Education guarantees transfer of postsecondary credit through postsecondary articulations that ensure that students transferring from one institution to another receive credit for comparable coursework without unnecessary repetition. The Statewide Postsecondary Articulation Manual outlines the articulation system used to facilitate efficient and effective progression and transfer of students between public postsecondary institutions. Using the following mechanisms, Florida guarantees transfer of postsecondary credit: Florida Statute 1007.23 Statewide Articulation Agreement (2+2); and Florida Department of Education Rule 6A-10.024 Articulation Between and Among Universities, Florida Colleges, and School Districts.

Florida Statute 1007.24(7) provides that an undergraduate student who transfers among public state colleges, 12 public state universities, and nonpublic institutions participating in the Statewide Course Numbering System shall be awarded credit by the receiving institution for courses satisfactorily completed by the student at a previous institution. The Statewide Course Numbering System facilitates the transfer of students among participating postsecondary Florida institutions; credit is awarded if courses are judged by the appropriate Statewide Course Numbering System–faculty committees to be academically equivalent to courses offered at the receiving institution, including equivalent in faculty credentials. In compliance with state law, the university accepts and awards course equivalency credit for commonly numbered courses taken at participating institutions. An online database hosts course descriptions and specific information about course transfer for commonly numbered courses.

Pursuant to Board of Governors’ Regulation 6.004, a grade of D is generally accepted for transfer credit; however, a D grade in coursework in the major field of study is subject to review and approval by faculty members from the appropriate academic department. Lower-division credits in excess of 60 credits may serve to meet specific course requirements for a degree, but credit hours represented by those courses do not count toward the total number of credit hours required for degree completion by the university. Florida Statute 1007.25(10) allows the following exception: a student who received an Associate in Arts degree from a Florida College System institution after successfully completing 60 credit hours may continue to earn additional credits at a community or state college. The university must provide credit toward the student’s baccalaureate degree for an additional community or state college course if, according to the Statewide Course Numbering System, the community or state college course is listed in the university catalog as required for the degree or as a prerequisite to a course required for the degree.

Coursework transferred from Florida institutions not participating in the Statewide Course Numbering System or from institutions outside Florida must be comparable to courses offered by FIU and completed at a postsecondary institution whose institutional accreditor is recognized by the U.S. Department of Education. The board of trustees of each constituent institution of the State University System develops regulations governing the admission of undergraduate transfer students; regulations developed by boards of trustees must align with the requirements set forth in Board of Governors’ Regulation 6.004. In addition to meeting university requirements, this regulation stipulates that undergraduate transfer applicants must be in good standing and eligible to return to the last postsecondary institution attended as a degree-seeking student, and must have a GPA of at least 2.0 on a 4.0-scale for all college-level academic courses attempted. Transfer applicants must meet the admissions requirements of the university.

An international transfer student is one who has fully enrolled in a two- or four-year higher education institution and seeks to continue his or her academic career at FIU. International student applicants must meet the admissions requirements of the university. For credit to be transferred from an international institution, applicants must submit official college and university transcripts to the FIU International Admissions office, which confirms the accreditation status of the international institution, assesses general transferability of coursework, and calculates a United States–equivalent GPA based on resources available through professional organizations including the American Association of Collegiate Registrars and Admissions Officers. International Admissions staff members work with applicants, retrieving course syllabi and academic catalog information from previously attended institutions, to articulate transferable coursework. Transfer and Transition Services staff members are consulted concerning transfer credit for the University Core Curriculum; faculty members are required to approve transfer credit for upper-division courses.

Applicants unable to retrieve official original transcripts may, on a case-by-case basis, submit unofficial transcripts to a member of the National Association of Credential Evaluation Services, which verifies documents and provides a course-by-course evaluation. All admission and transfer documentation must be provided in English. FIU prefers an American Translators Association organization to provide translations; however, other translation services are accepted on a case-by-case basis if documentation was translated outside of the United States. Information about this process is published and readily accessible via the International Admissions website.

**University Process for Determining Course Equivalency**

FIU Policy - *Transfer Credits #340.290* (attached) delineates the acceptance (i.e., transferability) of lower- and upper-division transfer credits. The policy is published and readily accessible via the online FIU Policies and Procedures Library. As stipulated by FIU Policy 340.290, a maximum of 60 lower-division credits taken by a student at an accredited, two- or four-year institution may be counted toward an undergraduate degree. Transfer and Transition Services staff have responsibility for evaluating and determining the total number of transferable lower-division credits. A maximum of 30 upper-division credits taken by a student at an accredited four-year institution may be counted toward an academic degree program, provided that the student completes the last 30 credits at FIU; departmental faculty members have responsibility for determining the total number of transferable upper-division credits.

Transfer and Transition Services staff members collaborate with faculty members determine course equivalencies applicable to academic degree programs and majors. Within the BME department, the lead faculty member for each upper-division course is responsible for evaluating course syllabi and course descriptions from the previously attended university to assess equivalency. After evaluation of foreign credentials, credits may be transferred from accredited institutions outside the United States; the same credit limits noted above apply. Transfer credits are posted on the student’s degree audit and transcript.

The following steps outline the process for determining equivalency of a course:

1. Transfer and Transition Services staff members review the institution from which the student seeks to transfer credit, the course prefix and number, and grade earned. Questions that may arise in this initial step include: Is this a two-year or four-year institution? Is it a Florida public institution; if not, is it a Florida institution that participates in the Statewide Course Numbering System? Are the general education requirements similar to those of FIU? Are courses designated as writing-intensive? Is this an institution with a semester or quarter system?

1. Staff use College Source’s Transfer Evaluation System database to access official course descriptions and course catalogs for the year in which the transfer course was completed at the originating institution. This information facilitates review by faculty members from respective. In addition to course descriptions, the Transfer Evaluation System database provides course sequences and prerequisites, which aid in determining course level. For courses with lengthy course sequences, as those in the fields of mathematics or sciences (e.g., biology, chemistry), the equivalency team requires review of syllabi to determine equivalency. Syllabi are provided by the student and may be vetted further by the Transfer and Transition Services staff using the originating institution’s website, or via direct requests to faculty members from the appropriate academic unit.

1. When reviewing syllabi, staff and faculty consider any required textbooks, chapters assigned as required reading, content covered, time spent on content, and assessments; these are compared against FIU syllabi. The number of credits the course is worth and how the course fits into the student’s major also are considered. When additional information is needed to make a course equivalency determination (e.g., whether a course is considered writing-intensive), the equivalency team conducts additional research using the institution’s website, or via direct requests to faculty members from the appropriate academic unit.

Once faculty and Transfer and Transition Services staff determine a transfer course to be equivalent to a course in the University Core Curriculum or to an upper-division course, it is articulated as a general transfer rule and automatically applied to future students transferring from the same originating institution. An overview of the transfer equivalency process is published and readily accessible on the Transfer and Transition Services website.

**Biomedical Engineering Admission of Transfer Students**

Students applying as transfer students can apply as early as one year prior to the term in which they want to enroll. Admission to FIU as a transfer student does not guarantee admission into the BSBME program.

To transfer directly into the BSBME, applicants must:

1. Submit an application to the Office of Admissions

2. Submit transcripts to the Office of Admissions

3. Meet the university’s lower-division requirements

4. Complete all of the seven pre-core courses (listed below) and have achieved a minimum of a “C” grade and a GPA of at least 2.0 in all common prerequisite courses taken

5. Have achieved a minimum GPA of 2.0

6. Additional Requirements: Students with fewer than 60 transferable academic credits must also submit their secondary school transcripts and official copies of SAT or ACT scores (this also applies to international students).

**Pre-Core Courses (17 Credits)**

BSC 2010 General Biology I

BSC 2010L General Biology I Lab

CHM 1045 General Chemistry I

CHM 1045L General Chemistry I Lab

PHY 2048 Physics I with Calculus

PHY 2048L General Physics I Lab

MAC 2311 Calculus I

Academic advisors from the Biomedical Engineering department review all transfer student applications for the BME program. Upon confirming that all admission requirements are met, advisors approve these applicants as Biomedical Engineering majors. An advising hold is immediately placed on newly admitted students to ensure they meet with a BME advisor prior to beginning their first semester. Students are presented with a BME flowchart, and advisors make recommendations for course selections based on the student’s progress toward the degree. Subsequent to advising meeting, students proceed to make their selection of classes and enroll in them. Refer to the chart in **Figure 1.2.**

***Figure 1.2 Process for Admitting and Advising Students Who Transfer to the BSBME***



1. ***Advising and Career Guidance***

Summarize the process for advising and providing career guidance to students. Include information on how often students are advised and who provides the advising (for example, program faculty member or program, departmental, college or university advisor).

**Centralized Academic Advising Services**

Academic advising takes place within FIU’s colleges and schools with centralized support provided by the Division of Academic and Career Success. Administrators and staff from this division collaborate with college and university leadership to identify and develop strategies for improving student retention and graduation rates, to implement programs supporting the university’s student success goals, and to facilitate communication across FIU. The university’s Council for Undergraduate Academic Advising comprises representatives from across multiple FIU support offices (including Advising offices within the colleges, Academic and Career Success, Enrollment Management Services, Admissions, Transfer and Transition Services, Orientation and Family Programs). The council aims to ensure uniform application of advising-related policies in a coordinated, effective approach through academic advising. The council focuses on university-wide processes, procedures, operations, and functions common across programs interrelated with academic advising. The council serves as a vehicle for communication between academic advising leadership within the university and its executive administration, with the ultimate goal of facilitating student success and meeting state and university academic requirements. Academic and Career Success and its Academic Advising Technology Team have developed and implemented a portfolio of technological tools for use by academic advisors, administrators and students serving different purposes.

* *Panthersoft* is the fundamental information system for all things academic at FIU. The system includes functionalities that facilitate admissions, registration, student financials, financial aid, grades, transcripts, and course searches and scheduling.
* *Panther Degree Audit* is a reporting tool within Panthersoft. It lists degree requirements and is broken down into sections that include the University Core Curriculum section (i.e., general education courses), state- and university-specific requirements (e.g., foreign language, civics, Global Learning requirements), and program-specific requirements. The Panther Degree Audit facilitates tracking of degree completion, allowing students and advisors to review courses and requirements completed, in progress, or remaining. The Transfer Credit Report reflects how transfer courses have been equated to FIU courses and are reflected in the Panther Degree Audit based on rules built into the system and supported by specific course evaluations performed by appropriate academic departments and faculty members.
* *The Panther Success Network* is an online platform which facilitates the connection between students and their academic advisors, instructors, success coaches, College Life coaches, career coaches and tutors, all of which comprise a student’s “Success Team.” The platform aids students in tracking degree progress through advising progress reports, advising notes, and documented achievement of major-specific milestones available for review to students and their advisors. Advisors can view a student’s file and performance to date using dashboards that highlight specific academic information.
* *The Panther Degree Pathway* generates personalized educational plans for students. The tool allows academic advisors or students to customize and adjust their academic plan while observing course prerequisites, future course offerings, and other constraints specified by the user. The tool connects with the university’s Panthersoft system, used by students to enroll in classes. The Panther Degree Pathway notifies students of open and available courses, and suggests alternative course options that help students achieve a timely graduation.
* *MyMajorMatch* is a tool which assesses the interests and skills of users; advisors may ask students to take the assessment and use the results to help guide students toward degree pathways that align with the student’s interests and academic and career goals.

Academic advisors are required to complete a set number of continuing education hours through a variety of trainings, seminars, and workshops available to the FIU advising community. Professional trainings are also available via LinkedIn. Advisors are provided professional development opportunities through attendance at national and regional advising conferences. The Division of Academic and Career Success organizes university-wide academic advising community forums and meetings with recognized national speakers to present new policies and regulations, and to discuss best advising practices, career growth and progression, and student success.

**Undergraduate Advising Provided by Colleges and Schools**

All of FIU’s colleges and schools provide advising services to their students. Key to meeting FIU’s retention- and graduation-rate goals, students declare their majors as freshmen and receive one-on-one advising within their college, school, or department. The College of Engineering and Computing’s Office of Advising provides academic and career guidance to current and prospective students. The College of Engineering advising staff has grown from 12 in 2015 to 19 in 2022. Two full-time academic advisors support the BSBME program: Ms. Saradia-Laure Lerouge and Ms. Maria Monje Ramos, together with a caseload of approximately 350 Biomedical Engineering students and 400-450 total engineering students. Both have a very high degree of understanding of the BSBME curriculum and remain up to date on university policies and procedures. Both attend BME faculty meetings to remain apprised of proposed curricular or other programmatic changes. They also collect and prepare relevant student data to present to the faculty for discussion and inform the faculty of issues that may affect academic progression, making recommendations accordingly. During the Summer of 2022 the College experienced some attrition in the advising staff and presently working to quickly hire and train new advising team members.

Admitted students are assigned to work with an academic advisor upon admission and matriculation. The academic advisor works with the same student throughout his or her enrollment. Students meet their academic advisors during freshman or transfer orientation events, which are coordinated by the university’s Office of Orientation and Family Programs.

Students make use of the Panther Success Network to self-book appointments with their assigned advisor, or may contact the Advising Office for assistance. The Panther Success Network “shows” new appointment availabilities in two-week windows, with new appointments becoming available every Monday. This provides adequate accessibility to appointments for all students. FIU’s Office of the Registrar implemented priority registration where students enroll in classes by priority dates and times based on academic standing (i.e., seniors followed by juniors). Priority registration encourages students to seek advising at earlier points of the semester. The Panther Success Network system provides appointment reminders, which improves on-time attendance.

Prior to the COVID-19 pandemic, advising appointments were conducted face-to-face or by phone. During the pandemic, advisors implemented virtual advising using remote meeting tools (i.e., Zoom). This option has proven to be very effective and popular with students and advisors. Students are able to select in-person or virtual advising appointments and have expressed appreciation for the convenience and flexibility that virtual advising offers. Other benefits have emerged through the use of virtual advising: screen sharing, messaging, and other Zoom functionalities have improved efficiency of advising. Advisors can create long-term (i.e., multi-year) study plans very quickly/easily while sharing screens with the student. Increased efficiency allows advisors to create more-detailed study plans and facilitates more robust discussion about topics such as career planning, internship opportunities, and plans for advanced study. Previously, students were urged to meet with advisors each semester. With long-term study plans containing multi-year course planning details, it is no longer critical for students to meet an advisor every term (although students have the option to meet with advisors as often as they desire, which is recommended but not enforced).

In the past, college policy was to issue an advising hold to all students with a GPA below 2.5 forcing the student to meet an advisor to lift the hold. This policy created major bottlenecks in advising and student frustration with lack of advisor appointment availability. Currently, only students with GPA below 2.0 have a mandatory advising hold. This policy, along with multi-year course planning, alleviate the immediate urgency for a student to see an advisor. Students are better informed in what they should enroll in advance via their long-term advising plan, available on the student’s Panther Success Network page. The university also uses a 90-credit progress-towards-degree check hold to ensure third-year students are on track as they enter their fourth year of the program.

**Career and Talent Development**

The Career and Talent Development unit, also under the aegis of the Division of Academic and Career Success, seeks to support career-related needs of undergraduate and graduate students, providing services unique to each academic unit. Staff members provide college-specific programming, employment outcomes data, subject matter expertise, job market trends, employer development and connections, and classroom guest speakers. The centralized staff coordinates and delivers professional development workshops and career assessments and provides career coaching for current students and alumni. Career and Talent Development has launched Career Partners, a university-wide program that trains university faculty and staff (including academic advisors) to initiate career conversations and refer students at all academic levels to the Career and Talent Development office for assistance. The Career Partners program is offered every semester; the Division of Human Resources awards professional development credit to participants.

Additionally, Career and Talent Development engages hundreds of employers in various recruitment activities (e.g., on-campus interviews, employer-led information sessions and webinars, career and internship fairs, classroom presentations, career panels). Every year, thousands of employers and job postings are carefully vetted in accordance with National Association of Colleges and Employers and Department of Labor guidelines to ensure that FIU students and alumni have access to internship and employment opportunities with reputable organizations.

***Career and Talent Development efforts within Biomedical Engineering Department***

Various BME student chapters conduct workshops and events related to resume building, skills development, job market, and interactions with industry. A summary of all student chapter-driven activities related to career and talent development is provided in Criterion 6. In addition, BME 4908 Senior Design course trains and requires each student to submit a resume while preparing to graduate. The various guest lectures in this course expose students to careers and the current BME industry.

1. ***Work in Lieu of Courses***

Summarize the requirements, process, and documentation for awarding credit for work in lieu of courses. This could include such things as life experience, Advanced Placement, dual enrollment, test out, military experience, etc.

**Credit Used to Accelerate Undergraduate Time-to-Degree**

Pursuant to State University System of Florida Board of Governors’ Regulation 6.006 Acceleration Mechanisms, public universities in Florida award credit for work in lieu of courses. Florida Statute 1007.27 specifies articulated acceleration mechanisms to shorten the time necessary for a student to complete requirements associated with the conferral of a high school diploma and a postsecondary degree. For the BSBME program, the below method is used to award credit for work in lieu of courses:

* *Credit by Exam*, which entails credit for Advanced Placement, the Advanced International Certificate of Education program, IB program, College-Level Examination Program, DSST (formerly “Defense Activity for Non-Traditional Education Support”), and Excelsior exams. Course equivalencies are included in a student’s transcript; no grades are associated with these exams.

Transfer and Transition Services staff (and, when appropriate, faculty members) review evidence and documentation submitted for accelerated credit considerations in accordance with the specifications noted above (e.g., University Core Curriculum, lower-division and upper-division courses). Accelerated credit cannot be applied to meet the residency 30-credit undergraduate degree credit requirement. If duplicate credit exists among any accelerated credit mechanism, the mechanism yielding the most credit will be awarded. Students may contact Transfer and Transition Services to appeal the acceptance or denial of credits used to accelerate time-to-degree, which must be based on additional evidence or documentation. FIU Policy 340.350 Credit Used to Accelerate Undergraduate Time-to-Degree Upon Admission is published and readily accessible via the online FIU Policies and Procedures Library.

As stipulated by Florida Statute 1007.271 and noted in FIU Policy 340.135 Dual Enrollment, dual enrollment is a mechanism of acceleration for eligible secondary students or home education students to enroll in postsecondary courses creditable toward high school completion or an associate or baccalaureate degree. Section 6 of the statute delineates curriculum standards for college-credit dual enrollment, requiring competencies, student learning outcomes, instructional materials, and course requirements to be at the same level of rigor or depth as those for non–dual enrollment postsecondary students. Pursuant to Section 9 of the statute, Commissioner of Education–appointed faculty committees establish the number of postsecondary semester credit hours of instruction and equivalent high school credits earned through dual enrollment. In accordance with Board of Governors’ Regulation 6.006 Acceleration Mechanisms, each constituent university must award credit to a dually enrolled student when he or she demonstrates competency by successfully passing an approved dual enrollment course.

1. ***Graduation Requirements***

Summarize the graduation requirements for the program and the process for ensuring and documenting that each graduate completes all graduation requirements for the program. If applicable, describe the process and documentation for how course deviations are handled to ensure that graduation requirements are met. State the name of the degree awarded (Master of Science in Safety Sciences, Bachelor of Technology, Bachelor of Science in Computer Science, Bachelor of Science in Electrical Engineering, etc.)

FIU awards undergraduate degrees only to those students who have earned at least 25 percent of the credit hours required for the degree through instruction offered by the institution. The university’s academic degree requirements for the bachelor’s degree are published in the Undergraduate Catalog, which is readily available online to faculty, advisors, and students. FIU confers the bachelor’s degree only when all degree requirements have been met; for the BSBME, these include completion of a minimum of 128 semester credit hours and completion of the last 30 credits at FIU. As stipulated by FIU Policy 340.065 Award of Initial Baccalaureate Degree, in no case is the number of credits awarded by FIU fewer than 25 percent of the total number of credits required for the degree program. The Panther Degree Audit tool provides real-time status of a student’s progress toward completion of the undergraduate degree, allowing the student and his or her advisor to monitor that at least 25 percent of credit hours required for the degree are earned through instruction offered by FIU. This is reflected in the “Total Earned Units” section, which notes transfer credits and total FIU units completed by the student.

All students who intend to graduate in a given semester must meet with the academic advisor for graduation advising, ahead of their final term registration. Graduation requirements are checked and verified to ensure they are either fulfilled or are in progress. If so, the student is counseled to complete an online graduation application. This application will initiate an online graduation certification form, which is verified again by the undergraduate advisor. If all graduation requirements are completed, or in progress, the application is certified and forwarded to the Dean of the College of Engineering and Computing for verification and approval.

The graduation requirements for the BSBME are:

1. Complete a minimum of 128 credit hours, which may include up to 60 transfer credits.
2. Complete the University Core Curriculum requirements.
3. Complete nine credit hours of summer classes.
4. Earn a cumulative GPA of 2.0 or higher at the university.
5. Meet the minimum grade required for all major, core courses, and course sequences established by the College of Engineering and Computing.
6. Achieve a minimum “C” grade in all BME program common prerequisite courses.
7. Complete BME 4930 - Undergraduate Seminar requirement.
8. Complete the last 30 credit hours at the university. Exceptions (normally not to exceed six hours) may be approved in advance by the Dean.
9. Receive recommendation by the undergraduate advisor in consultation with the Undergraduate Program Director.
10. Obtain certification by the Dean that all requirements of the degree of BSBME have been completed.

In addition to the above requirements, the completion of a minimum of eight credits in one foreign language is also required (American Sign Language is acceptable). Students who entered the university with a foreign language requirement deficiency, regardless of whether those students hold AA degrees, must complete this graduation requirement. Transferred credits are applicable to the requirement and exemption by examination is available through the Center for Testing and Career Certification. In addition, students who completed two years of high school foreign language study in one language are considered to have met the requirement.

1. ***Transcripts of Recent Graduates***

The program will provide transcripts from some of the most recent graduates. **The team chair will specify which transcripts to provide.** New programs requesting retroactive accreditation must provide transcripts from graduates from all academic years covered by the retroactive accreditation request. Transcripts should be accompanied by copies of degree audits and/or other explanations for interpreting the transcripts. State how the program and any program options are designated on the transcript. (See APPM, Section I.E.3.a.)

The BSBME program will provide transcripts at the direction of the team chair.

# CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

1. ***Mission Statement***

Provide the institutional mission statement.

**Florida International University (FIU)**

FIU has a clearly defined, comprehensive, and published mission specific to the institution and appropriate to higher education:

“Florida International University is an urban, multi-campus, public research university serving its students and the diverse population of South Florida. We are committed to high-quality teaching, state-of-the-art research and creative activity, and collaborative engagement with our local and global communities.” (In addition to dissemination in numerous institutional publications, the mission is available online at <https://www.fiu.edu/about/vision-and-mission/index.html>.)

**College of Engineering and Computing**

FIU’s College of Engineering and Computing’s mission is “to explore and introduce new frontiers in engineering and computer science and reach preeminence in the classroom, laboratory, and industry:

* **Classroom**: Prepare students for future careers by offering degree programs that address our nation’s most urgent and emerging needs.
* **Laboratory**: Explore and introduce new frontiers in engineering and computing, and foster innovation and interdisciplinary research that leads to entrepreneurial pursuits, primarily by providing engineering and computing solutions in grand challenge areas.
* **Industry**: Partner with industry to support tech transfer and innovations, enhance post-graduation opportunities for our students.” (The college mission is available online at <https://cec.fiu.edu/about/vision-mission>)

**Department of Biomedical Engineering (BME)**

“The mission of the Biomedical Engineering Department is to bridge engineering, science, and medicine:

* To educate and train the next generation of diverse biomedical engineers.
* To promote a culture of inclusion amongst all biomedical engineers.
* To conduct research leading to significant discoveries in medical sciences.
* To develop innovative medical technology.
* To translate scientific discovery and medical technology to industry or clinical practice.
* To engage with the regional to international community for knowledge dissemination.” (The department mission is available online at <https://bme.fiu.edu/academics/degrees/>.)

1. ***Program Educational Objectives***

List the program educational objectives and state where they may be found by the general public as required by APPM Section I.A.6.a.

The Program Educational Objectives (PEOs) for the Bachelor of Science in Biomedical Engineering (BSBME) are readily available, and are published in the FIU Undergraduate Catalog (<https://catalog.fiu.edu/2021_2022/undergraduate/College_of_Engineering_and_Computing/UG_Biomedical_Engineering.pdf>) and on the department’s website.

The Program Educational Objectives of the BSBME program at FIU are the following:

1. To produce graduates that continue in one or both of the following:

a. Advanced study in engineering, medicine, or the applied sciences

b. Professional practice as an engineer in a biomedical or health care related field

2. To produce graduates whose careers demonstrate proficiency in one or more of the following:

a. Clinical application of biomedical engineering tools

b. Product development, manufacturing, and commercialization in the biomedical industry

c. Participation in diverse teams

d. Biomedical engineering research

3. To produce graduates who have effective communication skills and a commitment to professionalism, leadership, ethics, and community service.

1. ***Consistency of the Program Educational Objectives with the Mission of the Institution***

Describe how the program educational objectives are consistent with the mission of the institution.

The BSBME PEOs are consistent with the mission of the institution, deriving (at least in part) from the mission of the College of Engineering and Computing, and ultimately the mission of the university. The PEOs—to produce skilled, proficient graduates prepared for advanced study or professional practice—align with the institution’s commitment to high-quality teaching, state-of-the-art research and creative activity, and engagement with the community. Success in achieving the BSBME program educational goals is supported by the institution’s overall effort to educate learners who are prepared to serve the diverse population of South Florida and to engage with the global community.

The BSBME program offers a curriculum designed to help the student gain a thorough understanding of the basic laws of science and fundamental engineering principles, while stimulating creative and innovative thinking. The program is situated at the interface of engineering and biology, and provides opportunities for concentrated knowledge acquisition in tissue engineering, biosignals and systems, and biomaterials and biomechanics. During the course of study, students are expected to develop a professional attitude, sound economic judgment, and environmental consciousness. The goal is to provide the necessary resources and instruction to help the student reach his or her full potential; to prepare the student for superior performance as a biomedical engineer; and to provide the student with the fundamental principles necessary for pursuing advanced study in the diverse fields of engineering, science, medicine, and business. Therefore, the program prepares graduates for the wide range of career opportunities that address biomedical needs within South Florida and the global community.

1. ***Program Constituencies***

List the program constituencies. Describe how the program educational objectives meet the needs of these constituencies.

**D.1** **Description**

The main constituents of the BSBME program at FIU are:

* Biomedical industry partners that hire FIU BSBME graduates;
* Graduate and health professional (e.g., medical) schools where FIU BSBME graduates seek advanced degrees;
* FIU BSBME undergraduate students; and
* FIU BSBME alumni.

**D.2** **Constituent needs**

The primary goal of the BSBME is to graduate students who meet the PEOs. Continuous effort is made by the department to produce graduates with proficiency in the qualities listed in the PEOsbased on the feedback provided by our different constituencies in order to meet our primary goal.

* + 1. ***Communication skills:*** Students learn effective communication, develop their professional and leadership skills, and engage in giving back to society. Skills and training in effective communication (oral and written) are being inculcated through multiple opportunities to present to peers and evaluators. Every core course in BME has been updated to include effective communication—written reports and/or oral presentations—as a course outcome. The Senior Design project requires both a written report as well as an oral presentation to an industrial panel by every student. Communication skills become even more essential in team projects and team efforts, in the classroom, and in the research environment.

(b) ***Team skills and project-based learning:*** Students work on teams in multiple projects while completing their curriculum at FIU. Opportunities for demonstrating leadership are available in the student societies, the senior design course, and research laboratories. Instruction and testing on effective communication is provided. BME 1008C (Intro to Biomedical Engineering) has been modified to provide a project-based learning environment. BME 2740 (BME Modeling and Simulation), BME 3721 (BME Data Evaluation Principles), and BME 3632 (BME Transport) have adopted active learning tools to improve student interactions via learning assistants in the classroom. Many courses, including BME Labs-I and II (BME 4050L, BME 4051L) and Senior design courses (BME 4800C: Design Biomedical Systems and Devices, BME 4908: Senior Design Project), offer team-based projects as part of their courses to effectively improve team working skills. These courses also offer opportunities for students to develop skills for working in diverse environments and to practice skills for effective leadership.

(c) ***Biomedical engineering research:*** Many students also conduct research in laboratories. Since 2011, the department has hosted an annual undergraduate research day (organized early Fall semester each year), offering the students a formal platform for scientific presentation. The students are also encouraged to participate in a university-wide undergraduate research conference hosted by the Honors College. Multiple students also participate at national and state scientific meetings, including the Biomedical Engineering Society national meeting, the National Conference for Undergraduate Research (NCUR), the Florida Undergraduate Research Conference (FCUR), nanoFlorida, BioFlorida.

1. Coulter Undergraduate Research Excellence (CURE) program: Since 2016, the department has offered the CURE program, an undergraduate research education program. This program allows undergraduate students to gain research experience as they progress through three tiers (i.e., trainee, researcher, fellow). Students develop independent research projects and are required to present their research results at a BME undergraduate research day. All CURE students participate in mandatory workshops, which have included discussions on effective written and oral communication in science, applying to graduate school, work-life balance, and dealing with impostor syndrome. Future topics will include responsible conduct of research and fellowship proposal writing. Feedback is requested from CURE students at the end of each semester and is used to improve program offerings and procedures. As an example of a recent program modification, applications to the CURE program were previously accepted once per year and required students to remain enrolled for the entire following academic year. In Fall 2021, we changed the program to accept applications at the end of each semester, and we now offer CURE year-round. This will open opportunities for more students to become involved in undergraduate research. In the last five years, we have had 94 participants in CURE across the trainee, researcher, and fellow levels.
2. Norman Weldon Summer Research Program: The department also runs the Norman Weldon Summer Research Scholarship. Students submit a written proposal that is evaluated by a panel of faculty members. Students chosen to enter the program conduct a paid 12-week summer research project within the BME department and are required to present their work at the BME undergraduate research day in early Fall semester.
3. Other research opportunities at the college and university-level: In addition to these departmental programs, the college-level Opportunities for Undergraduate Research and Scholarship (OURS) provides research opportunities that have included BME undergraduates. Notably, OURS helps organize Research Experiences for Undergraduate (REU) programs offered by two Engineering Research Centers (ERCs) funded by the National Science Foundation (NSF). The BME department is actively involved in both ERCs, and as a result, our undergraduate students have participated in REUs at universities across the nation. BME undergraduate students have also participated in the university-wide Maximizing Access to Research Careers (MARC) Undergraduate Student Training in Academic Research (U-STAR) program, which is supported by the National Institutes of Health (NIH), as MARC U-STAR fellows. One BME faculty member, Dr. Joshua Hutcheson, serves on the MARC U-STAR and OURS program advisory boards and directs the CURE program. In these roles, he is able to leverage feedback from participants to improve overall undergraduate research experience in all programs.

(d) ***Leadership and service via student chapters:*** The students are encouraged to participate in activities of the student chapters of professional societies. Currently the department has five very active student chapters: Biomedical Engineering Society (BMES), Alpha Eta Mu Beta (AEMB) biomedical engineering honor society, SPIE (Society for Photo-Optical Instrumentation Engineers) , IEEE-EMBS (Institute of Electrical and Electronics Engineers- Engineering in Medicine and Biology Society), and IEEE-EPS (Institute of Electrical and Electronics Engineers - Electronics Packaging Society). Details concerning these student chapters and member activities and accomplishments are given in Criterion 6. The student chapters (with BME faculty as advisors) provide annual reports and meet with the chair to discuss improvements and next steps for the BSBME program. In addition, many of our BME students are part of the Honors College (approximately 75 students per year between 2014-2021), developing leadership skills and global and local community awareness.

The department has provided financial support to students attending the national BMES conference. Faculty mentors serve as guides to the society chapters. The commitment of the students to professionalism, leadership, and community service is reflected by successful completion of multiple activities by the students.

(e) ***Engaging BME alumni:*** Furthermore, frequent announcements are sent to the students to encourage them to connect through the LinkedIn FIU Alumni chapter. While these efforts do not show that our alumni are achieving PEO-1, our anecdotal evidence informs us that many of our alumni are either continuing education in medicine or biomedical research or are employed in a related industry three to five years after graduation. We keep track of alumni employment history via LinkedIn. We are reaching out to those who are not LinkedIn members through an invitation from our departmental LinkedIn account, with the expectation that we will be able to communicate with them. In recent years, BME also communicates with alumni (and currently enrolled students) via other social media routes, including Facebook and Instagram, to provide updates about ongoing accomplishments and information about the BME department.

(f) ***Diversity lectures/discussions:*** As described in the section below, the department has been actively advocating diversity, equity, and inclusion (DEI) discussions with students, as well as exposing them to various lectures related to diversity. This allows the students’ voiced to be heard and provides students with the opportunity to hear voices of experts in the field.

As mentioned, the goal of the BSBME program is to prepare students for careers in industry and/or continuing education in graduate and professional schools. In order to achieve the PEOs designed to achieve this goal, we have identified specific areas of need for our student constituents. These needs were developed and are continuously evaluated through interactions with representatives from biomedical industry and graduate/health professional programs. The following sections discuss the process used to define student needs and actions that we have implemented to meet the student needs.

**D.2.1. Biomedical Industry**

When developing the undergraduate program, the general needs of the biomedical industry were initially determined from information presented at the Whitaker Foundation Biomedical Engineering Education summit in 2000, which was used to establish the initial PEOs. The PEOs were further updated and refined across the years as a continuous improvement to keep our program abreast of current industry requirements.

Four approaches are utilized to gather input from the biomedical industry to develop, refine, and modify our PEOs. These include general information collected at national meetings and workshops, input from industry members of the department’s Industry Advisory Board (IAB) and academia/industry/clinical advisory board, feedback from our graduates in industry, and ongoing input from industry sponsors participating in our Senior Design Project and other industry members delivering guest lectures in our BSBME courses.

* 1. ***Annual IAB event –‘Evening with Industry’:*** Our annual IAB event is organized by the BMES student chapter every Fall semester (since 2019). Invited speakers from industry and BME faculty present their work, followed by interactions with students regarding what industry seeks and their job prospects. Speakers provide input on potential job opportunities and experiences expected from BME graduates in their firms.

1. ***Industry lecture series (part of IAB efforts):*** A separate industry lecture series with guest speakers from industry are invited as part of the IEEE-EPS student chapter since Fall 2019. These meetings provide current industry directions and the experience or educational background required for students to prepare themselves better for the respective industry the speaker represents. A list of the speakers and the topics will be available during the ABET Engineering Accreditation Commission (EAC) site visit.
2. ***Guest lectures from industry representatives in BME courses:*** BME 4011 (Clinical Rotations) and BME 4908 (Senior Design Project) have guest lectures from industry representatives who share experiences in research and development, manufacturing, quality assurance, and entrepreneurship and explain industry needs to students in these courses. These sets of lectures outline the needs of industry and provide us the opportunity to receive input regarding their expectations for our graduates.
3. ***Feedback from BME senior design industry sponsors:*** BSBME senior design projects are typically industry sponsored. Every Fall/Spring semester, towards the end of the two-semester senior design project courses (BME 4800C and BME 4908), the industry sponsors provide feedback not only on the student team performance, but also on the next generation expectations on biomedical engineering skills/learning objectives for industry. Additionally, each senior design team provides an oral presentation of its project to a panel of judges (typically people from industry), which then scores the performance on a rubric to assess student learning outcomes. In addition, the senior design projects are also presented as posters at the College of Engineering and Computing’s Senior Design Capstone Project Showcase conducted at the end of each semester across all engineering disciplines. The showcase involves industry representatives from across South Florida, who participate in informal discussions.
4. ***Academic/Industry/Clinical Advisory board surveys***: In Fall 2021, the department established a new academic/industry/clinical advisory board (<https://bme.fiu.edu/biomedical-engineering-advisory-committee/>). The board was presented the current mission, vision, and PEOs of the BSBME program, along with the current updates, accomplishments, and focus of the department. Surveys were conducted to obtain input on our BSBME PEOs. This advisory board will meet annually every Fall.
5. ***Panel discussion with BME Alumni (including industry reps):*** Since Fall 2018, a 90-min panel discussion with BME alumni is conducted during the Annual BME Undergraduate Research Day. Our BME alumni from industry, an integral part of this panel discussion, provide valuable feedback on how the BSBME program prepared them for industry and what the current industry seeks in graduating engineers. These events are documented as recordings in our BME YouTube channel.

(<https://www.youtube.com/c/BiomedicalEngineeringatFIU/about>).

**Based on these interactions and discussions with industry, we have summarized the current needs** of the biomedical industry below:

* Knowledge of broad engineering fundamentals (PEOs 1a, 2a);
* Strong grounding in the life sciences, and engineering applications down to the cellular and molecular level (PEOs 1a, 2a, 2d);
* Knowledge and skills of statistical practice in the biomedical industry (PEOs 1b, 2b);
* Experience working in teams (PEOs 2c, 3);
* Excellent communication skills (PEO 3);
* Implementation and management of engineering and design projects (PEOs 1b, 2a, and 2b);
* Hands-on experience in biomedical and clinical measurements and analyses (PEOs 1b, 2a, 2b, 2d);
* Understanding of regulatory requirements for medical devices and the biomedical industry (PEOs 1b, 2b, 3);
* Ability to assess market needs for potential biomedical devices and technology (PEOs 1b, 2b); and
* Ability to work in a diverse environment with an understanding of the current DEI needs in any workplace (PEOs 2c, 3).

Based on all of the different sources of input described above, various improvements are made continuously across years to match our PEOs to the current needs of the industry (see last section of this Criterion 2).

**D.2.2. Graduate and Health Professional Schools**

The needs of health professional schools, in particular medical schools, were primarily assessed from discussions with FIU pre-medical advisors and Admissions Committee members, guest lectures by clinicians in BME seminars and BME courses, our academia/industry/clinical advisory board, and our BME alumni in health care professional and graduate schools.

(i) ***Discussion with FIU pre-med advisors and Admissions Committee members:*** One member of the BME faculty (Dr. Michael Christie) is currently on the FIU pre-medical advisory committee, and another BME faculty member (Dr. Michael Brown) has served on the FIU Herbert Wertheim College of Medicine Admissions Committee for several years in the past. These two instructors provide regular feedback to pre-health students who are working to assemble applications for health profession schools and advise faculty on up-to-date metrics through which student applications are considered for health profession programs.

***(ii) Guest lectures by clinicians and research experts in the BME department:*** Students also regularly interact with clinicians and other medical professionals through ongoing research collaborations in our department and at seminars and symposia. For example, the annual Miami Heart Day Symposium (hosted by our department every year since 2017) has featured seminars and discussion panels with cardiologists and cardiac surgeons. Undergraduate students attend these events and actively participate in the discussion. BSBME students are also invited to attend the annual International Symposium on Endovascular Therapy meeting at no cost. This meeting allows the students to interact directly with radiologists and cardiologists and to learn about areas of need in cardiovascular medicine. Our BME Coulter Seminar Series (held every Friday in the Fall and Spring semesters) invites researchers (academic and non-academic) and clinicians to share their work and experiences. These seminars are usually followed immediately with 30-min informal discussions with undergraduate and graduate students on addressing the vision and direction of their respective research or medical field. In addition to these interactions, there are in-person, zoom, and/or pre-recorded guest lectures from clinicians and researchers in the Clinical Rotations (BME 4011) course offered every semester (Fall, Spring, and Summer).

***(iii) Panel discussion with BME Alumni (including graduate students and healthcare professionals):*** Since Fall 2018, a 90-min panel discussion with BME alumni is conducted during the Annual BME Undergraduate Research Day. Our BME alumni from health care professions, medical school, and/or graduate school are an integral part of this panel discussion, and provide valuable feedback on how the BSBME program prepared them for medical or graduate school, or clinical engineering careers. Alumni discuss the current focus of these aspiring graduating engineers in these paths should be. These events are documented as recordings in our BME YouTube channel. (<https://www.youtube.com/c/BiomedicalEngineeringatFIU/about>)

**Based on these discussions, we have summarized the current needs of the Graduate and Health Profession Schools below:**

* Knowledge of broad engineering fundamentals (PEOs 1a, 2a)
* Strong grounding in life sciences and engineering applications, including cellular and molecular physiology (PEOs 1a, 2a, 2d)
* Excellent communication skills (PEO 3)
* Hands-on experience in biomedical and clinical measurements and analyses (PEOs 1b, 2a, 2b, 2d)
* Understanding of mathematical and experimental modeling of biological and physiological phenomena (PEOs 1a, 2d)
* Research experience towards improved critical thinking beyond the classroom (PEOs1a, 2d)

These general needs from the diverse sets of stakeholders described at the ends of sections D.2.1. and D.2.2. and evaluation of our programs by representatives from these groups were then coalesced into a rigorous, coherent set of needs for our students that align with the PEOs. The student needs, associated PEOs, and actions taken to address the needs are outlined in section D.2.3.

**D.2.3. Students and Alumni**

In addition to identifying needs based upon interactions with stakeholders interested in the outcomes of our graduates (industry and graduate/professional schools), the needs of students are also determined through interactions with students in our program as well as with alumni. Based upon feedback received from all constituents (sections D.2.1. and D.2.2.), the specific needs of our BSBME students to meet the PEOs are:

1. Inclusivity in the biomedical engineering community (PEOs 1b, 2c, 3)
2. Knowledge of broad engineering fundamentals (PEOs 1a, 2a)
3. Strong computing skills and hands-on experience in biomedical and clinical measurements and analyses (PEOs 1, 2a, 2b, 2d)
4. An understanding of the need for global learning, ethics, and a sense of responsibility to the surrounding community (PEO 3)
5. Experience working in teams with DEI (PEOs 2c, 3)
6. Effective communication skills (both written and oral) (PEO 3)
7. Implementation of modern engineering tools in the curriculum (PEOs 1a, 2d)
8. Participation in active learning environments (PEOs 1a, 3)
9. Development of leadership skills (PEO 3)

Examples of specific actions taken to address these needs include:

1. ***Encouraging earlier interactions with BME peers and faculty:*** Many of our students are first-generation college students (16%) and a significant number are Pell grant recipients (35%). These constituents may be less aware of the diverse career opportunities open to biomedical engineers. Our PEOs seek to prepare students for eventual careers across the wide spectrum of opportunities in health care, research, and industry. In recognition of the uniqueness of our first-generation student population, we have sought to introduce instruction and opportunities that align with our PEOs early in the undergraduate curriculum. We previously received student feedback that while completing core course requirements during their first two years (e.g., math, science, and liberal arts courses), students felt that they did not have the opportunity to interact with Biomedical Engineering faculty and did not have a sense of belonging in the department. To address this disconnect, in 2014, we began requiring that first-year students take an Introduction to Biomedical Engineering (BME 1008C) course. As part of this course, students learn about the wide variety of career opportunities available across health care, research, and industry. Students also interview current Biomedical Engineering faculty about ongoing research in the department as part of a group project requirement. The groups present findings from their interviews to the rest of the class. Students are also introduced to the CURE program at this time. **Introducing BME 1008C (Intro to Biomedical Engineering) has allowed us to promote inclusivity (need 1), introduce students to engineering fundamentals (need 2) and modern engineering tools/research (need 7), and provide instruction and feedback on communication skills (need 6).**

***(ii) Meetings with current students during the CURE program induction ceremony:*** First-year students along with parents and student inductees into the CURE program meet during the CURE induction ceremony in early Fall. The mission, vision, and objectives of the BSBME program and the opportunities provided are shared with the students. These meetings provide a forum for students to ask questions and have their concerns directly addressed, including information on:

* Skills and aptitudes necessary to compete for available positions in the biomedical industry, from start-up companies to large established corporations;
* Sufficient preparation for advanced study;
* Opportunities for interaction with fellow students, faculty, and clinical/industry partners; and
* Maintaining a collegial and dynamic environment.

During these meetings, our mission, PEOs, student learning outcomes, and the overall accreditation process are explained. Students are given opportunities to participate in discussion, ask questions, and provide feedback. Beginning in 2018, we have held annual open house events at the beginning of the Fall semester. The 2018, 2019, and 2020 open house events were combined with an induction ceremony for students entering the CURE program. The 2020 open house event was held online through Zoom due to the COVID-19 pandemic. We invited all undergraduate students, including those recently admitted to the department. In recognition of the fact that a significant portion of our student population represents students who are the first in their families to attend college, we also invited parents and guardians to attend these events. At the in-person events, representatives from academic advising and student societies (e.g., BMES, IEEE-EMBS, SPIE) set up booths to interact with students and answer questions about the program. Faculty also attended to network with students and family members. At each meeting, a presentation is given to introduce the goals of the department, including PEOs, and how to navigate the undergraduate curriculum. Students and family members are encouraged to ask questions and provide feedback at these events. In 2021, we combined the open house and CURE induction events with our annual Undergraduate Research Day, where our undergraduate students are given the opportunity to present their research projects at a judged poster symposium. We also provided tours of departmental facilities and faculty laboratories.

In 2021, we established a year-long MedTech track within the CURE program, where students work closely with the FIU Technology Management and Commercialization office to participate in intellectual property protection, entrepreneurship, and commercialization. This track supplements our efforts to increase industry involvement in our department through our IAB and our annual Industry Night, where students can meet with industry representatives, network, and seek feedback on finding a career in industry. **Our CURE program and open house activities serve to promote inclusivity (need 1), provide hand-on experiences in relevant biomedical projects (need 3), facilitate active learning that supplements coursework (need 8), and expose students to development and utilization of modern technologies (need 7).**

***(iii) Iterative improvements and continuity throughout the curriculum***: Each semester since 2014, the BME chair and the senior design course instructor (Dr. Christie) informally meet senior students after their senior design project presentations. At these meetings, the chair and course instructor solicit feedback on where students feel the BSBME program can improve to better prepare them towards their career goals. Some of the main concerns over the years have been students’ desire for design software training, additional computational courses, and hands-on experience. These were addressed by including an 8-week Solidworks training in the senior design course (BME 4908 initially and later moved to BME 4800C), introducing a one-credit Intro to Computing course (BME 1054L), and initiating an undergraduate research experience (CURE program) pathway for students to get involved in hands-on/research experiences from early on. Senior design now also emphasizes the need for assessment of global impact, which must be explicitly addressed in reports and the final presentation.

Through established collaborations between our department and health care professionals and efforts to translate technologies for the clinic, students in our program are also exposed to career opportunities within medicine. Health care and clinical opportunities are reinforced in our curriculum (BME 4011 Clinical Rotations). Our weekly departmental seminars cover topics from basic research to translational technology development to clinical case studies, and undergraduate students are encouraged to attend these talks while enrolled in the BSBME program. Through programs both inside and outside of didactic coursework, we aim to prepare students for diverse opportunities by instilling technical proficiency in engineering and biomedical fundamentals along with "soft" skills in communication and the ability to function in diverse teams. The offered programs form a thread that runs from the first year of enrollment through the capstone senior design project and ensures that PEOs are reinforced throughout. In the following sections we review these efforts in detail and describe the mechanisms through which we interface with students and other program stakeholders (alumni, industry, clinical partners) to receive formal feedback and iteratively improve. **Connecting instruction in introductory courses to concepts in senior design and exposing students to biomedical practice and professionals throughout the curriculum emphasizes engineering fundamentals (need 2), provides hands-on and relevant computational experience (need 3), emphasizes global learning (need 4), promotes collaboration (need 5), provides feedback and instruction in communication (need 6), provides hands-on experience in the utilization of modern technology (need 7), facilitates active learning (need 8), and promotes student ownership in design and innovation (need 9).**

***(iv) Chocolate with the Chair event***: Chocolate with the Chair is another annual informal meeting forum where students meet with the BME chair (Spring semesters of each year since 2018) and provide feedback on the BME program, as organized by the BMES Student Chapter. During the pandemic, this in-person event was temporarily paused in 2020 and 2021. **This event promotes inclusivity in the department (need 1).**

**(v)** ***Ad hoc surveys***: Ad hoc surveys are also conducted as needed. For example, a survey was conducted among the senior student population in 2017-2018 to assess student needs on what modern engineering tools should be introduced in the BSBME program. Based on the feedback, an 8-week Solidworks workshop as part of the BME 4908 (Senior Design Project) course. It was later realized that students would benefit significantly from learning these tools sooner, and this workshop was moved as a lab component in BME 4800C (Design Biomedical Systems and Devices) in Fall 2019. **The ad hoc surveys give the students a voice in identifying areas of potential improvement (need 1) and promote student ownership/leadership within the program (need 9).**

***(vi) Panel discussion with BME Alumni:*** Since Fall 2018 a 90-min panel discussion with BME alumni is conducted during the Annual BME Undergraduate Research Day. BME alumni from industry, academic, medical school, and graduate school are invited in an open forum discussion with BME students (mostly graduating seniors) to learn of what each career path needs are and also provide feedback on how BSBME PEOs will allow meeting them. The feedback from these alumni prepares our current BME undergraduates towards their future, and the outcomes also assist the department in assessing our PEOs on a continuous basis. **These panels provide the students with real examples that connect the fundamentals of the curriculum (need 2) to real-world outcomes in industry, graduate school and medicine (need 7).**

These annual events are documented as recordings in our BME YouTube channel.

(<https://www.youtube.com/c/BiomedicalEngineeringatFIU/about>)

***(viii) Discussion on DEI-related issues:*** Apart from focusing on the program education objectives, the department has sought to foster DEC within our department. In 2018, we established a formal DEI plan within the department to codify specific goals with measurable outcomes. As part of these efforts, our faculty now complete training offered by the FIU Office to Advance Women, Equity, and Diversity. These programs help increase faculty awareness of DEI-specific issues and help the department to identify areas of needed improvement. We review our stated DEI goals each year, and our performance is evaluated by independent Office to Advance Women, Equity, and Diversity representatives before we establish goals for the following year. The various events include:

(a) In Summer 2020, a Zoom-based BME conversation was initiated to discuss the sense of belonging within the context of national dialogue related to the importance of diversity and inclusion. Dr. Manu Platt, the 2017 BMES Diversity Lecture Award recipient, also attended via Zoom to hear and discuss with students their anxiety related to the COVID-19 pandemic and the ongoing protests over racial injustice. He also actively participated and shared his experiences. These departmental programs and conversations have sought to provide a welcoming environment where students feel empowered to express their opinions.

(b) Diversity lectures in the department: We also have held two seminars and receptions focused on the importance of DEI initiatives. The first included a reception and discussion on September 28, 2018 with Dr. Sheldon Weinbaum, a renowned researcher and recipient of the inaugural BMES Diversity Lecture Award in 2009. Dr. Manu Platt, the 2017 BMES Diversity Lecture Award recipient, joined us for a special DEI lecture and reception on February 8, 2019.

(c) Thirst for Science series: In addition to DEI-focused conversations, we also have held regular events where faculty and students can interact outside of the traditional university setting. A monthly Thirst for Science series (since Spring 2018) promotes discussion of current research topics in casual off-campus settings. Establishing inclusivity also enhances our formal feedback efforts, which we use to evaluate and improve our program.

**These events promote inclusivity (need 1) and promote perspective and awareness of broader issues in the local and global communities (need 4).**

***(vii) Alumni surveys:*** In late Summer and early Fall 2021, the department conducted an alumni survey (generated via Qualtrics). Alumni were contacted via personal email and social media (Facebook and LinkedIn) and were invited to participate in the survey. **These surveys allow us to iteratively assess and update our strategies to achieve our PEOs in a way that benefits current and future student constituents.** The action plans based on alumni survey results were discussed at the annual retreat (May 2022), and suggestions have been summarized at the end of this document.

1. ***Process for Review of the Program Educational Objectives***

Describe the process that periodically reviews the program educational objectives including how ALL of the program’s various constituencies are involved in this process. Describe how this process is systematically utilized to ensure that the program’s educational objectives remain consistent with the institutional mission, the program constituents’ needs and these Criteria.

We follow the ABET guidelines for continuous improvement of our undergraduate program. The constituent needs described above were coalesced into a rigorous, coherent set of PEOs. These PEOs are tested in relation to student outcomes through performance indicators. Educational assessment strategies and curriculum changes are evaluated internally and externally, and program education outcomes are revised as needed. The process for reviewing feedback/outcomes and iteratively altering the BSBME program is outlined in more detail in Criterion 3. Particularly for evaluation of PEOs and the associated needs identified above, feedback is recorded from the interactions with the constituents as described in the above sections (e.g. Chocolate with the Chair, Meet the Alumni, Student Chapters, CURE induction ceremony, Evening with industry, etc.). Relevant feedback and action items are discussed once per month in scheduled Undergraduate Program Committee meetings. Proposed changes to the curriculum or other program offerings are then presented to the department at scheduled faculty meetings (twice per month). Any changes to policy, curriculum, or stated objectives must be approved by faculty vote and sent for approval to relevant committees in the College of Engineering (e.g., the College Curriculum Committee). The entire BSBME program (including the PEOs) is reviewed at an annual ABET retreat held at the end of the Spring semester to ensure that the PEOs and curriculum aligns with the institutional mission and ABET criteria.

Of particular value are the data collected from our alumni. We aim to produce graduates that continue in one or both of the following:

a. Advanced study in engineering, medicine, or the applied sciences

b. Professional practice as an engineer in a biomedical or health care-related field

More details of student placement are provided below in this section E and **Figures 2.1-2.4**.

As stated, the PEOs specifically aim to produce graduates whose careers demonstrate proficiency in one or more of the following:

a. Clinical application of biomedical engineering tools

b. Product development, manufacturing, and commercialization in the biomedical

industry

c. Participation in diverse teams

d. Biomedical engineering research

**Attainment of PEOs**

The validation process (of PEOs) is no longer done, but the verification process (of Student Learning Outcomes) continues on a one-year cycle basis. Based on the sectors of employment in which our graduates are being employed or in which they enroll (including graduate or medical schools), we can be confident that they are achieving these objectives (See **Figures 2.1** and **2.2** below).

Attainment of the PEOs were assessed via surveys from alumni (to be conducted every 3 years from 2021 onwards) and the academic/industry/clinical advisory board (to be conducted every year from 2021 onwards).

The BME program has a group on LinkedIn (Alumni, Faculty and Friends of BME at FIU) and we have been encouraging students to join even before they graduate. As is expected, we are not able to locate all of the graduates from the program, and even though we require a resume be submitted at the time of graduation, many students do not have positions at the time of graduation. Alumni surveys were most recently conducted in Summer/Fall 2021 via Qualtrics. The department reached out to all alumni students from 2014-2021 (Spring) via LinkedIn, Instagram, Facebook, and directly via emails. The surveys were to assess the employment sector, their primary function and responsibility, tools/techniques used in their current jobs, involving teams in their jobs, certifications required, their salary ranges, and assessing if the BME BS PEOs were met to prepare them for current chosen careers. Survey information was acquired across 60 alumni, out of ~580 alumni between Summer 2014 to Spring 2021. Of 60 alumni students recently surveyed (2015-2021), ~25% continued their education in a graduate program or joined a medical school program, and ~50% of the students found employment in industry (biomedical as well as other types of industry) (**Figure 2.1**).

Of these alumni, >36% are involved in research activities as their primary job responsibility (**Figure 2.2)**, and >80% work in an environment where teamwork is an integral part of their current career (**Figure 2.3**). Although many industries or work environments require certifications, >50% of the jobs did not require any special certifications (such as Six Sigma, LEAN, total quality management [TQM], project management professional [PMP]) as part of their job (**Figure 2.4**). The employed alumni average salary was ~61K and median of ~69K. When surveyed on what aspects are important for BSBME students, it was agreed that (i) clinical application of biomedical engineering tools, (ii) product development, manufacturing, and commercialization in biomedical industry, (iii) participation in diverse teams, (iv) biomedical research, and (v) to produce graduates with a sense of professional responsibility, service to community, leadership, ethics, and means of communication – all of these were fairly to very important (rated 4 to 4.7 on a scale of 5) (**Figure 2.5**). When asked the importance of these aspects for their personal career, it was noted that (i) there was a bigger need or importance for (i) clinical application of biomedical engineering tools (PEO-2a); (ii) product development, manufacturing and commercialization in biomedical industry (PEO-2b); and (iii) biomedical engineering research (PEO-2d) than the general skill for BSBME students. Based on this feedback, new action items were discussed during our annual retreat in May 2022; these actions are detailed in the next section.

Chart, pie chart

Description automatically generated

**Figure 2.1 Alumni Survey 2021 – Type of Employer**

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**Figure 2.2 Alumni Survey 2021 – Primary Function/Responsibility**

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**Figure 2.3 Alumni Survey 2021 – Team work environment**

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**Figure 2.4 Alumni Survey 2021 – Certifications Required**

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**Figure 2.5 Alumni Survey 2021 – Importance of BSBME PEOs**

Feedback from the Academic/Industry/Clinical Advisory Board (**Figure 2.6**) included perceptions that the new BSBME graduates are less prepared for (i) clinical application of biomedical engineering tools (PEO-2a) and (ii) product development, manufacturing, and commercialization in the biomedical industry (PEO-2b) than what is needed as a general skill. This advisory board input is incorporated into the continuous improvement and action plans to meet the changing needs of the Biomedical Engineering industry/clinic/academia. Details of the action items as discussed during the annual BME retreated in May 2022 are provided in the next section.

However, program review is not limited to these events. Faculty attendance at Biomedical Engineering Conference regular faculty meetings (held approximately twice per month in Fall and Spring semesters), undergraduate committee meetings (held one per month in Fall and Spring semesters), annual IAB meetings (via BMES student chapter), and Academia/Industry/Clinical Advisory Board meetings (beginning Fall 2021) provides opportunities to continuously improve our program.

Chart, scatter chart

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**Figure 2.6 Industry/Academia/Clinical Advisory Board Survey 2021 – Importance of BSBME PEOs**

**Ongoing Actions items to Program Educational Objectives:**

Based on the alumni and advisory board surveys, we developed action plans for 2022-2023 during our BME annual retreat in May 2022.

|  |  |
| --- | --- |
| **Program Educational Objective (PEO)** | **Action Items for 2022-2023** |
| 2b. Product development, manufacturing, and commercialization in biomedical industry | 1. CURE MedTech program for commercialization aspects As mentioned, we recently (Summer 2021) established a MedTech track within the CURE program. In CURE MedTech, undergraduate students are embedded within the FIU Tech Transfer office for one year (there have been three trainees to date). Students commit to spending 15 hours per week helping with intellectual property research, identifying commercial potential, and analyzing translational potential of technologies developed at FIU. This experience reinforces teamwork, communication, and critical thinking important to translation of new technologies. We will collect feedback from students, Tech Transfer representatives, and our industry partners to evaluate and improve this track. **We will continue to grow this program, although it does not cater all BSBME students.** 2. Proposal to develop an **Introductory Design course** that incorporates these concepts related to PEO-2s from formative years (sophomore/early junior years) before they are strengthened in the summative years (graduating senior year). **This will cater to a majority of BSBME students** (initially as an elective in the first two years). |
| 2a. Clinical application of biomedical engineering tools | Various courses in the BSBME curriculum have been expanded in the past few years to better incorporate clinical applications of biomedical engineering tools. These include BME 1008C (Intro to BME), BME 3403 (Engineering Analysis of Biological Systems-I), BME 3404 (Engineering Analysis of Biological Systems-II), BME 4011 (Clinical Rotations), BME 4800C (Design of Biomedical Systems & Devices), BME 4908 (Senior Design Project), and BME 4930 (BME Undergraduate Seminar).  The advisory board and the alumni will receive these details and the course syllabi prior to the next annual meetings with the board members and prior to sending the alumni surveys (once every 3 years). |
| 2c. Participation in diverse teams  *Need to define ‘diverse’* | The department will revisit the wording on “diverse” to determine if we need to change the PEO. Currently, we use ‘diverse’ to mean multi-disciplinary. But, there are other aspects of diversity that could be considered.  Example: Currently, in BME 4800C, the instructor considers diverse experiences based on the spectrum of student’s past elective course selections when teams are put together. The instructor also maintains gender diversity in team formations.  - One approach is to ask BME industry about their definition of ‘diverse’ teams, via our advisory board surveys, alumni surveys, or other industry meetings/forums.  - Develop and initiate surveys about DEI – with current students, faculty/staff in the department, alumni, and industry– to understand their definition of diversity and how it should be achieved.  - A new ‘diversity’ faculty (hired via Office of Advance Women, Equity, and Diversity [<https://awed.fiu.edu/>]) is given an offer as a tenured associate professor in BME (to begin Fall 2022). If the faculty joins FIU, he or she will be taking the leads on some of these efforts to define “diversity” in the context of BME curriculum and teamwork. |
| 2d. Biomedical engineering research | - Introduce a research-based course as one of the potential BSBME approved electives. This course may be partly integrated with our CURE program. **The course will cater to a majority of the BSBME students,** beyond the relatively few students who are part of the CURE program. |

# CRITERION 3. STUDENT OUTCOMES

The Bachelor of Science in Biomedical Engineering (BSBME) program has documented Student Learning Outcomes (SLOs) that support its Program Educational Objectives (PEOs). The attainment of student outcomes (1) through (7) prepares graduates to enter the professional practice of engineering.

***A. Student Outcomes***

List the student outcomes and state where they may be found by the general public as required by APPM Section I.A.6.a. If the student outcomes used by the program are stated differently than those listed in Criterion 3, provide a mapping of the program’s student outcomes to the student outcomes (1) through (7) listed in Criterion 3. In the event that a program has not stated any student outcome verbatim as cited in the Engineering Accreditation Criteria, all elements required by that outcome must be retained. Further, the program must not alter the intent or otherwise diminish the meaning of that outcome.

With the ABET outcomes modified in 2018, the Biomedical Engineering (BME) Student Learning Outcomes (SLOs) (same as ‘Student Outcomes’ as termed by ABET) were updated accordingly in Spring 2018. The BME SLOs are the following.

Graduates of the program will possess the following skills and knowledge:

1. An ability to identify, formulate, and solve complex engineering problems (including those associated with the interaction between living and nonliving systems) by applying principles of engineering, physical (calculus-based physics, chemistry) and life sciences (biology, human physiology), and mathematics (through differential equations and statistics).
2. An ability to apply engineering design to realize/produce solutions that meet specified biomedical engineering problems and needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, health, safety, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation to measure, analyze and interpret data from living and non-living systems, and use engineering judgment to draw conclusions.
7. An ability to acquire new knowledge as needed, using appropriate learning strategies in acquiring techniques and skills necessary for biomedical engineering practice; including the ability to model and perform engineering analyses of biomedical devices, systems, components, and processes.

Each of these seven SLOs maps directly to ABET outcomes (1) – (7).

**Table 3.1** indicates the one-to-one relationship between the BME Student Learning Outcomes and the outcome requirements of ABET Criterion 3. All correlations are high; there are no low degrees of correlation across these two sets of outcomes. The BME SLOs are publicly available at <https://bme.fiu.edu/academics/degrees/>.

**Table 3.1 Relationship of BME Student Learning Outcomes (SLOs) to ABET Criterion 3 Outcomes**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ABET Criterion 3** | | | | | | | | |
|  | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Student Learning Outcomes** | A | **H** |  |  |  |  |  |  |
| B |  | **H** |  |  |  |  |  |
| C |  |  | **H** |  |  |  |  |
| D |  |  |  | **H** |  |  |  |
| E |  |  |  |  | **H** |  |  |
| F |  |  |  |  |  | **H** |  |
| G |  |  |  |  |  |  | **H** |

1. H= High Degree of Correlation

**A.1** **Process for Establishing and Revising Student Learning Outcomes**

The FIU BME SLOs were established as follows: An Undergraduate Education Committee of the FIU BME Advisory Board was established and first convened in Fall 2003. Based on their input, a draft set of Program Educational Objectives (PEOs) and SLOs were fully developed at the BME Annual Faculty and Staff Retreat in December 2003. A consultant was retained in Spring 2004 to assess our progress towards accreditation. The consultant met with our Undergraduate Education Committee and the draft PEOs and SLOs were discussed. Major modifications were suggested. Over the following Summer, the PEOs and SLOs were modified according to those suggestions and the initial set of PEOs and SLOs were approved by the BME faculty. The SLOs outcomes were further refined across the years during subsequent Advisory Board meetings and faculty retreat and regular meetings. The current BME SLOs can be found on the department’s website (<https://bme.fiu.edu/academics/degrees/>).

**A.1.1 Assessment plan**

The verification process, as depicted in **Figure 3.1**, is used to ensure that the capabilities of our graduates are consistent with the department’s SLOs. The review loop is designed as a yearly process. Outcome measures data are collected for a calendar year and reviewed at our annual departmental ABET retreat (typically at the end of the Spring semester). At each retreat, the appropriateness of the measure and measurement tools are evaluated to determine whether each outcome was met. If a modification to the measure or measurement tool is deemed necessary, data are collected for the subsequent term before assessing whether the outcome was met. If it is determined at any point that an outcome is not met, modifications to the curriculum are required. The measurement tools, which are inherently derived from the curriculum, are then modified as needed and data collected for another year.



**Figure 3.1 The BME Verification Process**

**A.1.2 Overview of the Primary and Secondary Student Measures**

The assessment plan includes two sets of outcomes measures: a primary set and a secondary set. The primary set of outcome measures has prescribed acceptance criteria (i.e., a rubric). If the rubrics are not met, action must follow (typically a root cause identification, and modification of the curriculum if the measure and measurement tool are appropriate). The secondary set of outcome measures does not contain specific rubrics. These data are used to help determine the possible reasons why the primary outcome measures were not met, if applicable, and point to possible remediation measures. For example, one primary outcome measure used was a rating of student performance on the Senior Design Project by the faculty who serve as advisors. If, over the course of one year of student design projects, the rating for a specific outcome does not meet the rubrics, then the secondary measures are used to determine where in the curriculum that outcome is not being covered adequately. The secondary outcomes measures are, for the most part, tied to specific courses. Each of the courses, in turn, has course outcomes that relate to SLOs. We then look at the courses that contribute to that outcome and analyze the secondary outcome measures to determine where changes in the program may result in improvement of that SLOs. Each of the seven SLOs is evaluated similarly and independently.

The primary set of outcomes is assessed during the summative years of the undergraduate program, while the secondary set of outcomes is assessed across the formative and summative years of the undergraduate program. **Table 3.2** summarizes the current primary and secondary student outcome measures.

**Table 3.2 Primary and Secondary Student Outcome Measures**

|  |  |
| --- | --- |
| **Primary Outcome Measure** | **Secondary Outcome Measures** |
| * Senior Design Project Evaluation (Faculty Assessment) * Senior Design-1 Course Assessment * BME Lab Course Assessment * Student Exit Survey – indirect measure | * Course outcomes for BME 1xxx-4xxx level core courses * Transcripts * Course Outcome Surveys * Student Resumes * Senior Design Project External Evaluation * Self-Assessment Student Surveys (since Fall 2021) – indirect measure |

**A.2 The Primary Student Outcome Measures are as follows:**

The four primary outcome measures are derived from student performance on the Senior Design Project (from Senior-2 or BME 4908 and Senior-1 or BME 4800C), BME lab courses (BME 4050L and BME 4051L), and student exit surveys; and are used to measure student achievement of outcomes. The FIU BME curriculum is designed such that all knowledge gained through the formative years of the curriculum is put into practice via this set of senior-level courses (BME 4050L, 4051L, 4800C, 4908) apart from the indirect measure via exit surveys. Therefore, all these measures combined encompass the entire set of SLOs.

**(i) Senior Design Project Faculty Assessment**

Each Senior Design Project team is assigned a faculty advisor/mentor. The faculty advisor employs a rubric to assess the quality of the project and assign a grade. Each item on the rubric assessment tool is assigned a grade of A-F (Outstanding, Very Good, Good, Acceptable, and Unacceptable) that is then converted to a quantitative score from 4-0. Each of these items in turn contributes to a score for each program outcome, also on a 4.0 scale. Faculty members complete their assessments using the same taxonomy as do external evaluators. This results in a direct measure of each program outcome based on specific performance on the senior design project. Student Learning Outcome E (ability to function on multidisciplinary teams) is partially assessed through a separate Self and Peer Evaluation tool (within the senior design project teams). This assessment tool is given to each student team member to fill out upon completion of the project.

**(ii) BME Senior Design-1 Course Assessment**

Each BME student is required to complete Senior-1 (BME 4800+ BME 4880, or BME 4800C since Fall 2019) prior to Senior-2. The SLO that are high in priority for Senior-1 are assessed and used as primary measures.

The Senior Design-1 Instructor uses the Senior Design-1’s course assessment tool to assess the quality of the initial phase of their senior-design project’s design and assign a grade. Each item on the assessment tool is assigned a grade of Outstanding, Very Good, Good, Acceptable and Unacceptable, which is then converted to a quantitative score from 4-0. The students/teams are assessed based on the evaluations done by the course instructor (e.g., quizzes, mid-term exam, in-class activities/presentations, final exam, project proposal presentation to the department faculty, peer review, and/or a written proposal). Each ABET outcome that is supported with high degree of relevance by this course is measured using examples selected from the evaluations.

**(iii) BME Lab Courses Assessment**

Each BME student is required to complete BME lab courses (BME 4050L and BME 4051L) during the senior year. The SLOs that are high in priority for these lab courses are assessed and used as primary measures.

The laboratory instructor uses the lab course assessment tool to assess the quality of the laboratory work and assign a grade. Each item on the assessment tool is assigned a grade of Outstanding, Very Good, Good, Acceptable and Unacceptable, which is then converted to a quantitative score from 4-0. Each of these items in turn contributes to a score for each program outcome, also on a 4.0 scale. This results in a direct measure of each program outcome based on specific performance in the two BME lab courses.

**(iv) Student Exit Survey (Indirect Measure)**

Each graduating senior is required to complete the Exit Survey. This survey asks each graduate to assess his or her own capabilities and rate the level of achievement of the outcomes, in his or her opinion, after completing the entire curriculum. Survey items use a scale 1-4, where 1 indicates “strongly disagree,” 2 indicates “disagree,” 3 indicates “agree,” and 4 indicates “strongly agree.”

**A.3** **The Secondary Program Outcome Measures are as follows:**

1. **BME 1xxx-4xxx Core Course Outcomes**

All BME required courses from 1xxx-4xxx levels are assessed here. Excluding the Senior Design Project (BME 4908) and Senior Design-1 (BME 4800+4880 or BME 4800C), and BME lab courses (BME 4050L and BME 4051L), all BME 4xxx level core courses are assessed for the respective SLOs, which is in high priority in the respective courses.

Each BME 1xxx, 2xxx, 3xxx and 4xxx core course outcome has an associated student output (homework or exam question, part of written report, etc.) that is used to assess the student’s ability to master that capability. The course instructor uses these data as a discussion item during the course review at the Faculty and Staff Annual Retreat; discussion is intended to contribute to continuous improvement in the formative years and improved summative assessment (in our primary outcome measures).

1. **Transcripts**

Since each course has outcomes that contribute to the overall SLOs, the grades each student earns in the required BME courses are also a measure of a student’s ability to master the expected capabilities.

1. **Course Outcomes Surveys**

At the end of each course, students are surveyed as to their opinion of their own mastery of the outcomes stipulated for each course. These data are quantified (achieved – 1.0, partially achieved – 0.5, and not achieved – 0.0) and used as another discussion item for each course review at the BME Annual Faculty and Staff Retreat.

1. **Student Resumes**

At the time of graduation from the program, each student is expected to provide a professional resume to the department after review by personnel from the university’s Career and Talent Development Center or qualified industry professional, research mentor, or internship supervisor. Their resumes contain extracurricular activities that contribute to the demonstration of their experiences and capabilities. Examples of such activities include participation in student organizations, working in research laboratories, and internships or co-op experience.

1. **Senior Design Project External Evaluation**

At the end of each Fall and Spring term, student teams completing their Capstone Senior Design Projects present their projects at the annual Biomedical Engineering Expo and Competition. This event, which is open to the public, comprises student presentations of projects. These projects are evaluated by a panel of judges who are practicing engineers and scientists from the medical device manufacturing industry, clinicians and, occasionally, legal experts on intellectual property. Judges evaluate students’ engineering competence, product development acumen, ability to communicate technical information, and ability to respond to technical interrogation. Then, judges determine winners of the competition, who are recognized by the department and their peers, and are awarded prizes for first-, second-, and third-place finishes. The judges also rate the student teams on their ability to demonstrate, through activities required to complete the design project, all FIU BME SLOs. The presentations are 10-12 minutes in length, followed by 10 minutes of questions from the judges. Each judge receives a four-page executive summary and additional project documentation approximately a week in advance. Based on this input, the judges rate the student team’s ability to demonstrate each Student Learning Outcome on a scale of 4-0 (Excellent, Very Good, Good, Fair, and Poor). To ensure that evaluations are consistent, judges receive a taxonomy defining these terms and their relationships to expected student performance. Projects are also evaluated with respect to SLOs A-G, and results are recorded and evaluated by the department’s Undergraduate Program Committee.

**(vi) Self-Assessment Student Surveys (Indirect Measure)**

In Fall 2021, the department began administering self-assessment student surveys across the formative and summative years of the students. These self-assessment surveys are initiated in the first few weeks of the semester to sophomores, juniors, seniors, and graduating seniors in BME 2740 (Modeling & Simulation), BME 3404 (EABS-2), BME 4800C (Senior Design-1), and BME 4908 (Senior Design-2). The same set of questions that relate to the SLOs is asked of students across different stages of the BSBME program. During BME 4908, the survey is given at the beginning and end of the course as well. The survey uses a scale of 1-5, where 1 indicates “novice,” 2 indicates “advanced beginner,” 3 indicates “competent,” 4 indicates “proficient,” and 5 indicates “expert.” This is an indirect measure that spans the formative and summative years of the BSBME program.

**A.4 Relationship of Courses in the Curriculum to the Student Learning Outcomes**

Each of the required BME courses contains a specific set of course outcomes (see course syllabi in Appendix A) that describe the capabilities that each student should possess by the end of the course. Each of these course outcomes corresponds to at least one Student Learning Outcome as indicated in the syllabus. The contribution of each required BME course to the SLOs is provided in **Table 3.3**. The level of support a specific course provides to a given Student Learning Outcome may be high (H), medium (M), or low (L). Each Student Learning Outcome is supported to a high or medium degree in at least eight different required BME courses. Since Spring 2018, the high, medium, and low levels of support offered by the courses have changed as needed during our annual ABET retreats as a way of continuously improving the courses. **Table 3.4** is a reflection of the SLOs and their level of support, based on our BME Annual ABET Retreat in May 2021 (as a part of our continuous improvement to the SLOs across BSBME-required courses).

**Table 3.3 Matrix of BME Undergraduate Student Learning Outcomes (SLOs)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course** | **Outcome** | | | | | | |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** |
| BME 1008 Intro to BME | **L** | **L** | **H** | **H** | **H** |  | **M** |
| BME 1054L Intro to BME Computing (since 2014) | **H** |  |  |  |  |  | **H** |
| BME 2740 BME Modeling & Simulation | **H** |  | **M** |  | **L** |  | **H** |
| EGM 3503 Applied Mechanics | **H** | **M** | **L** |  |  |  | **L** |
| BME 3632 BME Transport | **H** | **M** | **H** |  | **M** |  | **H** |
| BME 3403 EABS I | **H** | **L** | **H** | **L** | **L** | **H** | **M** |
| BME 3404 EABS II | **H** | **L** | **H** | **L** |  | **H** | **M** |
| BME 3721 BME Data Evaluation Principles | **H** |  | **H** | **M** | **M** | **M** | **H** |
| BME 4011 Clinical Rotations | **H** | **H** | **M** | **M** |  | **M** | **L** |
| BME 4050L Lab I | **H** | **L** | **M** | **H** | **H** | **H** | **M** |
| BME 4051L Lab II | **H** | **L** | **M** | **H** | **H** | **H** | **M** |
| BME 4880 Design Project Organization  (course number changed from BME 4090) | **H** | **H** | **H** |  | **H** | **M** | **H** |
| BME 4100 Biomaterials Science | **H** | **M** | **M** |  | **L** |  |  |
| BME 4503C Medical Instrumentation Design (course number changed from ELR 4202) |  | **H** | **H** | **L** |  | **H** | **M** |
| BME 4908 Senior Design Project | **H** | **H** | **H** | **H** | **H** | **H** | **H** |
| BME 4800 Design Biomedical Systems Dev | **H** | **H** | **H** | **H** | **M** | **H** | **M** |
| BME 4800C Design Biomedical Systems Dev (merged BME 4800/4800 since Spring 2020) | **H** | **H** | **H** | **M** | **H** | **M** | **H** |

H= High Degree of Support

M= Medium Degree of Support.

L = Low Degree of Support

**Table 3.4 Matrix of BME Undergraduate Student Learning Outcomes (updated H M L degree of support since Summer 2021)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course** | **Outcome** | | | | | | |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** |
| BME 1008 Intro to BME | **L** | **L** | **H** | **H** | **H** |  | **M** |
| BME 1054L Intro to BME Computing (since 2014) | **H** |  |  |  |  |  | **H** |
| BME 2740 BME Modeling & Simulation | **H** |  | **M** |  | **L** |  | **H** |
| EGM 3503 Applied Mechanics | **H** | **M** | **L** |  |  |  | **L** |
| BME 3632 BME Transport | **H** | **M** | **H** |  | **M** |  | **H** |
| BME 3403 EABS I | **H** | **L** | **H** | **L** | **L** | **H** | **M** |
| BME 3404 EABS II | **H** | **L** | **H** | **L** |  | **H** | **M** |
| BME 3721 BME Data Evaluation Principles | **H** | **M** | **H** | **M** | **M** | **M** | **H** |
| BME 4011 Clinical Rotations | **M** | **H** | **M** | **M** |  | **M** | **L** |
| BME 4050L Lab I | **H** |  | **H** | **H** | **H** | **H** | **M** |
| BME 4051L Lab II | **H** | **M** | **H** | **H** | **H** | **H** | **M** |
| BME 4880 Design Project Organization  (Course number changed from BME 4090) | **H** | **H** | **H** |  | **H** | **M** | **H** |
| BME 4100 Biomaterials Science | **H** | **M** | **M** |  | **L** |  |  |
| BME 4503C Medical Instrumentation Design (course number changed from ELR 4202) | **H** | **H** | **H** | **L** |  | **H** | **M** |
| BME 4908 Senior Design Project | **H** | **H** | **H** | **H** | **H** | **H** | **H** |
| BME 4800 Design Biomedical Systems Dev | **H** | **H** | **H** | **H** | **M** | **H** |  |
| BME 4800C Design Biomedical Systems Dev (merged BME 4800/4800 since Spring 2020) | **H** | **H** | **H** | **M** | **H** | **M** | **H** |

H= High Degree of Support

M= Medium Degree of Support.

L = Low Degree of Support

Additionally, a detailed curriculum map was developed based on the discussion during the May 2021 ABET retreat in the BME department. Faculty concluded that, although BME required (or core) courses support different ABET outcomes with high, medium, or low priority (or degree), courses may only address parts of the outcome and not the whole. Hence, three performance indicators were developed for each of the SLOs A to G, to demonstrate which aspect of the outcome supports each course and to ensure all aspects of each ABET outcome are supported across all BSBME required courses. The SLOs A to G and the corresponding performance indicators are given in **Table 3.5**. A detailed curriculum map showing alignment of performance indicators with respective outcomes is provided in **Table 3.6**.

**Table 3.5 Student Learning Outcomes (SLOs) A to G and the corresponding performance indicators, PI (developed Summer 2021)**

|  |
| --- |
| A - Solving Complex Problems |
| PI -1: Identify engineering problems (including those associated with interaction between living and non-living systems) |
| PI -2: Formulate solutions for engineering problems using principles of math/physics/life sciences |
| PI -3 Solve engineering problems applying math/physics/life sciences |
| B - Realize and Produce Solutions Through Engineering Design |
| PI-1 Apply engineering design to **realize** solutions |
| PI-2 Apply engineering solutions to **produce** solutions |
| PI-3 Design considerations considering safety, global, social, environmental/economic factors |
| C - Communication |
| PI-1 Providing supporting details which enhances quality of the report/presentation |
| PI-2 Uses logical organizational pattern, which enhances understanding |
| PI-3 Applies the rules of standard English |
| PI-4 Uses graphics that enhance audience understanding |
| D - Recognizing Ethical and Professional Responsibilities |
| PI-1 Recognize ethical responsibilities in engineering situations |
| PI-2 Recognize professional responsibilities in engineering situations |
| PI-3 Consider impact of engineering solutions in global, economic, environmental, health, safety, and societal contexts |
| E - Functioning Effectively on a Team |
| PI-1 Participates in the establishment of goals and workplan of the team |
| PI-2 Contributes to the development of a collaborative team environment |
| PI-3 Encourages an inclusive team environment |
| PI-4 Exhibit dependability in the achievement of the team’s goals |
| F - Measuring, Analyzing, and Interpreting Data |
| PI-1 Develop and conduct experimentation to **measure** data |
| PI-2 Develop and conduct experimentation to **analyze** data |
| PI-3 Experimental to **interpret** data, and use engineering judgement to draw conclusions |
| G - Acquiring New Knowledge |
| PI-1 Acquire **new knowledge** using appropriate learning strategies (techniques and skills) necessary for biomedical engineering practice |
| PI-2 Ability to **model** engineering analyses of biomedical devices, systems, components, and processes |
| PI-3 Ability to **perform** engineering analyses of biomedical devices, systems, components, and processes |

PI=performance indicator

**Table 3.6 Curriculum map related to BME required courses, Student Learning Outcomes (SLOs) and its corresponding performance indicators (developed Summer 2021)**

Chart, timeline

Description automatically generated

***B. Relationship of Student Outcomes to Program Educational Objectives***

Describe how the student outcomes prepare graduates to attain the program educational objectives.

The BME SLOs prepare graduates to attain the program educational objectives. The SLOs were derived from the constituent needs formalized into the PEOs, as described in the narrative response to Criterion 2. Each student learning outcome either directly or indirectly contributes to a PEO. The relationship of the BME SLOs to the PEOs is indicated in Table 3.7. PEO 1 describes type of practice graduates will pursue (professional practice as an engineer in a large entrepreneurial company; advanced study in engineering, medicine, or the applied sciences; and professional practice as an engineer in a biomedical or healthcare-related field). PEO 2 is to produce graduates whose careers demonstrate proficiency in participating in diverse teams using skills and tools acquired in their respective engineering programs. PEO 3 is to produce graduates who have effective communication skills and a commitment to professionalism, leadership, ethics, and community service.

Senior Design is the closest experience in the undergraduate curriculum that bears a resemblance to what graduates will encounter in the real world; hence, it is used for two of the primary outcome measures and two of the secondary outcome measures used to assess SLOs A-G. In fact, every one of these SLOs is found in this capstone course. Student groups are assigned, and students solve a real-world engineering problem over the duration of the semester. They are required to work as a team, communicate, and apply all that they have learned.

Another secondary outcome measure is the student resume. Preparing a good resume is critical for getting a job in the field, and students are encouraged to take advantage of services offered by the university’s Career and Talent Development office for assistance in resume preparation and interviewing skills. Courses in the program, such as Clinical Rotations BME 4011, include presentations from company executives as to what they are looking for in graduates and tips to successfully obtain a job. Students fill out exit surveys when they graduate (primary outcome measure) and self-assessment surveys at various points as they progress through the program (secondary outcome measure). These act as a gauge to how well students feel they are being prepared to attain their career goals.

**Table 3.7 Relationship of Student Learning Outcomes (SLOs) to Program Educational Objectives (PEOs)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Program Educational Objectives** | | | | | | | |
|  | | 1 | 2a | 2b | 2c | 2d | 3 |
| **Student Learning Outcomes** | A | **x** | **x** | **x** |  | **x** |  |
| B | **x** | **x** | **x** |  |  |  |
| C | **x** |  |  | **x** |  | **x** |
| D | **x** | **x** | **x** |  | **x** | **x** |
| E |  |  |  | **x** |  | **x** |
| F | **x** | **x** | **x** |  | **x** |  |
| G | **x** | **x** | **x** |  | **x** | **x** |

# 

# CRITERION 4. CONTINUOUS IMPROVEMENT

1. ***Student Outcomes***

The Bachelor of Science in Biomedical Engineering (BSBME) program at FIU conducts ongoing assessment processes that include the regular collection and evaluation of data. These assessment data provide information about the extent to which students are attaining learning outcomes. Results of these processes are utilized to affect continuous improvement of the program.

A listing and description of the assessment process used to gather the data upon which the evaluation of each Student Learning Outcome (SLO) is based is listed in Section A.1. The process for the regular assessment and evaluation of SLOs and the frequency and method for carrying out these assessment processes is described in Section A.2. The Metric Goals for the expected level of attainment of each SLO are listed in Section A.3. An analysis of the extent to which the SLOs are being attained each year, a summary of the results, and major actions to improve the program each year are described in Section A.4. Details of where the results are documented and maintained are described in Section A.5. A short summary table of all these details is given in **Table 4.1**.

The program has historical assessment data from academic year 2014-2015 onwards, the year during which the last ABET self-study was completed. In 2018, the program faculty made changes to the learning outcomes to correspond with changes made by ABET. Assessment measures were revised and in 2018-2019, the program began assessing student outcomes based on the revised outcomes. In the following response, the program has provided data and results for the assessment processes since the 2018-2019 academic year. Assessment data collected and reviewed between 2014-2015 and 2017-2018 are available onsite at program evaluators’ request.

**Table 4.1: Summary of Assessment Process, Frequency, Metrics, and Results**

|  |  |  |
| --- | --- | --- |
| **Assessment** | **Details** | **Other Comments** |
| **Listing of the Assessment material**  **(Section A.1)** | BME uses the following four primary outcomes measures to assess student outcomes:   * Senior Design Project Evaluation (direct measure) * Senior Design-1 In-Course Assessments (direct measure) * BME Lab Course Assessment (direct measure) * Student Exit Survey (indirect measure) | * Faculty assessment of senior design written project reports and presentations via internally developed rubrics. * Faculty assessment of quizzes, mid-term exam, in-class activities/presentations, final exam, project proposal presentation to the department faculty, peer review, and/or a written proposal used from senior design-1 course. * Faculty assessment of lab reports, and specific final-exam questions. * Student assessment of the learning experience using internally developed student surveys. |
| **Description of Assessment Process**  **(Section A.1)** | Data collected on an ongoing basis throughout the academic year.  Results analyzed at:   * whole-day retreat with BME faculty and staff * Faculty meetings * Undergraduate committee meetings |  |
| **Frequency of the assessment process**  **(Section A.2)** | * Once a year * Biweekly/monthly meetings | * Retreat * Faculty meeting (typically once in 2-3 weeks), Undergraduate committee meetings (every month) |
| **Expected level of attainment for each of the student outcomes**  **(Section A.3 and Table 4.3)** | * Senior Design Project Faculty Assessment (80% achieve ≥ 2.5/4.0) * Senior Design-1 Faculty Assessment (75% achieve ≥ 4.0/4.0) * BME Lab Course Assessment (80% achieve ≥ 2.5/4.0) * Student Exit Survey (90% achieve ≥ 3.0/4.0) | These target metrics are for each of the A-G BME Student Learning Outcomes |
| **Summaries of the results of the evaluation process and analysis (Section A.4 and Tables 4.4-4.6)** | Results are summarized by each academic year across all primary outcome measures and outcomes A-G. | Data tabulated for 2018-2019, 2019-2020, 2020-2021 |
| **Results documentation & maintenance (Section A.5)** | Results tabulated and stored in BME shared drives |  |

**A.1 Listing and Description of the Assessment Process**

A listing and description of the assessment processes used to gather the data upon which the evaluation of each student outcome is based. Examples of data collection processes may include, but are not limited to, specific exam questions, student portfolios, internally developed assessment exams, senior project presentations, nationally-normed exams, oral exams, focus groups, industrial advisory committee meetings, or other processes that are relevant and appropriate to the program.

A map showing the alignment between BME SLOs A-G and ABET student outcomes 1-7 is included in the narrative response to Criterion 3 (Table 3.1). For each BME SLO, four primary quantifiable outcome measures are evaluated. These four primary outcome measures, calculated for each of the seven SLOs, are listed below. This data is evaluated by the BME department faculty each year at the annual retreat through the process explained in the section. If any of the four primary outcome measures for a given student do not meet the target metric, the faculty evaluates potential causes (as a part of the continuous improvement process noted in Section B below), determining whether there was a problem with the assessment method or whether a course needs to be changed to address deficiencies. Changes to the program and a rationale for these changes are also addressed in Section A.4. Section B.1 provides a summary of changes made to individual courses and Section B.3 tabulates the significant future program improvement plans.

**Metric Goals for Each Outcome**

For each of the four primary outcome measures, the department has determined specific, quantifiable metric values that we expect the BME students to achieve. For each primary outcome measure, we expect a certain percentage of students to achieve a particular minimum score (see Table 4.2). For example, for SLO A, one of the four primary measures is from the Senior Design Project External Evaluation tool. The target metric for this outcome measure is for 80% or more of the students to achieve a score of 2.5/4.0.

We expect that all students that graduate with the BSBME have achieved the SLOs and possess, at a minimal level, the skill set that those outcomes describe. The target metrics shown above represent the kind of quality we hope to achieve from our graduates. The rationale for each outcome measure is as follows.

**Primary Outcome Measure #1: Senior Design Project Faculty Assessment**

The Senior Design Project Faculty Assessment score ranges from 0 to 4. We expect that at least 80% of all students’ senior design project teams will receive a score of 2.5 or greater on each outcome from the team faculty advisor. A score of 2.5 indicates that the student design team demonstrated above-satisfactory achievement for a particular student learning outcome. Faculty advisors of each team schedule weekly meetings with their team where all team members are required to attend and brief the advisor on the progress of the project. Each team member discusses accomplishments and planned activities for the coming week. To aid with this, each team is required to submit to its faculty advisor a summary of each individual’s contribution to the project and the percentage of that task completed by a given team member. All members of the team are required to sign this document signifying their agreement with the listed contributions and percentages. The faculty advisor then uses this summary together with the results of weekly team meetings and the student’s Self & Peer Evaluations to individually assess each team member. This score contributes 20% of the student’s grade for the course.

**Primary Outcome Measure #2 Senior Design-1 Course Assessment**

The Senior Design 1 (BME4800C, Design of Biomedical Systems and Devices) Course Assessment scores range from 0-4. It is expected that 75% of the students (individually or as team depending on the outcome) achieve a score of 4 for each outcome. A score of 4 indicates that the student or the team demonstrated above satisfactory achievement for a particular student learning outcome. The students/teams are assessed based on the evaluations done by the course instructor (Quizzes, Mid-Term Exam, In-class Activities/Presentations, Final Exam, Project Proposal Presentation to the department faculty, Peer Review, and/or a Written Proposal). Random examples for each ABET outcome that this course supports with high degree are used in turn towards this primary outcome measurement.

**Primary Outcome Measure #3: BME Lab Course Assessment**

The BME Lab Course Assessment score ranges from 0 to 4. We expect that at least 80% of all students will receive a score of 2.5 or greater on each outcome from the laboratory instructor. A score of 2.5 indicates that the student demonstrated above satisfactory achievement on a particular student learning outcome. The exception to this target metric is for SLO D. For SLO D, we require all students to complete online training on the following: Ethical use of animals in research (administered through FIU’s Institutional Animal Care and Use Committee, IACUC), and in biohazard safety, and safe laboratory practices (administered through FIU Environmental Health & Safety and Risk Management departments). We require 100% of students to complete all the trainings. If a student completes all of these online training modules, he or she receives a score of 4.0. The NIH on-line course on Human Subjects in Research which addresses the ethical conduct of human research is completed by students in in BME 4908 Senior Design.

**Primary Outcome Measure #4: Student Exit Survey**

Student Exit Survey items are scored on a range of 1 to 4. Since this is a self-assessment of overall outcomes achievement, we expect that 90% of all students will score themselves at a level of 3 or greater on each outcome. A score of 3 indicates that the student is satisfied that with attainment of the abilities represented by each outcome.

**A.2 Evaluation and Frequency of Assessment Process**

The frequency with which these assessment processes are carried out

At least once each year, typically at the end of Spring semester, the department holds a faculty and staff retreat that lasts a full day. Generally, this retreat is devoted to the undergraduate program. The results of the data collected from the undergraduate program verification process throughout the previous academic year (Fall, Spring, Summer) are thoroughly reviewed. First, the major accomplishments of the undergraduate program and the major changes made to the undergraduate program are summarized for the recent academic year. The course outcomes (i.e., learning outcomes in a given course) as assessed from student surveys on BME-required courses obtained each semester are discussed. Results related to the primary outcome measures are discussed, followed by detailed discussion of the secondary measures, particularly those derived from each of the required courses of the program. The Undergraduate Program Committee meets once a month during the Fall and Spring semesters to discuss undergraduate program-related issues. These undergraduate program issues are also summarized and updated/discussed at every regular faculty meeting. Each required course is assigned a Course Coordinator. See **Table 4.2** for a list of the current Course Coordinators and their assigned courses.

The primary actions taken to improve the program each year are given in Section A.4, below the table, listing the data for that year. Proposed changes are discussed and agreed upon during the annual faculty and staff retreats or regular faculty meetings. Proposed program changes must go through a curriculum approval process that includes both college and university committees and typically takes up to a year to become a program requirement. For example, analysis of assessment data following the 2018-2019 academic year would typically take place during the end of Fall 2019 and Spring 2020, with any major program changes implemented in Fall 2020 or Spring 2021. Changes to the university catalog that are approved by the University Curriculum Committee by early Spring semester are included in the catalog for the beginning (Fall) of the following academic year.

Changes to individual courses (other than a change in the number of credits, in pre- or co-requisites, course name, or the catalog description) are not considered “program changes” by the university and do not require Curriculum Committee approval; thus, these changes can be implemented immediately. The semester each change was implemented is given in the summaries below. As a result of the faculty discussion of individual courses, recommendations are made by each Course Coordinator and approved by the entire faculty. The approved changes are implemented in the following course offering.

**Table 4.2 Course Coordinators for BME Courses**

|  |  |
| --- | --- |
| **BME Required Course** | **Course Coordinator** |
| BME 1008 Intro to Biomedical Engineering | Wei-Chiang Lin |
| BME 1054L Intro to BME Computing (ONLINE) | Nikolas Tsoukias |
| BME 2740 Model & Simulation | Nikolaos Tsoukias, Zachary Danziger |
| BME 3632 Transport | Sharan Ramaswamy/ Joshua Hutcheson/ Anuradha Godavarty |
| EEL 3310 Circuit Analysis and Lab | Gustavo Roig (Electrical) |
| EGM 3503 Applied Mechanics | Leonard Lagos |
| BME 3403 EABS I | Michael Brown |
| BME 3404 EABS II | Michael Brown |
| BME 3721 Data Evaluation Principles | Markondeya Raj Pulugurtha, James Schummers |
| BME 4011 Clinical Rotations | Michael Brown |
| BME 4050L Lab I (HYBRID in Fall 2020) | Shuliang Jiao, Michael Christie |
| BME 4051L Lab II (HYBRID in Spring 2021, and one section in Spring 2022) | Shuliang Jiao, Michael Christie |
| BME 4880 Design Project Organization (merged to BME 4800C, Fall 2019 onwards) | Hamid Shahrestani, Michael Christie |
| BME 4100 Biomaterials | Michael Christie |
| BME 4503C Medical Instrumentation Design (ONLINE) | Jessica Ramella-Roman |
| BME 4800 Des Bio System Dev, Prior to Spring 2021 | Hamid Shahrestani, Michael Christie |
| BME 4800C Des Bio System Dev (merged version of BME 4880 & BME 4800) (HYBRID since Spring 2021) | Hamid Shahrestani, Michael Christie |
| BME 4908 Sr. Design Project | Michael Christie |

**A.3 Expected Level of Attainment for each of the Student Outcomes**

The expected level of attainment (or target metrics) for each of the SLOs across the four primary measures of assessment in given in **Table 4.3**.

**Table 4.3: Outcome Measures and Target Metrics**

|  |  |  |
| --- | --- | --- |
| **Outcome** | **Measure** | **Metric Target** |
| A. An ability to identify, formulate, and solve complex engineering problems (including those associated with the interaction between living and nonliving systems) by applying principles of engineering, physical (calculus-based physics, chemistry) and life sciences (biology, human physiology), and mathematics (through differential equations and statistics). | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 |
| Senior Design-1 Faculty Assessment | 75% achieve = 4.0/4.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 |
| Student Exit Survey | 90% achieve ≥ 3.0/4.0 |
| B. An ability to apply engineering design to realize/produce solutions that meet specified biomedical engineering problems and needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 |
| Senior Design-1 Faculty Assessment | 75% achieve = 4.0/4.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 |
| Student Exit Survey | 90% achieve ≥ 3.0/4.0 |
| C. An ability to communicate effectively with a range of audiences. | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 |
| Senior Design-1 Faculty Assessment | 75% achieve = 4.0/4.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 |
| Student Exit Survey | 90% achieve ≥ 3.0/4.0 |
| D. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, health, safety, and societal contexts. | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 |
| Senior Design-1 Faculty Assessment | 75% achieve ≥ 4.0/4.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 |
| Student Exit Survey | 90% achieve ≥ 3.0/4.0 |
| E. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 |
| Senior Design-1 Faculty Assessment | 75% achieve = 4.0/4.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 |
| Student Exit Survey | 90% achieve ≥ 3.0/4.0 |
| F. An ability to develop and conduct appropriate experimentation to measure, analyze and interpret data from living and non-living systems, and use engineering judgment to draw conclusions. | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 |
| Senior Design-1 Faculty Assessment | 75% achieve = 4.0/4.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 |
| Student Exit Survey | 90% achieve ≥ 3.0/4.0 |
| G. An ability to acquire new knowledge as needed, using appropriate learning strategies in acquiring techniques and skills necessary for biomedical engineering practice; including the ability to model and perform engineering analyses of biomedical devices, systems, components and processes. | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 |
| Senior Design-1 Faculty Assessment | 75% achieve = 4.0/4.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 |
| Student Exit Survey | 90% achieve ≥ 3.0/4.0 |

**A.4 Summaries of the Results of the Evaluation Process, Analysis, and Actions Taken to Improve the Program**

Summaries of the results of the evaluation process and an analysis illustrating the extent to which each of the student outcomes is being attained

Metric goals have been established for each of the primary outcome measures, based on a target percentage of students (80-90%) achieving a target score (above average) from the measurement tool. **Tables 4.4-4.7** represent the data starting from 2018-2019 to 2021-2022. The tables display, for each outcome and their four measures, the average score achieved, the target metric, and the percentage of students that achieved equal to or greater than the target metric. The Metric values highlighted in **bold** and marked with **\*\*** indicate results below the target metric for that given outcome by the specific measurement tool.

The data from academic year 2018-2019 (*i.e.*, Fall 2018 to Summer 2019) is shown in **Table 4.4**.

**Table 4.4: Outcome Measures, Target Metrics and Outcome Data for 2018-2019**

**(Fall 2018 – Spring 2019)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Outcome** | **Measure** | **Metric Target** | **Avg. Score (100%)** | **Metric** |
| A | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 82.9 | 81.3 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 88.3 | 86.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 81.0 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 80.0 | **89.8\*\*** |
| B | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 88.4 | 91.3 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 88.3 | 86.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 84.5 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 83.3 | **89.8\*\*** |
| C | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 91.9 | 97.5 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 91.9 | 93.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 86.7 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 82.9 | 91.5 |
| D | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 90.1 | 88.8 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 98.4 | 99.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | - | - |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 83.3 | **89.8\*\*** |
| E | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 89.3 | 92.5 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 98.5 | 97.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 93.0 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 83.8 | 93.2 |
| F | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 84.7 | 86.3 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 85.8 | 81.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 79.0 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 81.3 | **89.8\*\*** |
| G | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 90.6 | 92.5 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 82.6 | 76.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 79.8 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 83.8 | 91.5 |

**\*\* Indicates metric not met**

**Note on Metric Calculations:**

* Senior Design Project Faculty Assessment – Originally reported as weighted scores and then converted to GPA.
* BME Lab Course Assessment - Originally reported as GPA data out of 4, already averaged
* Senior Design 1 Course Assessment – Originally reported as total % of students who got a 100 (4.0/4.0) on each outcome related question.
* Student Exit Survey – Originally reported as categorical data (1-4 = Very dissatisfied, Dissatisfied, Satisfied, Very satisfied) rather than GPA. 90% achieve ≥ 2.5/4.0 interpreted as number of students reporting Satisfied or Very Satisfied.

Number of students evaluated in Senior Design Project Faculty Assessment: **80**

Number of students evaluated in BME Lab 1 & 2: **88+82 = 170**

Number of students evaluated in Senior Design 1 (Fall: BME 4880 & BME 4800, Spring: BME 4880): **44+44+42= 130**

Number of students completing Student Exit Survey: **59**

**Concerns and Remedial Action (based on 2018-2019 outcome data):** The impact of introducing Calculus-ready as BSBME admission requirement in Summer 2015, and introducing calculus for engineers (MAC 2281, 2282, 2283) in 2017-2018 began to positively impact outcomes related to identify, formulate and solve complex engineering problems using engineering principles (new SLO-A). There was significant improvement in all outcomes and scoring, with only SLO-G related to acquiring new knowledge, ability to model and perform engineering analysis scored low by one measure (BME Labs) but improved before the graduation via Senior-1 and Senior-2 (Senior Design Project) and students’ exit surveys.

**Additional changes as part of continuous improvement**: As a continuous improvement to the BME senior design courses, in Fall 2019, the BME 4800 and BME 4880 were merged as one 4-credit hour course (BME 4800C) and a lab component included. Students need to pass both these courses to continue taking BME 4908 (Senior Design Project) and merging these two synergistic courses was thus deemed appropriate. The 7-week SolidWorks workshop was now offered as part of BME 4800C course. In prior semesters, this workshop was offered in Senior-2 (BME 4908) but has been moved a semester ahead to BME 4800C to better prepare students with required design skills for their senior design project. In addition, all BME core courses (except the 1-credit hour BME 1054L Intro to BME Computing course) had implemented written and/or oral communication skills as one of their course outcomes (either as low, medium, or high priority) to continue strengthening these skills not just in senior years, but during the formative years (freshman to junior) as well.

The data from academic year 2019-2020 (*i.e.*, Fall 2019 to Summer 2020) is shown in **Table 4.5**.

**Table 4.5: Outcome Measures, Target Metrics and Outcome Data for 2019-2020**

**(Fall 2019 – Spring 2020)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Outcome** | **Measure** | **Metric Target** | **Avg. Score (100%)** | **Metric** |
| A | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 88.8 | 95.3 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 90.2 | 90.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 83.4 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 84.3 | **88.9\*\*** |
| B | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 91.4 | 98.4 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 90.2 | 90.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 82.0 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 81.9 | **85.2\*\*** |
| C | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 93.7 | 98.4 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 87.4 | 87.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 84.4 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 81.5 | **83.3\*\*** |
| D | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 91.9 | 90.9 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 91.2 | 96.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 82.3 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 81.9 | **88.9\*\*** |
| E | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 92.9 | 98.4 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 89.3 | 88.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 85.6 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 84.7 | 90.7 |
| F | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 88.8 | 90.6 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 88.9 | 89.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 82.8 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 81.9 | **85.2\*\*** |
| G | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 94.5 | 98.4 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 87.3 | 87.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 87.5 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 83.8 | 90.7 |

**\*\* Indicates metric not met**

**Note on Metric Calculations:**

* Senior Design Project Faculty Assessment – Originally reported as weighted scores and then converted to GPA.
* BME Lab Course Assessment - Originally reported as GPA data out of 4, already averaged
* Senior Design 1 Course Assessment – Originally reported as total % of students who got a 100 (4.0/4.0) on each outcome related question.
* Student Exit Survey – Originally reported as categorical data (1-4 = Very dissatisfied, Dissatisfied, Satisfied, Very satisfied) rather than GPA. 90% achieve ≥ 2.5/4.0 interpreted as number of students reporting Satisfied or Very Satisfied.

Number of students evaluated in Senior Design Project Faculty Assessment: **33+31=64**

Number of students evaluated in BME Lab 1 & 2: **76+80 = 156**

Number of students evaluated in Senior Design 1 (Fall: BME 4880 & BME 4800, Spring: BME 4880): **40+40+37= 117**

Number of students completing Student Exit Survey: **54**

**Concerns and Remedial Action (based on 2019-2020 outcome data):** The SLOs with lower-than-desired scores were all from students’ exit surveys. With the onset of pandemic in Spring 2020, a sudden switch from in-person classes to remote learning via zoom and/or recordings may have impacted students’ self-assessment of their abilities across outcomes. This might be especially true for senior design projects, which require students to apply engineering design to realize/produce solutions to biomedical engineering problems (outcome A), develop and conduct experimentation to measure analyze and interpret data (outcome F), and effective communication across team members (outcome C). Here, students missed a part of their hands-on experience in their capstone project. Moving the 7-week SolidWorks workshop from BME 4908 to BME 4800C (a semester prior to senior design project) positively impacted outcome G from 2018-2019 scores.

A Qualtrics survey was administered to all BME faculty and teaching assistants (TAs) to immediately compile best practices of remote teaching, assessing, platforms used etc. (due to the pandemic), as a steep learning curve to ensure that quality education is continued from Summer 2020 semester onwards. The best practices were implemented across courses from Summer 2020, which possibly and positively impacted the Student Exit Surveys in 2020-2021 (as shown in **Table 4.6**).

The data from academic year 2020-2021 (*i.e.*, Fall 2020 to Summer 2021) is shown in **Table 4.6**.

**Table 4.6: Outcome Measures, Target Metrics and Outcome Data for 2020-2021**

**(Fall 2020 – Spring 2021)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Outcome** | **Measure** | **Metric Target** | **Avg. Score (100%)** | **Metric** |
| A | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 94.2 | 93.5 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 90.9 | 95.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 81.0 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 88.0 | 93.8 |
| B | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 96.1 | 100.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 90.9 | 95.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 80.3 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 87.4 | 95.1 |
| C | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 97.7 | 98.7 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 94.6 | 98.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 83.0 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 89.8 | 96.3 |
| D | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 92.7 | 93.5 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 98.0 | 98.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | - | - |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 90.4 | 97.5 |
| E | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 96.1 | 100.0 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 95.5 | 96.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 78.3 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 91.1 | 96.3 |
| F | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 93.2 | 93.5 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 90.6 | 95.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 78.5 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 89.5 | 96.3 |
| G | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 96.1 | 98.7 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 90.3 | 96.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 92.0 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 88.6 | 97.5 |

**\*\* Indicates metric not met**

**Note on Metric Calculations:**

* Senior Design Project Faculty Assessment – Originally reported as weighted scores and then converted to GPA.
* BME Lab Course Assessment - Originally reported as GPA data out of 4, already averaged
* Senior Design 1 Course Assessment – Originally reported as total % of students who got a 100 (4.0/4.0) on each outcome related question.
* Student Exit Survey – Originally reported as categorical data (1-4 = Very dissatisfied, Dissatisfied, Satisfied, Very satisfied) rather than GPA. 90% achieve ≥ 2.5/4.0 interpreted as number of students reporting Satisfied or Very Satisfied.

Number of students evaluated in Senior Design Project Faculty Assessment: **31+46 = 77**

Number of students evaluated in BME Lab 1 & 2: **99+87 = 186**

Number of students evaluated in Senior Design 1 (Fall: BME 4800C, Spring: BME 4800C): **52 + 39 = 91**

Number of students completing Student Exit Survey: **81**

**Concerns and Remedial Action (based on 2020-2021 outcome data):** The data in **Table 4.6** provides further evidence that the BSBME program is generally meeting the program’s SLOs for students that have graduated during the current accreditation cycle. It is noteworthy that the results of the Student Exit Surveys for 2020-2021 exceeded the target metric for each SLO, even though these students graduated during the pandemic. Overall, all SLOs were met across all the primary outcomes and no specific remedial action was taken.

**Additional changes as part of continuous improvement**: As a continuous improvement, in Fall 2021 the tutoring program offered by Center for Diversity and Student Success at FIU’s College of Engineering and Computing assessed the numbers of Fs (fails), DRs (drop), and INCs (incompletes) earned by students who came to tutoring (with tutoring initially initiated for key courses across all engineering departments since Fall 2018). They found that none of the students that attended tutoring more than once failed, and they also tracked the number of sessions and courses for which tutoring was offered.

The data from academic year 2021-2022 (*i.e.*, Fall 2021 to Spring 2022) is shown in **Table 4.7**.

**Table 4.7: Outcome Measures, Target Metrics and Outcome Data for 2021-2022**

**(Fall 2021 – Spring 2022)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Outcome** | **Measure** | **Metric Target** | **Avg. Score (100%)** | **Metric** |
| A | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 95.0 | 97.6 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 82.9 | 83.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 80.3 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 81.9 | 95.8 |
| B | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 97.0 | 97.6 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 82.9 | 83.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 89.3 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 82.4 | 92.7 |
| C | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 97.7 | 98.8 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 90.2 | 90.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 82.8 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 82.1 | 95.8 |
| D | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 94.1 | 91.5 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 92.3 | 90.5 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | - | - |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 83.0 | 96.9 |
| E | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 95.8 | 98.8 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 88.7 | 86.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 83.8 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 84.6 | 93.8 |
| F | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 96.5 | 96.3 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 83.4 | 83.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | - | - |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 81.4 | 95.8 |
| G | Senior Design Project Faculty Assessment | 80% achieve ≥ 2.5/4.0 | 97.2 | 98.8 |
| BME Lab Course Assessment | 80% achieve ≥ 2.5/4.0 | 83.9 | 83.0 |
| Senior Design 1 Faculty Assessment | 75% achieve = 4.0/4.0 | 100 | 90.3 |
| Student Exit Survey | 90% achieve ≥ 2.5/4.0 | 81.7 | 91.7 |

**\*\* Indicates metric not met**

**Note on Metric Calculations:**

* Senior Design Project Faculty Assessment – Originally reported as weighted scores and then converted to GPA.
* BME Lab Course Assessment - Originally reported as GPA data out of 4, already averaged
* Senior Design 1 Course Assessment – Originally reported as total % of students who got a 100 (4.0/4.0) on each outcome related question.
* Student Exit Survey – Originally reported as categorical data (1-4 = Very dissatisfied, Dissatisfied, Satisfied, Very satisfied) rather than GPA. 90% achieve ≥ 2.5/4.0 interpreted as number of students reporting Satisfied or Very Satisfied.

Number of students evaluated in Senior Design Project Faculty Assessment: **38+44 = 82**

Number of students evaluated in BME Lab 1 & 2: **91 + 77 = 168**

Number of students evaluated in Senior Design 1 (Fall: BME 4800C, Spring: BME 4800C): **45 + 39 = 84**

Number of students completing Student Exit Survey: **31+65=96**

**Concerns and Remedial Action (based on 2021-2022 outcome data):** The data in **Table 4.7** provides further evidence that the BSBME program is generally meeting the program’s SLOs for students that have graduated during the current accreditation cycle.

**Additional changes as part of continuous improvement**: As a continuous improvement in the upcoming academic year (2022-2023), the rubrics employed across all courses where functioning in teams is assessed (SLO E) will be evaluated and possibly standardized across the courses. Additionally, faculty assessment forms used in evaluating students in the Senior Design Project will be simplified from the current complex version that exists. The correlation of all the factors assessed via the current evaluation form is complex in terms of how they are related to each of the SLOs. Hence, as a part of the continuous improvement, these forms will be simplified in the overall rubrics and their relationship to the SLOs A to G. We plan to consider incorporating the external judges’ evaluations as one of the primary outcome measures (instead of secondary outcome measures), by providing the complete report and project details to the judges early on for a thorough review prior to the SLO assessment.

**A.5** **Documentation and Maintenance of Results**

Information Used for Program Improvement: Materials Available for Review That Demonstrate Achievement

All results are documented and maintained in departmental shared drives, apart from a copy on university’s secured One Drive. The following materials will be available for review during the site visit to demonstrate Continuous Improvement and the achievement of the SLOs and assessment:

* Materials related to Primary Outcome Measures:
  + Senior Design Project (BME 4908) Evidence: Senior Design Project reports (examples) with corresponding evaluations from Faculty Advisors. Students’ final Senior Design Project presentations (oral and poster) as electronic copies.
  + BME Labs (BME 4050L, 4051L) Evidence: Examples of BME Lab reports with student evaluations.
  + Senior-1 (BME 4800C) Evidence: Examples of Senior-1 project reports with final student presentations (as electronic copies).
  + Exit Surveys Evidence: All student exit surveys (Qualtrics based).
* Materials related to Secondary Outcome Measures
  + 1xxx-4xxx level Courses Evidence: Example problems and average scores of student work from courses – arranged by course and outcome (for all BME required courses).

As indicated in each course syllabus, each course outcome is associated with a particular student output such as a homework problem, test problem, or section of a report. Examples of these questions that were used to assess students for course outcomes that have a high level of support to SLOs from the respective course will be included.

* + Evidence of each SLO: A second set of folders will provide direct evidence of achievement of each student learning outcome across all the courses.
  + Senior Design Project (BME 4908) Evidence: Senior Design Project’s external evaluations from judges and Poster Judging. Students’ final Senior Design Project presentations (oral and poster) as electronic copies.
  + Course Outcome Surveys: All course outcomes surveys (Qualtrics based) for each course and each academic year.
  + Resumes: Resumes of students that have graduated from the program.
  + Transcripts: Transcripts of students that have graduated from the program as requested by the program evaluators.
  + Self-Assessment Surveys: Survey results available from Fall 2021 & Spring 2022 (Qualtrics-based surveys)
* All raw data that contributed to the quantitative and qualitative outcomes measures described in the Criteria 3 and 4 sections of the Self-study report.
* Undergraduate committee meeting agendas and minutes and related files that were discussed during these meetings.
* Annual retreat summary powerpoint slides and action items related to the program assessment and improvement.
* All surveys (Qualtrics based) conducted, including alumni, and advisory board (towards assessment of PEOs).

1. ***Continuous Improvement***

Describe how the results of evaluation processes for the student outcomes and any other available information have been systematically used as input in the continuous improvement of the program. Describe the results of any changes (whether or not effective) in those cases where re-assessment of the results has been completed. Indicate any significant future program improvement plans based upon recent evaluations. Provide a brief rationale for each of these planned changes.

The results of the evaluation processes for the SLOs and any other available information have been systematically used as input in the continuous improvement of the program. The outcome of the primary measures and course evaluations were summarized and discussed at the annual retreat (at the end of each Spring semester). Remedial actions are determined at annual faculty and staff retreats, at monthly undergraduate committee meetings, and periodic faculty meetings; and actions are implemented as course modifications. The changes made across each of the required courses offered in BME are as given below in Section B.1.

The results of any changes made to the courses to continuously improve the SLOs are reassessed via secondary outcome measures (i.e., surveys of course outcome measures by students) in the following academic year (and each semester). These results are discussed during undergraduate committee meetings and faculty meetings apart from the annual departmental retreat.

All the related material of our secondary outcome measures and the results will be available during the site visit.

**B.1 Individual Undergraduate Course Contributions and Modifications to Continuously Improve the Student Learning Outcomes (SLOs)**

All core courses have been offered every Fall and Spring semesters since 2017. Some courses (BME 3403, 3404, 4011, 4100) are also offered in the Summer terms to allow students to stay on track towards a 4-year graduation. Course modifications are driven by course outcomes survey analysis for each course across each semester, students written feedback, instructor’s assessment in students’ performance across assignments and exams; and overall effect of the primary measures (as described above). Each course was individually reviewed during the annual ABET retreat (at the end of Spring semester each year). With continuous modifications in individual undergraduate courses each semester, the overall student performance improved in the respective SLOs as assessed from course outcome surveys and the primary and secondary measures of all the SLOs (A to G) and presented at the annual ABET retreat.

Details of the modifications in individual undergraduate (required) courses across the years (since 2014 onwards) is described below.

***BME 1008C Intro to Biomedical Engineering***

A new required course (BME 1008) was introduced from 2012 (Fall) to prepare freshmen and transferred students for their undergraduate studies in Biomedical engineering. This course broadens students’ knowledge about various subdivisions of Biomedical Engineering and essential Biomedical Engineering technologies. More importantly, it helps students discover their true interests in biomedical engineering and identify potential career pathways to pursue, which allows them to individualize their undergraduate studies. Finally, the course improves students’ communication skills using various assignments such as team presentations.

BME 1008 is offered every Fall and Spring semester. In the beginning, this course was one credit hour. One additional credit hour course was added to this course in Fall 2014; programming was introduced to enhance students’ engineering skills. This course also replaced a required course, the Intro to Engineering (EGN 1100), in the previous Biomedical Engineering undergraduate curriculum.

In 2016, Dr. Wei-Chiang Lin became the lead instructor of this course. He implemented the project-based learning concept into the class by introducing (1) team topic presentations and (2) team programming exercises (i.e. incorporated SLO E). Students in BME 1008C were divided into multiple teams, and each team presented a technological topic in a biomedical engineering subdivision assigned. The presentation would contain (1) an introduction to the biomedical engineering subdivision assigned, (2) an introduction to the technological topic selected, (3) the underlining scientific and engineering principles of the technological topic selected, (4) the latest development of the technological topic selected, (5) business opportunities associated with the technological topic selected, and (6) regulations and ethics associated with the technological topic selected. Regarding team programming exercises, student teams would work on work on five practical exercises that will develop students' skills in (1) programming, (2) data analysis, and (3) 3D modeling. Dr. Lin also used a web-based teaching tool (i.e., TopHat) in his classes to enhance student engagement.

In Fall 2017, Dr. Lin added “expert interview” into the team topic presentation, which allowed students to get to know BME faculty and their research activities. Furthermore, he added a dedicated lecture about bioethics in BME1008C (i.e. incorporated SLO D), recognizing biomedical technologies have contributed to new ethical dilemmas and biomedical engineers need more training in facing these problems.

As many junior and senior BME students expressed the desire and the need to improve their 3D modeling skills, Dr. Lin added 3D modeling into BME1008C by introducing Fusion360 software. He selected Fusion360 (instead of SolidWorks) because the software was freely available to FIU students. Dr. Lin also created in-class 3D modeling challenges as well as 3D modeling contests to facilitate the learning of Fuion360 (relating to SLO B and G).

In 2018, Dr. Lin started using Canvas as the primary means to deliver course materials and assignments and administrate quizzes and discussions. In addition, he updated the programming exercises so they are strongly connected to essential biomedical engineering technologies such as electrocardiography.

In Spring 2020, the course was delivered remotely because of the pandemic. Dr. Lin updated and revised the course contents to make them suitable for remote teaching.

In Fall 2020, two sessions of BME 1008c were offered and each session was limited to 55 students. Dr. Lin made this change was to reduce the number of students per student team and hence increase students’ engagement in team assignments. The hybrid teaching concept was utilized in the design of the course plan; students would meet with the lead instructor once a week and conduct self-study with TA in a separately weekly meeting.

As the popularity of Python in the biomedical engineering industry increased continuously, Dr. Lin added Python as the second programming language taught in BME 1008C in Fall 2020. Students were offered with various opportunities, such as online tutorials, to learn Python. In addition, they were also encouraged to use Python to complete the programming exercises.

***BME 1054L Intro to Biomedical Computing***

This one-credit online course was designed and implemented in 2014 to address student deficiencies in computer programming. In 2019, based on the data collected on student performance (2018-19) and feedback from students and instructors in subsequent courses we decided to update course content in an effort to further enhance basic computational skills. We included lecture recordings to accompany the reading assignments and we increased content by adding two computational projects/case studies. To facilitate further student engagement, we added extra-credit computational assignments to each course module and a TA to the course every semester. We also updated the course outcomes to better reflect how the course supports SLOs A, and G. To better monitor how students retain the presented material and acquire computational skills, we also implemented an additional assessment in BME 2740 (see description below).

***BME 2740 BME Modeling and Simulation***

We created an assessment to evaluate students’ fundamental knowledge in MATLAB programming and calculus prerequisites when entering BME 2740. This revealed that certain elements of MATLAB programming (especially “loops”) required additional review at the start of the term so students could engage confidently with the material. This prompted us to include a short additional unit at the start of each term that targeted these deficit concepts, which improved student scores on subsequent assignments.

We moved away from purely conceptual presentation of the concepts, which some students reported as unengaging or confusing. Instead, each new concept, algorithm, or computational technique is presented alongside a simplified motivating example, inspired by a biomedical application. This increased students’ willingness to complete assignments and engage during class.

We also moved from a completely lecture-based format to an active-learning format. During almost every lecture period we ask the students to work in small groups on example problems related to the day’s topic while the instructor and his learning assistants move between the groups answering questions and helping them figure out how they would solve the problem. This has greatly increased class participation because they are more comfortable with the instructors, since we talk with them in small group settings. The small group active-learning exercises format also helps students clearly see what concepts they do not grasp because they are engaged with the content immediately (towards improved communication or SLO C and team working abilities or SLO E). Many students believe they understand the material as we are explaining it to them in lecture but encounter unexpected difficulty once they begin working with an example for themselves. This quick feedback is helpful in motivating students to ask questions, seek help, and understand where they stand in the course and substantially improved student perception of learning since Fall 2019.

***BME 3403 Engineering Analysis of Biological Systems (EABS) I and BME 3404 Engineering Analysis of Biological Systems II***

Both EABS I and EABS II (BME 3403 and BME 3404) utilize learning assignments where videos, recent journal articles, and current events are used to demonstrate the real-world application of physiological concepts to highlight their importance. Dr. Michael Brown began working with the Engineering faculty in the department prior to as well as after to the last ABET visit to increase the engineering content in the course (related to SLO A). Dr. Riera developed a Nernst Equation Simulation modeling homework relating neuron function and the Nernst equation for BME 3403. For EABS II, Dr. Brown was assisted by Dr. Ramaswamy in developing a homework assignment involving calculation of the pressure gradient across dysfunctional cardiac valves. Dr. Hutcheson also developed a transport project based on how the kidney functions after the previous ABET visit. Clinical content on the pathophysiology of relevant disease processes such as atherosclerosis and metabolic syndrome has also been expanded as well as the treatment of cardiovascular diseases (including heart failure) using Biomedical devices. The courses were modified during the pandemic when all of FIU went virtual. The same powerpoints and lecture topics were presented. Increased use of research-based assignments on topics such as the thrombogenicity of medical devices and what can be done to reduce its occurrence, heart failure and the medical devices used to treat it as well as incorporating questions where the students are required to research various diseases related to the organ system being discussed. The pandemic forced incorporation of various remote learning tools such as Zoom and pre-recorded lectures using a GoPro camera. Students liked having the lectures recorded in the cloud so that they could study for exams as well as reinforce material that was covered quickly in class. Learning assignments consisted of various current journal articles on relevant topics dealing with such issues as cardiovascular disease and sexual health. Students were asked to read or watch videos on these topics and discuss what they had learned as well as their views on the topics presented. Student feedback for the courses remained positive with the reviews for the class post-pandemic being better than those received prior to the pandemic. Subsequent to the resumption of in-person classes, the assessment methods were changed back to multiple choice, true/false, and essay-based questions. Some students actually preferred the research-based assignments, as they felt they were able to learn more (strengthening writing-based communication skills related to SLO C). This led to the inclusion of a list of six essay questions for each exam that require research, two of which will be used on the exam. Multiple choice questions will also incorporate clinical scenarios that allow students to predict symptoms or outcomes based on their understanding of the underlying physiology.

***EGM 3503 Applied Mechanics***

This course covers statics and dynamics and is intended for engineering students not in Mechanical Engineering. Results from the student surveys of the learning outcomes indicated that students felt that dynamics was not being adequately covered in this course. In addition to statics topics, now the course includes five chapters in dynamics covering kinematic particles topics such as force and acceleration, work and energy, impulse and momentum) and planar kinematics, thus resolving the students’ concerns (and strengthening SLO A). This was also reflected in BME 4100 (Biomaterials), a required course, and in two electives (BME 4211 Orthopaedic Biomechanics and BME 4260 Engineering Hemodynamic). Starting Fall 2010-2011 this course was changed from three credits to four credits to allow for better coverage of both statics and dynamics. This course was being taught by the Mechanical and Materials Engineering Department but now the course is being taught by the Biomedical Engineering Department. The majority of the students in this class are from BME. After meeting with the instructors of this course, they agreed to try to provide more biomedical applications.

***BME 3632 BME Transport***

To address apparent deficiencies in SLO A: Added a review on differential equations (as needed). MATLAB based assignments (as homeworks and/or projects) were included to help the students solve differential equations (both ordinary and/or partial). Quizzes were included in few semesters for 10% of the total grade, improving the overall class grade and performance in the entire course. Student learning related to SLOs A. After implementation of the suggested changes to BME 3632, the students were capable of relating the content from previously taught courses (BME 2740 Modeling & Simulation) to help them in MATLAB programming in transport. In addition, over the past few semesters (since Fall 2020), learning assistants (LA) were recruited as a part of the course. These LAs had previously taken BME 3632 and had done very well in it. They assisted the course through peer guidance and mentorship by helping students further understand transport phenomena problems that were worked out in class by the instructor, or that were a part of the homework assignments.

***BME 3721 BME Data Evaluation***

BME 3721 includes a one-hour lab/tutorial for statistical software packages (i.e., SPSS, MiniTab, Excel and MATLAB) to improve students' ability to analyze engineering and medical data using modern statistical software packages. Friday labs were exclusively dedicated to using SPSS software. Group project presentations with real biomedical field data, SPSS software use, and covering all the topics of the course were required by students. Students are required to perform their course project on applying the principles taught in the course to real biomedical field data. Project results are orally present as a team while reports are individually submitted (to strengthen SLOs C and E).

Special current and society-relevant examples are added to the class. These include problems such as sample size determination for studying vaccine effectiveness, common mainstream and social media errors in interpreting statistics data, validation and comparison of new clinical techniques amongst others. More emphasis was placed on nonparametric techniques with biomedical data that does not follow standard distributions etc. were added to the lectures. Applicability and limitations of Gaussian distribution-derived methods are emphasized as students quickly tend to use them for their thesis and industry R&D without checking the Gaussian fit. Practical industry relevance of statistics in Design of Experiments, Industry Quality control etc. were covered in 2 lectures. Difference in Quality and Reliability in manufacturing is illustrated through examples.

Both the course instructors for BME 3721 (Dr. James Schummers and Dr. Raj Pulugurtha) participated in hybrid training and got certified in Fall 2020. In order to support the hybrid model during the pandemic: a)Lecture slides were posted in advance for students to review, b)Voicethread® videos, online videos, custom videos from LAs on-practice problems were created , 3)Students were asked to view ahead and review the videos in the class , 4) Most Wednesdays had LA sessions with practice problems. However, in Spring 2021, since the classes were remote with nonideal student-instructor interaction on Mondays, Wednesday lectures were also offered in synchronous mode to compensate for the remote teaching.

***BME 4011 Clinical Rotations***

The class focuses on medically relevant topics with the aim of showing students the many opportunities open to them once they obtain their degree in biomedical engineering. Multiple executives from the biomedical industry also give presentations with tips on obtaining a position after graduation, how to prepare for an interview and advice on how to prepare a resume. Since the previous ABET visit, the class has continued to visit local clinical sites, industry sites and had guest lectures from industry as well as medical professionals. Students prefer to visit the companies in person but because of the pandemic this has not been possible. Companies and medical professionals are still reluctant to host groups of students due to liability concerns, but the current plan is to slowly return to those sites willing to host visits as soon as possible. The class also regularly attends the ISET (Interventional Society of Endovascular Technology) meeting held in the Spring of each year (with the exception of during the pandemic). Students were able to once again attend the meeting in Spring 2022 and were assigned a homework assignment based on meeting with company representatives and learning about new products that were being sold to clinicians and writing a brief report. The class has consistently visited Beckman Coulter, Mako Surgical (Stryker) and Zimmer Biomet in the past. Multiple speakers from industry were recruited to give lectures to the class by the previous BME students themselves. Extra credit was given to those students who brought in medical professionals, industry representatives, and former students who had graduated from the program. With the use of Zoom many more outside speakers were scheduled from biomedical device companies such as Medtronic and companies recent BME graduates ended up getting jobs with. In this way the class was able to hear from physicians from other states, FDA specialists, HR representatives for medical device companies, and biomedical researchers (enhancing their exposure to real-world design considerations or SLO B). The class also was assigned to attend various department events such as Evening with Industry, Graduate Research Day, and Heart week. Assignments based on each of these events were given as homework. Sites visited since the last ABET visit include Miami Cardiac and Vascular Institute, Beckman Coulter, Stryker/Mako and Zimmer/Biomet Clinical lectures incorporating relevant technologies such as the production of monoclonal antibodies and their use in treating various diseases such as Covid and many other diseases were also incorporated into the curriculum. The midterm also required students to research the FDA and watch videos about the role of the FDA in regulating medical and biological devices. Lectures were also incorporated into the curriculum going over the role of the FDA in approving medical devices and how clinical trials are performed. Recent classes have incorporated assignments based on the department events previously mentioned.

***BME 4050L and 4051L Biomedical Engineering Labs I and II***

To enhance SLO B, we added an exercise in BME 4051L in Fall 2010 in which the students are required to design and conduct an experiment to identify an unknown analyte in a chromatography experiment. Another example is to design an experiment to predict and confirm the heat transport through conductors and insulators, introduced in Spring 2014. Additional changes include several new protocols in Transport and Mechanics. Students are required to use Matlab to do image processing in the protocol “Image Processing” since Fall of 2020. Students are required to use Matlab to process the measured human data in the first two protocols using BIOPAC MP36 (Reaction Time and ECG-1) since 2015. We provided a template for the lab report of each protocol to enhance the learning process except the last two protocols in BME 4050L and the projects in BME 4051L. We added a quiz consisting of five questions at the beginning of each class to enhance the readiness and understanding of the protocols. The quiz also serves as a tool for assessing the attendance and accounts 5% of their final grades. Starting from Fall of 2020, the quiz was offered online in Canvas. We planned to add a second project using Beer’s Law starting Spring 2022. The two projects of BME 4051L will take 4 weeks, each taking 2 weeks (and one of the project is related to design). This arrangement is to address concerns from the students about the duration of the Heat Transfer project. New equipment purchases were made to meet the requirements for these new protocols. New “modern engineering tools” were introduced to address SLO G. For example, five sets of MP30s, which are the data acquiring units of BIOPAC student lab were upgraded to MP36s, the latest generation with enhanced functions for conducting physiology protocols. Furthermore, five sets of BSLEXP-W systems (BIOPAC systems, Inc.), six sets of viscometers (Brookfield engineering laboratories, Inc.), three sets of AmScope binocular digital compound microscopies (United scope, LLC), three sets of OceanView spectrophotometers (Ocean optics, Inc.), as well asfive5 of Dell OptiPlex 9020 all in one desktops (Dell, Inc.) were purchased. With these equipment purchases, as well as the purchases of other laboratory materials and supplies at a total cost over $150,000, BME labs I and II are now capable of providing 8-10 workstations for undergraduates to study physiology protocols. More sections are being offered. More TA involvement for guiding students. The space for the labs was expanded by over 1,000 sq ft during the Summer of 2014. During the pandemic, hybrid sections were offered, and thirty sets of BIOPAC home kits were purchased for students to practice physiological protocols remotely. Once students returned to face-to-face classes, a single hybrid section has been retained. The purpose is to accommodate students who are encountering situations that hinder their ability to attend 100% face-to-face settings.

***BME 4100 Biomaterials Science***

The COVID epidemic necessitated the course delivery to move to an online platform from Spring 2020 to Spring 2021. In Fall 2022, the course resumed to its original face-to-face format, but all course materials, including exams and quizzes remained online. Office hours remained online post COVID as well. Prior to Fall 2020, successive semesters showed instances of course learning outcomes that were not met. An investigation by the instructor and department leadership determined and identified the root cause of this observation as a mismatch between the course outcomes listed in the syllabus, and those that were used in the course evaluation. The mismatch was corrected, and the outcomes for assessment and course were aligned to a one-to-one correspondence. Additionally, the instructor routinely review course outcomes at the beginning and end of the course, and students. The instructor began each lecture with an brief review of the prior lecture’s accomplishment, and outlined the course outcomes for that day. Since Fall 2021, students are administered a self-assessment survey at the end of the course. Results of individual and collective interventions have yielded improvements that are consistent with program expectations for all subsequent course assessments.

***BME 4503C Medical Instrumentation Design***

BME 4503C is a fully online course taught. The course presents an insider's perspective on how medical instrumentation is designed, built, and functions. Topics covered include Bio-Sensors, Bio-Electrodes and Amplifiers, Blood Pressure and Flow, Respiratory System, and Electrical Safety. The course consists of 3 main modules with online lectures (Basic Electronics used in Bioinstrumentation (4 lectures), The origin of Biopotentials (3 lectures), and Applications of medical instrumentation (4 lectures), 6 laboratory exercises, 10 quizzes a midterm and final exam.

The course has been offered completely online since Spring 2014. The decision of bringing the course online was taken after discussion in faculty meeting and the faculty retreat in the Fall 2013 and was motivated by two main factors. First, we wanted to enhance student learning by providing a self-paced structure and higher content to the lectures. Second, we wanted to improve the student laboratory experience by reducing group sizes (from four to two students) and increasing student involvement and ownership in the labs and projects by creating an "a- home laboratory" that was not limited by an instructor or TA schedule.

Students work on a proven platform (Arduino microcontroller) that allows them easy control of sensors and testing. Kits containing basic electronics (op amps, resistors, LEDs, capacitors etc.) are distributed at the beginning of the course. The instructor is available in online forums to discuss any questions; online message boards are also available to foster discussion and interaction among the students. The instructor also has in-person office hours to address any issues, and a TA is available to help with experimental layouts in person.

One of the major improvements (according to the TA that assisted with this course both in the Fall and in the Spring when converted to online delivery) was the ability to conduct the experiments on the Arduino at home (thus enhancing SLO F). This solved many logistical issues with the Biomedical Engineering Laboratory, but the more tangible effect was that various groups did not have to share lab components (op amps, resistors etc.) since electronic kits were assigned to each group. This issue had frustrated previous students that were not able at times to complete the assignment in allotted time due to missing parts.

Feedback from the students has been generally positive and the class was consistently evaluated above 4 (very good to excellent) every semester. During Covid this course was briefly turned from group to individual projects so that students could take the course even if in isolation.

***BME 4800 Design BME Systems and Devices and BME 4880 Design Organization (BME 4090 until 2017)***

From our discussions we strengthened the iterative writing process in these courses in Spring 2014, providing more feedback during the semester. This positively impacted the overall written communication skills related to SLO C. Based on the feedback received from the consultants reviewing the ABET compliance, it was determined that the use of the domestic and international standards (Design, Safety, and Test) during the Senior Design Projects were not sufficiently emphasized. As a result, the syllabus was changed for Fall of 2017 semester to include specific section to cover this subject deeper. Since 2015, all projects were sponsored by external people (outside BME) – preferably industry or clinic and sometimes by other departments/colleges in FIU. Course content continually changes to match the latest regulatory issues, standards, and new technologies developed.

***BME 4800C Design BME Systems and Devices (merged from BME 4880 and BME 4800, since Fall 2020) –*** *Certified hybrid since Fall 2020*

During the Fall 2019 retreat, faculty discussed the pros and cons of combining the BME 4800 and BME 4880 courses. The main motivation was that by having the two separate courses, there were instances when a student would pass one class but fail the other. However, due to the nature of the course, students were required to attend both classes, which caused conflicts in scheduling and time commitment for the students. Faculty members decided that the combined courses would better align the students’ activities/assignments to the SLOs, and BME 4800 (3 credits) and BME 4880 (1 credit) were combined to become BME 4800C (4 credits). The new course was approved and implemented in Fall 2020. Additionally, the faculty decided that the students working on senior design projects lack training and skills in CAD (Computer Aided Design) and Simulation software. An eight-week SolidWorks lab was added to the course syllabus starting in Fall 2020 (to strengthen SLOs B and G). Since the pandemic, the team project proposal presentations were pre-recorded, allowing faculty evaluators sufficient time to review the talk prior to the remote, live oral questioning session with the team.

***BME 4908 Senior Design Project***

As the result of the feedback received from the consultants reviewing ABET compliance in 2014, it was determined that the use of the domestic and international standards (Design, Safety, and Test) during the Senior Design Projects were not sufficiently emphasized. They were reinforced and mandated since 2015 in this course, and later in 2017 were also made part of BME 4800/BME 4880 course for strengthening the student’s understanding early on. Various other modifications in this capstone course include the following:

* Modified the Senior Design report template to address how the student’s project satisfies the individual SLOs. Weekly guest lectures from practicing engineers were added to the Senior Design course (BME 4908) starting in Spring 2009 that reinforce the course requirements and stress the importance of engineering analysis and the use of modern engineering tools.
* Program was converted to paperless in Fall 2019.
* Established on-line platform repository for all Senior Design Project documents, including video presentations, video poster presentations, faculty evaluations, links for judges’ external evaluations, sponsor evaluations, Design History Files and Device Master Record
* Acquired and introduced on-line innovation training which was obtained through a grant from the KEEN Innovation foundation.
* Introduced Solid works and Ansys simulation as a requirement for all projects in response to industry needs (to strengthen SLOs B and G).
* Introduced and implemented the sponsors’ evaluation
* Introduced part numbering system to provide traceability of all components used in the manufacturing of prototypes.
* Standardized all documentation and introduced document control and tracking system
* Introduced and implemented the “Design Freeze “ concept, more formally known as a pre-manufacturing agreement. This must be signed prior to the initiation of manufacturing activities.
* Since Spring 2020, and in response to the COVID pandemic, Senior Design Project judges are able to attend the Senior Design Expo and competition remotely or in person if they choose. Judges are provided documentation on each project before hand through the department’s Senior design on-line platform. This has expanded the pool of judges for the competition and ensures that there is broad representation from all critical constituencies. Developed internally published a handbook for faculty mentors. Handbooks for sponsors and students are currently being developed and will be available for the Fall 2022 cohort.
* The department established a Biomedical Engineering creativity lab that is equipped with multiple computers and 3-D printers along with hand tools and instruments for students to use in the development of their prototypes. Specialized instruments and tools are made available upon request from research labs within the college and across the university as well as the Engineering manufacturing Center.
* The course was certified and recertified in 2021 as a University Global Learning Course. All projects presentations must contain analyses on their projects with respect to Global Awareness, Global Perspective and Global Engagement. In addition, students are given an assignment each semester, which requires them to choose a healthcare problem of global significance, analyze it from the perspective of Global Learning and provide conceptual solutions on how to best address the problem, be it in a local or international context.
* Career development became an integral part of the program. We entertain guests from industry who work in the area of Research and Development, manufacturing, Quality Assurance, and Entrepreneurship. The university’s talent Development department are also invited to make presentations on job search, interviews and negotiation strategies. They are also made aware of resources that are available to help them in their professional development and careers.

**BME 4930- BME Seminars**

This a zero-credit hour course where students are expected to attend at least 10 invited seminar talks of researchers invited via our Coulter BME Seminar Series. As a way to improve communication skills, quality of writing and engagement of students during these seminars, the students have been asked to submit written reflections for any three seminar they attended during the semester (around 1 per month). Students are given feedback and overall, this has helped them improve in writing ability. The addition of reflections to this zero-credit hour course added immense value to student learning as they began to better comprehend the various areas of biomedical related research activities around the world, beyond classroom learning.

**Inclusion of Diversity, Equity, Inclusivity Components in BME Curriculum:**

Apart from modification to individual courses to improve students’ performance across the SLOs A to G, the department was actively working to raise awareness and help students understand and execute the concept of diversity in their school/work environment. Diversity based zoom discussions (Summer 2020), diversity related invited seminars are a few examples. A departmental diversity plan was implemented since 2018 and updated each year. These efforts are to improve the effectiveness of our students in working in a diverse team environment understanding various aspects including ‘inclusivity and collaboration,’ which is one of our SLOs (SLO-E) and part of our Program Educational Objective (2c) as well as our SLO-E.

**B.2 Significant Future Program Improvement Plans**

Based on the recent and continuously ongoing improvements to the program and reviewing our performance indicators across courses in the 4-year curriculum map (**Tables 3.5 and 3.6**), the following issues (**Table 4.8**) were identified, and improvement plans were proposed during undergraduate committee and faculty meetings in Fall 2021-Spring 2022 academic year and the departmental annual ABET retreat in May 2022. The proposed improvements that is planned to be implemented in 2022-2023 and 2023-2024 will be evaluated (at the earliest) towards the end of Spring 2024, during our departmental annual ABET retreat.

**Table 4.8 Future Program Improvement Plans**

|  |  |  |  |
| --- | --- | --- | --- |
| **Issue** | **Description** | **Improvement Plan** | **Implementation Period** |
| **SLO- B:** Design courses in formative years | Design (related to SLO D) is not emphasized in the formative years  (freshman, sophomore) | \* Introduce Freshman Design Competition as part of BME 1008C, apart from the design concepts discussed in class.  \* Develop a late sophomore/early junior level course on *‘Introduction to BME Design’* | Fall 2022/Spring 2023  Spring 2023/Fall 2023 |
| **SLO-D:** Ethics | There is less focus or metrics to measure ethics across the 4-years | \* Introduce guest lectures on ethics across the courses (initiated by Dr. Danziger)  \* Introduce pre- and post-self-assessments on ethics and professional responsibilities  \* Introduce ethics training courses via CITI (in relevant courses) and other online certification materials  \* Invite speakers on ethics via our Coulter Seminar Series  \* Discuss with dean’s office to introduce a general ethics course via SUCCEED (School of University Computing, Construction, and Engineering Education) program in College of Engineering and Computing (CEC), FIU. <https://succeed.fiu.edu/> | Spring 2023/Fall 2023  Fall 2022/Spring 2023 |
| **SLO-E:** Team skills | Effective team skills are not emphasized in in formative years | \* Introduce team-based projects in more BME required courses (e.g. BME 2740, BME 3721, BME 3632) with consistent rubrics across courses | Fall 2022/Spring 2023 |
| **DEI:** Diversity, inclusivity, equity | Not part of any course curriculum | \* Introduce these concepts since freshman as guest lectures across courses  \* Invited speakers on topics related to DEI via Coulter Seminar Series | Spring 2023/Fall 2023  Fall 2022/Spring 2023 |

1. ***Additional Information***

Copies of the assessment instruments and materials referenced in the above sections will be available for review at the time of the visit. One sample secondary measure obtained via self-assessment surveys is provided below.

**C.1 Self-Assessment Surveys (Secondary Measure):**

Starting in Fall 2021, self-assessment student surveys are initiated across the formative and summative years of the students. The SLOs A to G were simplified to multiple questions and the students were asked to self-assess during different levels of their BSBME program (sophomore, junior, senior, and graduating senior). From **Figure 4.1**, we see continuous improvement in students’ self-assessment of their knowledge in various aspects that relate to the BSBME SLOs. Data will be acquired once a year moving forward to assess shortcomings (if any) and implement remedial measures.

**Figure 4.1 Student self-assessment across the formative and summative years of the BSBME program (Fall 2021)**

Chart, bar chart

Description automatically generated

# CRITERION 5. CURRICULUM

1. ***Program Curriculum***

Complete Table 5-1 that describes the plan of study for students in this program including information on course offerings in the form of a recommended schedule by year and term along with maximum section enrollments for all courses in the program for the last two terms the course was taught. If there is more than one curricular path or option for a program, a separate Table 5-1 should be provided for each path or option.State whether the institution operates on quarters or semesters.

**A.1**  **Plan of Study**

The Bachelor of Science in Biomedical Engineering (BSBME) program plan of study is shown in **Table 5.1** (provided at the end of Criterion 5 section). It is a 128-hour semester-based curriculum leading to a BSBME. While there are no specific tracks, the program provides strong interdisciplinary training that integrates life sciences, physical sciences, mathematics, and multidisciplinary engineering fundamentals. These focus areas provide the foundation for three different concentration areas within the field of biomedical engineering (BME); they are **Biosignals and Systems, Biomechanics and Biomaterials, and Tissue Engineering/Pre-medical**. Students select and enroll in courses within their chosen concentration area at the advanced stages of the curriculum. The Tissue Engineering/Pre-medical concentration is identical to the most common course requirements for medical school admissions, and therefore attracts students who desire BME training as a background for their intended careers in medicine. A detailed flowchart of the recommended schedule by term towards the 4-year bachelor’s degree is given in **Figure 5.1** (provided at the end of Criterion 5 section). The course syllabi for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5 or any applicable program criteria are in **Appendix A**.

As such, the BSBME program Tissue Engineering/Pre-med concentration appeals to two distinct student populations: (a) The first includes students who intend to enroll in medical school upon completing the BS degree. It is quite evident that the practice of medicine is becoming more and more dependent on technology, and that the practicing physician who is trained in the fundamental principles in which that technology lies, along with the knowledge and experience with the design of medical devices, will be better prepared to meet the changing needs of the medical field. The program described herein is unique among BME programs in that it contains a very strong life sciences component along with engineering to assure optimal preparation for the medical school curriculum. (b) The second includes students intending to enter industry or pursue advanced study in the area of biological tissue engineering. As investigators unfold more and more knowledge of the principles of living systems at the cellular and molecular level, the medical device industry is being revolutionized, with development being increasingly directed away from classical mechanical, electrical, and electromechanical devices to combination devices and tissue-engineered solutions. As this industry continues to grow globally, a workforce of specially trained engineers will be required to sustain the innovation, growth, and development.

**A.2 Curricular Alignment with Program Educational Objectives**

Describe how the curriculum aligns with the program educational objectives.

The principal educational objective of the program is to prepare students for transition to a career in biomedical sciences, public health, medicine, or industry research and technology development. The following details below explain how our curriculum is structured to help achieve these goals.

The BSBME program’s Biosignals and Systems, and Biomechanics and Biomaterials concentrations appeal to students intending to enter the medical device industry or pursue advanced study in BME or related disciplines (supporting alignment with Program Educational Outcome [PEO] 1). Graduates of the BSBME program who elect to pursue careers in industry typically secure positions in medical device manufacturing, pharmaceutical manufacturing, research clinics, or medical centers. While most graduates who elect to pursue graduate study continue in the BME field, some have elected to pursue advanced training in mechanical engineering, electrical engineering, clinical engineering, or regulatory affairs.

Lower division requirements include at least 60 hours of pre-engineering credits (described in the undergraduate studies portion of the FIU Catalog; see the description below for specific requirements). A minimum grade of “C” is required in all writing courses and in all of the common prerequisite courses. All students must meet the Foreign Language Entry Exam (FLENT) and Foreign Language Exit Exam (FLEX) requirements and meet all of the state and university requirements for graduation. University Core Curriculum courses provide students with the foundation of basic written communication skills while the BME core courses further refine the student’s written and oral communications skills necessary for a professional career and to function on diverse and multi-disciplinary teams.

Preparation for a professional career is assured by an integration of the lower-division courses in humanities, social sciences, communication skills, mathematics, and the basic sciences, with the upper-division Life Sciences for Biomedical Engineers, and the upper-division BME core courses. The lower division and basic science courses set the foundations for professional career.

The BME core courses prepare students for professional career primarily through the BME laboratory course sequence and the culminating major design experience (supporting alignment with PEO 2). The program curriculum culminates with a significant and comprehensive design experience that includes BME 4503C Medical Instrumentation Design, BME 4800C Design of Biomedical Systems and Devices (formally BME 4800 and BME 4880), and BME 4908 Senior Design Project. In BME core courses, students are prepared for professional career through the use of a variety of software products (Matlab, Solidworks, Fusion 360, Python, Statistical Software-SPS, Minitab, etc.) used in industry; through practice in designing and conducting experiments, as well as measuring, analyzing, and interpreting data from living systems; and through the use of the techniques, skills, and modern engineering tools, including the ability to model and analyze biological phenomena and as engineering systems.

The BME curriculum prepares students for proficiency in working in diverse teams via team-based projects in multiple BME core courses including BME 1008C (Intro to BME), BME 4050L (Labs-1), BME 4051L (Labs-2), BME 4503C (Medical Instrumentation Design), BME 4800C (Design of Biomedical Systems and Devices) (formally BME 4800 and BME 4880), and BME 4908 Senior Design Project. Exposure to various research and diversity-related invited talks via the Coulter Seminar Series as part of the BME 4930 (BME Undergraduate Seminar) prepares the students for a professional career path in BME.

The BME curriculum also prepares students for effective communication skills (oral and written) which are reinforced in multiple BME core courses from freshman to senior years (supporting alignment with PEO 3). These courses include BME 1008C (Intro to BME), BME 3632 (Transport), BME 3403 (EABS-1), BME 3404 (EABS-2), BME 3721 (Data Evaluation Principles), BME 4050L (Labs-1), BME 4051L (Labs-2), BME 4503C (Medical Instrumentation Design), BME 4800C Design of Biomedical Systems and Devices (formally BME 4800 and BME 4880), and BME 4908 Senior Design Project.

**A.3 Details of the Curriculum Requirements for Biomedical Engineering**

Describe how the curriculum and its associated prerequisite structure support the attainment of the student outcomes.

The details of the curriculum requirements for BME are listed and categorized based on the courses related to mathematics and basic sciences, engineering topics, general education, and major design experience. The details of how the minimum credit hours are satisfied and distributed for each semester are provided in **Table 5.1**.

**A.4 Prerequisite Flowchart**

Attach a flowchart or worksheet that illustrates the prerequisite structure of the program’s required courses.

A flow chart showing the prerequisite structure of program’s courses required or allowed towards the BSBME is provided in Figure 5.1 and available online at [https://bme.fiu.edu/academics/degrees/ (see](https://bme.fiu.edu/academics/degrees/%20(see) undergraduate program tab).

**A.5 Programmatic Requirements by Subject Area**

Describe how the program meets the requirements in terms of hours and depth of study for each subject area (Math and Basic Sciences, Engineering Topics) specifically addressed by either the general criteria or the program criteria.

***Mathematics and Basic Sciences***

ABET Criterion 5 requires one year of a combination of college-level mathematics and basic sciences (some with experimental experience) appropriate to the discipline. First and second year coursework in BME is devoted primarily to learning basic math and sciences with some introductory engineering topics courses. Advanced sciences are covered in the third year. The total semester hours of college-level math and sciences required in the BME curriculum is 42, which includes a minimum of six one-hour laboratory courses in the physical and life science courses. These courses include calculus, differential equations, chemistry, physics, biology, and organic chemistry.

***Engineering Topics***

ABET Criterion 5 requires one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student’s field of study. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and professional career on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert optimally to meet these stated needs. All BSBME students (regardless of concentration or focus areas) take the same core courses, with the exception of six three-credit electives, a minimum of three of which must be engineering topics. Students who have chosen the Biomedical Tissue Engineering/Pre-medical concentration and are preparing to enter medical school after earning the BSBME, are advised to enroll in three science electives and three engineering electives.

All students who enroll in science electives are encouraged to enroll in the corequisite laboratories, as this is generally an enrollment requirement grounded in longstanding pedagogic theory and provides additional practicum experience for these students.

The curriculum begins in the freshman year with Introduction to Biomedical Engineering (BME 1008C), in which students are introduced to the engineering profession. Students tour the department research laboratories and learn how various engineering professional disciplines collaborate/interact and function. They are exposed to computer utilization and taught how to conduct a literature search. They use Excel and PowerPoint to prepare and analyze data, and to design and deliver class presentations. Students are also introduced to the Code of Ethics for Engineers and work in teams to research and present engineering topics. Students are exposed to the different sub-disciplines of BME via presentations by industry and academic professionals, combined with class projects, and the completion of specific tasks form on-going senior design projects.

In the second semester, students are introduced to problem-solving using computer methods through a one-credit course in Biomedical Engineering computing, BME 1054L. Students are taught the rudiments of the Matlab environment through in-class tutorials, homework assignments, and a group project.

In the second year, students learn computer applications in BME Modeling and Simulation (BME 2740). Students learn to apply advanced computational methods to describe and solve biological and physiological problems and learn to implement the solutions algorithmically with MATLAB.

Also in the second year, students are able to complete one three-credit science or engineering elective. Students are introduced to physiological control systems. These skills and techniques in modeling physiological systems are utilized in later courses, including BME Transport (BME 3632), the two laboratory courses (BME 4050L and BME 4051L), and required courses and electives (i.e., Engineering Hemodynamics [BME 4260], Cell and Tissue Engineering [BME 4332], Biomechanics of Cardiovascular Systems [BME 4230], Biophysics of Neural Computation [BME 4422], and Orthopedic Biomechanics [BME 4211]). Students complete at least two modeling projects, at least one of which requires a full written report. Students learn to evaluate experimental data in BME Data Evaluation Principles (BME 3721). This course stresses the ability to design and conduct experiments, as well as to measure, analyze, and interpret data from living systems. These two courses, BME 2740 and BME 3721, provide the quantitative foundation for all BME courses. Students who matriculate into the program, as of Fall 2021, are required to enroll in Introduction to BME Computing course (BME 1054L) in order to learn logic and computing fundamentals in preparation for BME 2740.

Alongside the Modeling and Simulation course students can also enroll in the first of a two-course sequence of Engineering Physiology (BME 3403), which applies knowledge developed from the core requirement courses in basic sciences (mathematics, biology, chemistry, physics, biochemistry) to BME principles and practice. BME 3404 is taken later, once both BME 2740 and BME 3403 are completed. In BME 3403, students learn to apply knowledge from the basic sciences courses to analyze chemical, subcellular, and cellular processes as systems. BME 3404 extends to organ systems and builds on the integrative processes of the body. Problem solving, systems analysis, and technology are emphasized throughout these courses. Students are taught to understand biological/physiological systems and diseases in an integrative and quantitative manner. Students compare and contrast human body systems to engineered systems. Students conduct a literature review and write reports detailing medical devices or products. In the first example, students are asked to identify recently approved devices or technologies that have had an impact on either cardiovascular diagnosis or treatment; explain the clinical need for and reasons behind success and failure of the device; explain any major, unanticipated problems that have occurred since each has been approved; compare one of the functional systems of the body to a mechanical device that has similar operating principles; and summarize the advantages and disadvantages of each the body structure and the device in performing its intended function. In the second example, students choose a disease process that affects the human endocrine or nervous system and describe what the defect is in that particular disorder; find a medical device that was designed to correct or improve the disorder and examine in detail; and explain the design features incorporated into the device to restore function that had been lost. Further, they undertake a critical engineering-based analysis of the device with respect to its intended use and provide evidence-based suggestions for improvements that could be incorporated in future iterations or redesigns; students also discuss whether there were any major unanticipated adverse events that occurred after implantation of the device.

Concurrently, students take a four-course sequence that completes the foundation for biomedical engineers: Circuits Analysis and Lab (EEL 3110C), Applied Mechanics (EGM 3503), Transport (BME 3632), and Biomedical Instrumentation (BME 4503C). While EEL 3110C is a pre-requisite for BME 4503C, EGM 3503 is a pre-requisite for BME 3632. These are fundamental engineering courses that stress the ability to apply knowledge of mathematics (including differential equations and statistics), physical and life sciences, and engineering to carry out analysis and design to solve problems at the interface of engineering and biology. These four courses provide the fundamental engineering knowledge to prepare the students for the advanced BME courses of Biomaterials (BME 4100), Design of BME Systems and Devices (BME 4800C), and the BME labs (BME 4050L and BME 4051L), as well as engineering electives. The elective courses allow students to attain depth of knowledge in any of the three main concentration areas. These courses stress the ability to apply knowledge of mathematics (including differential equations and statistics), physical and life sciences, and engineering to carry out analysis and design to solve problems at the interface of engineering and biology, and the ability to identify, formulate, and adapt engineering solutions to unmet biological/medical needs. In BME 4503C, students produce 6-10 written reports, and in each of the other courses at least one written report and/or an oral presentation is required to demonstrate the student’s ability to communicate effectively. In some courses, both written reports and oral presentations are required.

Students learn the science of experimental design and execution and analysis of experimental data in laboratory courses (EEL 3110C, BME 4050L and 4051L and the laboratory portion of BME 4503C). These courses stress the ability to use the techniques, skills, and modern engineering tools necessary for professional career, including the ability to model and analyze biological systems as engineering systems; the ability to design and conduct experiments; and the ability to measure, analyze, and interpret data from living systems. The laboratory courses require detailed written reports for each exercise. These reports require the students to demonstrate an understanding of the concepts, applications, instrumentation, data collection, and interpretation. Through these written reports, students display their ability to meet student outcomes.

Finally, students learn to design systems to meet unmet biological needs in the comprehensive engineering design sequence of Medical Instrumentation Design (BME 4503C), Design of Biomedical Systems and Devices (BME 4800C) and culminating in the capstone design course Senior Design (BME 4908). The Senior Design course incorporates the knowledge and skills obtained throughout the entire program and every SLO. Written and oral communication skills are stressed throughout the curriculum, but particularly in the Senior Design Project report and presentation to the instructor, and during the Biomedical Engineering Technology Expo & Competition, which is a formal oral presentation of the design projects open to the entire university community and judged by members of BME industry. Since Fall 2018, Senior Design Projects have also been presented as posters in the College of Engineering and Computing’s Senior Design Showcase. In this showcase, all engineering programs participate, with FIU and industry representative attendees. Awareness of the characteristics of responsible professional career behaviors (including ethical conduct, consideration of the impact of engineering solutions on society in a global and contemporary context, and the value of lifelong learning) are also stressed throughout the curriculum, particularly in the Design sequence. An Undergraduate Seminar (BME 4930) gives students an exposure to the various applications and research activities in the field of BME, beyond what is experienced from their courses and senior design project. In fact, students are often exposed to the “state-of-the-art” in BME, through the leaders who give invited talks. These invited talks via our seminar series serves as an engagement mechanism for students and leading researchers in BME.

Students must take a minimum of 18 credit hours of electives, nine of which must be engineering topics and the remaining nine may be science courses. For electives, students choose from a list (see below) that allows them to add depth and focus in their chosen area of interest. Electives are developed by the faculty in a synchronous strategy to match the research focus of the department: (1) Biosignals and Systems, (2) Biomaterials and Biomechanics, and (3) Tissue Engineering/Pre-medical.

**Approved Science Electives (9 Credits)**

1. CHM 2211 Organic Chemistry II
2. BCH 3033 General Biochemistry I
3. CHM 3120 Analytical Chemistry
4. CHM 4304 Biological Chemistry I
5. CHM 4307 Biological Chemistry II
6. MCB 3020 General Microbiology
7. PCB 3063 Genetics
8. PCB 4233 Immunology
9. PCB 4023 Cell Biology
10. ZOO 3753 Histology

**Biomedical Engineering Electives (Biosignals and Systems)**

1. BME 4562 Introduction to Biomedical Optics (hybrid course)

2. BME 4531 Medical Imaging (online course)

3. EEE 4510 Introduction to Digital Signal Processing

4. EEL 3135 Signals and Systems

5 EEL 3657 Control Systems I

6 BME 4422 Biophysics of Neural Computation

**Biomedical Engineering Electives (Biomaterials and Biomechanics)**

1. BME 4211 Orthopedic Biomechanics
2. BME 4260 Engineering Hemodynamics
3. EGN 3365 Materials in Engineering
4. EML 3036 Simulation Software
5. EML 4804 Introduction to Mechatronics
6. EGM 3311 Analysis of Engineering Systems
7. BME 4230 Biomechanics of Cardiovascular Systems

**Biomedical Engineering\* Electives (Tissue Engineering/Pre-medical)**

1. BME 4332 Cell & Tissue Engineering (Global Learning, hybrid course)
2. BME 4311 Molecular Engineering
3. BME 4230 Biomechanics of Cardiovascular Systems
4. BME 4211 Orthopedic Biomechanics

\*3 Approved Science Electives (from the list above)

The concentration areas and associated electives are shown above. Students are highly encouraged to choose their electives with a common emphasis, and this is reinforced through the advising process and through interaction with faculty and faculty mentors. Students are encouraged to take all 18 credits of electives from one concentration area. Students may take electives not on this list only with the approval of the academic advisor and the Undergraduate Program Director. The course is first evaluated to ensure that it satisfies the requirements of three credits of engineering topics; there must be a compelling rationale and justification for the deviation. In addition, students in the combined MS/BS program (4+1) are permitted to take graduate-level engineering courses to satisfy the undergraduate electives requirement. The following list is of electives that have been taken by students in the BSBME program since 2009.

**Graduate BME Courses used as BSBME Electives**

1. BME 5036 Biotransport Processes
2. BME 5200 Orthopedic Biomechanics
3. BME 5233 Biomechanics in Cardiovascular Systems
4. BME 5505C Engineering Foundation of Medical Imaging Instrument (online course)
5. BME 5536 Cell/Tissue Engineering (hybrid course)
6. BME 5560 Biomedical Engineering Optics (hybrid course)

**A.6** **Broad Educational Component**

Describe the broad education component and how it complements the technical content of the curriculum and how it is consistent with the program educational objectives.

The ABET criteria requires a general education component that complements the technical content of the curriculum and is consistent with the program’s and institution’s objectives. The University Core Curriculum provides the broad, well-defined curriculum that enables graduates to think critically, analytically, and creatively, with a passion to learn and with the skills and ability to assemble, assess, incorporate, and synthesize new knowledge and ideas. The general education curriculum allows students to determine the importance and relevance of new ideas through a synthesis of both broad and narrow contexts and the integration of seemingly disparate pieces into a meaningful whole. This is consistent with the PEO, which seek to prepare outstanding professional engineers and public health practitioners, through exposure to intellectually diverse subject matter and critical thinking. The University Core Course categories are described below:

* **First-Year Experience** (SLS 1501; one, one-credit course required): The transition to a university environment is a unique one for first-time university students. FIU's First-Year Experience course is designed to facilitate this transition. The course provides a forum for integrating the FIU experience and for discussing issues promoting intellectual, personal, academic, and social growth and success as a member of the university community. It also introduces students to university policies, procedures, and services; addresses academic and career choices; and enhances study and time-management skills. All students entering the university with fewer than 30 semester hours are required to take this one-credit course.
* **English Communication** (two, three-credit courses from either sequence required): These courses provide a foundation in the critical analysis of issues and texts, both discursive and creative, and in argumentation and persuasion. Communication courses provide this foundation by encouraging the mastery of written and oral communication models, including the essay and research paper.

For students entering FIU with 30 or fewer credits and for all first time-in-college students, ENC 1101 Writing and Rhetoric I and ENC 1102 Writing and Rhetoric II are required.

For students entering FIU with more than 30 credits (who are not first-time-in-college students), ENC 2304 College Writing for Transfer Students, and one of the following are acceptable: ENC 3311 Advanced Writing and Research, ENC 3249 Professional and Technical Writing for Computing, or ENC 3213 Professional and Technical Writing.

* **Humanities** (two, three-credit courses required, ): Students confirm the ability to think critically through demonstrating interpretive ability and cultural literacy. Students acquire competence in reflecting critically upon the human condition.
* **Social Science** (two, three-credit courses required): In these courses, students investigate social, political, and economic configurations; cultural and psychological features of human life; gender, race/ethnicity, and social class; consciousness and identity; social interactions with the natural environment; and local, national, and global aspects of the human world.
* **Arts Requirement** (three credit hours required): In fulfilling this requirement, students become acquainted with the fundamental aspects of the arts while developing a capacity to understand, appreciate, or experience particular forms. Students address universal themes central to the cultural traditions of the past and present as expressed through the perspectives of the arts.
* **Global Learning Foundations Course (GL)** (one, three-credit course required): Global learning foundations courses are indicated with a “GL” after the course title. This course is part of the university core curriculum. Interdisciplinary in content, they deal with essential questions and complex issues that are best understood and addressed through multiple disciplinary perspectives. <https://goglobal.fiu.edu/gl-curriculum/index.html>
* **Gordon Rule with Writing (GRW)** (six credit hours required): Students are required to demonstrate college-level writing skills through six semester hours of Gordon Rule Writing-designated courses (indicated with a “GRW” after the course title). To fulfill this requirement, students can select any two GRW-designated courses in the University Core Curriculum. These courses can be from the same or different categories.
* **Civic Literacy (CL)** Requirement: Students must demonstrate understanding of American Civics. This may be completed through coursework (AMH 2020 or POS 2041 completed at a Florida College System or State University System of Florida institution), or an approved assessment. https://transfer.fiu.edu/transfer-101/graduation-requirements/

**A.7 Major Design Experience**

Describe the major design experience that prepares students for engineering practice. Describe how this experience is based upon the knowledge and skills acquired in earlier coursework and incorporates appropriate engineering standards and multiple design constraints

BSBME incorporates design component (related to SLO B) across the undergraduate curriculum to prepare students for engineering practice.

***Design Component During Formative Years (Earlier Coursework)***

The BSBME also incorporates the fundamentals of design components during the formative years (freshman to early junior) apart from the summative years (late junior and senior) via courses such as BME 1008C (Intro to Biomedical Engineering), BME 3403 & 3404 (Engineering Analysis of Biological Systems I & II), BME 3632 (BME Transport). The engineering design concepts are introduced in BME 1008C. The course involved in-class 3D modeling challenges as well as 3D modeling contests to facilitate the learning of Fuion360 (a 3D engineering drawing software towards basics of engineering design). In BME 3403 and 3404, the basics of applying theoretical engineering design to realize solutions and design considerations considering safety, global, social, environmental/economic factors are elaborated when analyzing the biological systems. In BME 3632, students are exposed to the basics of engineering design (conceptually) via principles of transport phenomenon and numerical techniques in modeling complex physiological systems. Knowledge from these courses is further expanded in summative years to strengthen students’ engineering design experience.

***Design Component During Summative (or Senior) Years***

The BSBME program contains a significant and comprehensive design component which culminates in a major capstone design experience. The design experience is integrated into the curriculum through individual courses, but it explicitly addressed through Biomedical Instrumentation Design (BME 4503C, four-credit hours) in which students are required to design and build and medical device (e.g., a digital thermometer, incubator, motorized artificial hand) and through a design sequence (i.e., Design of Biomedical Systems and Devices [BME 4800C, four-credit hours] which provides students with an introduction to systems and devices used in the biomedical industry and the basic principles of their design). It is meant to offer the students an application in the biomedical area to the basic theory developed in the lower-level coursework, as well as an opportunity to learn basic steps and processes involved in engineering design as they specifically apply to biomedical problems. This course (BME 4800C now, and prior it was BME 4800 and BME 4880) also serves as a catalyst in integration of the students into a practical work environment interfacing with selected clinics, biomedical companies, researchers, or academic institutions. The course exposes the students to the mechanics and the challenges of working within multifunction teams to creatively develop a solution for a biomedical need. There is an emphasis on developing proposals, project planning, resource allocation, budgeting, design, risk assessment, reliability analysis through simulations and mathematical modeling; device fabrication; and verification testing. Students utilize acquired skills and knowledge through the entire biomedical program in the Senior Design Project (BME 4908, three-credit hours) as described below.

Senior Design Project (BME 4908) is the capstone project for BME students and prepares the students for professional career. Senior Design Project represents the biomedical engineering Practice component of the curriculum and is the last of a sequence of design-oriented courses (Data Evaluation Principles, Medical Instrumentation Design, and Design of Biological Systems & Devices) culminating in a capstone project that incorporates knowledge gained in mathematics, statistics, the physical and life sciences courses, the fundamental engineering courses, and the remainder of the BME program. This course enables the graduate to apply engineering principles to create, analyze, and improve processes, devices, and systems to meet a desired need. In the full design sequence, students learn to apply engineering knowledge to real-life design problems and to evaluate the solutions critically. At the end of the senior design projects, students present their work at the Biomedical Engineering Technology Expo & Competition. Projects are evaluated and judged by a committee consisting of industry and clinical professionals. The winning team receives an award. Occasionally in recent years, student teams have been invited to compete in state design competitions.

***Incorporation of Engineering Standards and Realistic Constraints***

As a part of the student’s experience in the biomedical engineering program, student are introduced to engineering standards, guidelines, and realistic constraints through multiple courses. For example, in BME 1008C Introduction to Biomedical Engineering students, are introduced to the Code of Ethics for Engineers. In BME 4011 students learn about the legal requirements of patient data confidentiality and the Health Insurance Portability and Accountability Act (HIPAA). In BME 4908 Senior Design Project, students must take and pass the online National Institutes of Health (NIH) course on human subjects in research, which addresses the ethical conduct of human research and the function and responsibilities of the Institutional Review Board (IRB). All senior design projects must demonstrate applicable engineering standards such as ISO (International Organization for Standardization), ASTM (American Society for Testing and Materials), ANSI (American National Standards Institute), IEEE (Institute Electrical and Electronics Engineers) and USP (United States Pharmacopeial Convention), and the consideration of appropriate standards must be explicitly identified in the final project report. These standards are incorporated into the designs and are standard references in the development and execution of verification protocols. The object of the protocols is to ensure safety, consistency, accessibility, and ease of use. Standard statistical techniques and tools are also employed in the verification process. In BME 4050L and 4051L (BME Laboratory I and II) students must take and pass online training in the ethical use of animals in research (administered through FIU’s Institutional Animal Care and Use Committee [IACUC]), biohazard safety, and safe laboratory practices (administered through FIU Environmental Health and Safety, and Risk Management departments). These experiences provide awareness of the characteristics required for responsible professional career behaviors, including ethical conduct, consideration of the impact of engineering solutions on society in a global and contemporary context, and the value of lifelong learning.

In BME 4503C Medical Instrumentation Design, students learn electrical safety and must consider safety in their design projects for the course. In BME 4800C Design of Biomedical Systems and Devices, students learn the concepts of the BME design process with special emphasis on recognition of a need/opportunity, meeting regulatory requirements (including the Department of Health and Human Services, Food and Drug Administration, Center for Devices and Radiological Health, American National Standards Institute, American Society for Testing and Materials, Institute of Electrical and Electronics Engineers Standards Association), hazard analysis (i.e., risk assessment), budget analysis, feasibility assessment, reliability assessment, project management and biocompatibility. These issues are presented with specific applications to selected human artificial systems. In this BME 4800C course (the first of the two-semester senior design courses), students are organized into teams to develop a proposal for their capstone project in BME 4908 Senior Design Project (described in more detail above). BME 4800C can be considered an initial kick-off for the Senior Design Project course. BME 4800C also serves as a platform to integrate the knowledge acquired in the BSBME program and serves as an interface between clinical and academic institutions, industry and researchers, and the students for talent recruitment. The course teaches students to suggest solutions and prepare proposals and budgets; plan work that involves conventional types of planning, investigations, testing, systems, or equipment with relatively few complex features; and prepare a final project proposal and presentation that requires obtaining and presenting data, plans, charts, and calculations as needed. A standing committee evaluates each team’s 20-minute oral presentation, followed by a 30-minute question and answer session. The committee later provides the teams and the course instructor with an evaluation of the presentation and written proposal. BME 4908 Senior Design Project is the culminating capstone design experience and emphasizes the economic, environmental, and societal impact of the device or instrument being designed. In addition, safety, manufacturability, and sustainability are carefully considered in the design process.

**A.8 Cooperative Education**

If the program allows cooperative education to satisfy curricular requirements specifically addressed by either the general or program criteria, describe the academic component of this experience and how it is evaluated by the faculty

Not applicable to the BSBME program.

**A.9 Materials Available for Review**

Describe the materials that will be available for review during and/or prior to the visit to demonstrate achievement related to this criterion. (See 2021-2022 APPM Section I.E.5.b.(2))

Additional materials demonstrating compliance with Criterion 5 will be available for review during and/or prior to the site visit. These materials are:

* Course-related folders for all the major undergraduate courses offered by BME. These course folders will include the course syllabus, example of problems (from exams, quizzes, project reports, etc.) that relate to the course and student outcomes (SLOs), and course outcomes evaluations by students.
* Textbooks of all the major undergraduate courses in the department.
* Syllabi for all math and science courses.
* Examples of senior design project materials of teams from different semesters. This also includes the evaluation of the senior design projects by faculty advisors and the evaluation of oral presentations by external evaluators (i.e., industry judges). Also available will be electronic copies of senior design project reports, PowerPoint presentations of their oral talk, and posters.
* Project reports (examples from each semester) from both the BME Laboratory courses, along with the student course evaluations.
* Meeting minutes (undergraduate committee meeting, annual departmental retreat) where curriculum was assessed and program changes were discussed.
* Departmental promotional materials.
* Examples of surveys and other instruments used to assess the program (that are not included in the self-study report, including the raw data).

***Course Syllabi***

In Appendix A of the Self-Study Report, include a syllabus for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5 or by any applicable program criteria.

Course syllabi for each course used to satisfy the mathematics, science, and BME-specific requirements required by Criterion 5 or any applicable program criteria are provided in **Appendix A**.

**Table 5-1 Curriculum**

**Biomedical Engineering**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Course (Department, Number, Title)  List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year. | | Indicate whether course is Required, Elective or a Selected Elective by an R, an E or an SE.1 | *Subject Area (Credit Hours)* | | | Last Two Terms the Course was Offered:  Year and,  Semester, or  Quarter | Maximum Section Enrollment  for the Last Two Terms the Course was Offered2 |
| Math & Basic Sciences | Engineering Topics.  Check if Contains Significant Design (√) | Other |
| **First Semester** | |  |  |  |  | F- Fall,  S-Spring |  |
| MAC 2281 Calculus I for Engineering | | R | 4 |  |  | *F21; S22* | *38,31* |
| CHM 1045 General Chemistry I | | R | 3 |  |  | *F21; S22* | *200,205* |
| CHM 1045L General Chemistry I Lab | | R | 1 |  |  | *F21; S22* | *49,22* |
| ENC 1101 Writing & Rhetoric I | | R |  |  | *3* | *F21; S22* | *25,24* |
| BME 1008C Intro to Biomedical Engineering | | R |  | *2* |  | *F21; S22* | *54,51* |
| SLS 1501 Freshman Experience | | R |  |  | *1* | *F21; S22* | *18,25* |
| BSC 2010 Biology I | | R | 3 |  |  | *F21; S22* | *297,100* |
| BSC 2010L Biology I Lab | | R | 1 |  |  | *F21; S22* | *23,24* |
|  | |  |  |  |  |  |  |
| **Second Semester** | |  |  |  |  |  |  |
| MAC 2282 Calculus II for Engineering | | R | 4 |  |  | *F21; S22* | *34,33* |
| BME 1054L Biomedical Engineering Computing | | R |  | *1* |  | *F21; S22* | *68,66* |
| CHM 1046 General Chemistry II | | R | 3 |  |  | *F21; S22* | *200,197* |
| CHM 1046L General Chemistry II Lab | | R | 1 |  |  | *F21; S22* | *22, 21* |
| PHY 2048 Physics w/ Calculus I | | R | 4 |  |  | *F21; S22* | *121,147* |
| PHY 2048L General Physics I Lab | | R | 1 |  |  | *F21; S22* | *36,36* |
| ENC 1102 Writing & Rhetoric II | | R |  |  | *3* | *F21; S22* | *24,24* |
| **Third Semester** | |  |  |  |  |  |  |
| MAC 2283 Calculus III for Engineering | | R | 4 |  |  | *F21; S22* | *39,40* |
| CHM 2210 Organic Chemistry I | | R | 4 |  |  | *F21; S22* | *201,201* |
| CHM 2210L Organic Chemistry I Lab | | R | 1 |  |  | *F21; S22* | *16,22* |
| Humanities Group I | | R |  |  | *3* | *F21; S22* | *-* |
| PHY 2049 Physics w/ Calculus II | | R | 4 |  |  | *F21; S22* | *162,85* |
| PHY 2049L Physics II Lab | | R | 1 |  |  | *F21; S22* | *35,32* |
|  | |  |  |  |  |  |  |
| **Fourth Semester** | |  |  |  |  |  |  |
| MAP 2302 Differential Equations | | R | 3 |  |  | *F21; S22* | *49,42* |
| ESI 3215 Evaluation of Engineering Data/STA 3033 Intro Probability & Statistics | | R | 3 |  |  | *F21; S22* | *54,61*  *55,54* |
| BME 2740 BME Modeling & Simulation | | R |  | *3* |  | *F21; S22* | *46,43* |
| Humanities Group II | | R |  |  | *3* | *F21; S22* | *-* |
| Social Science Group I | | R |  |  | *3* | *F21; S22* | *-* |
|  | |  |  |  |  |  |  |
| **Fifth Semester** | |  |  |  |  |  |  |
| EGM 3503 Applied Mechanics | | R |  | *4* |  | *F21; S22* | *63,60* |
| BME 3721 BME Data Eval Principles | | R |  | *3* |  | *F21; S22* | *40,49* |
| BME 3403 Engineering Analysis Bio Systems I | | R | 1.5 | *1.5* |  | *F21; S22* | *21,47* |
| EEL 3110C Circuit Analysis and Lab | | R |  | *4* |  | *F21; S22* | *81,83* |
| BME Engineering/Science Elective | | R |  |  | *3* | *F21; S22* | *-* |
|  | |  |  |  |  |  |  |
| **Sixth Semester** | |  |  |  |  |  |  |
| BME 3404 Eng Analysis Bio Systems II | | R |  | *3* |  | *F21; S22* | *34,18* |
| BME 4503C BioMedical Inst Design | | R |  | *4* |  | *F21; S22* | *86,54* |
| BME 4011 Clinical Rotations | | R |  | *1* |  | *F21; S22* | *31,20* |
| BME 3632 BME Transport | | R |  | *3* |  | *F21; S22* | *53,37* |
| BME Engineering/Science Elective | | R |  | *3* |  | *F21; S22* | *-* |
| Social Science Group II | | R |  |  | *3* | *F21; S22* | *-* |
|  | |  |  |  |  |  |  |
| **Seventh Semester** | |  |  |  |  |  |  |
| BME 4050L Biomed Lab I | | R |  | *1* |  | *F20;F21* | *21,21* |
| BME 4100 Biomaterials Science | | R |  | *3* |  | *F21; S22* | *37,22* |
| BME 4800C Design Biomed Systems & Development | | R |  | *4* |  | *F21; S22* | *45,39* |
| BME Engineering/Science Elective | | R |  | *3* |  | *F21; S22* | *-* |
| BME Engineering/Science Elective | | R |  | *3* |  | *F21; S22* | *-* |
| **Eighth Semester** | |  |  |  |  |  |  |
| BME 4051L Biomed Lab II | | R |  | *1* |  | *S21;S22* | *24,24* |
| BME 4908 Senior Design Project | | R |  | *3* |  | *F21; S22* | *39,44* |
| BME 4930 Biomedical Engineering Undergraduate Seminar | | R |  | *0* |  | *F21; S22* | *29,30* |
| BME Engineering/Science Elective | | R |  | *3* |  | *F21; S22* | *-* |
| BME Engineering/Science Elective | | R |  | *3* |  | *F21; S22* | *-* |
| Art Elective | | R |  |  | *3* | *F21; S22* | *-* |
| *Add rows as needed to show all courses in the curriculum.* | |  |  |  |  |  |  |
| TOTALS (in terms of semester credit hours) | | | 46.5 | *56.5* | *25* |  |  |
|  | |  |  |  |  |  |  |
|  | | |  |  |  |  |  |
| Total must satisfy minimum credit hours | Minimum Semester Credit Hours | | 30 Hours | 45 Hours |  |  |  |
|  | |  |  |  |  |  |

1. **Required** courses are required of all students in the program, **Elective** courses (often referred to as open or free electives) are optional for students, and **Selected Elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For Selected Elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verify

**Figure 5.1 BME Curriculum Flowchart including Prerequisite Structure (general track)**

Other curriculum related flowcharts for sequence of course offerings for the three sub-tracks for BSBME are available on BME website (<https://bme.fiu.edu/academics/degrees/>). Additionally, these flowcharts are available as interactive pdfs as well in the same BME website.

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# CRITERION 6. FACULTY

1. ***Faculty Qualifications***

Describe the qualifications of the faculty and how they are adequate to cover all the curricular areas of the program and also meet any applicable program criteria. This description should include the composition, size, credentials, and experience of the faculty. Complete Table 6-1. Include faculty resumes in Appendix B.

Faculty in the Department of Biomedical Engineering (BME) have qualifications adequate to cover all curricular areas of the Bachelor of Science in Biomedical Engineering (BSBME) program at Florida International University (FIU). Supporting materials for this Criterion 6 include completed Tables 6-1, 6-2, and 6-3 (at the end of this Criterion 6 response), and faculty resumes (included in Appendix B).

**A.1 Composition of Faculty and Education**

All BME regular faculty members have terminal degrees in their discipline from highly reputable institutions. As is typical in biomedical engineering, the degrees have been earned in a variety of fields (e.g., biomedical engineering, electrical engineering, chemical engineering, physics, biochemistry, medicine). This variety in educational background is necessary to cover the broad field of biomedical engineering. All the core courses and electives are listed in **Table 6-3** below, with corresponding names of the faculty members who offer the course on a regular basis (i.e., the primary instructor) as well as faculty who have served as instructors for the course or have the relevant experience to do so (i.e., secondary instructor). The faculty has a broad range of expertise and appropriate training to cover all the courses offered in the curriculum, with multiple faculty members who are qualified to offer each course.

**A.2** **Size and Experience of the Faculty**

The experience of the BME faculty is a mixture of levels. BME has one associate teaching professor, one teaching professor, two assistant professors, eight associate professors, and two full professors. All faculty members hold some combination of industry or post-doctoral experience gleaned before starting their faculty careers. Experience as a university faculty member range from three to 22 years.

**A.3 Credentials of the Faculty (Scholarship)**

All BME tenured/tenure track faculty members are actively involved in scholarly work. Each has funded research or is diligently applying for research funding. From 2018 to 2022 annual research awards and expenditures per faculty, average to approximately $5.25M and $2.88M, respectively. All faculty publish the results of their research regularly in peer-reviewed journals and present at regional, national, and international conferences.

All BME faculty members have affiliations with professional organizations, and all faculty members are active in their profession. These activities range from peer review for professional journals and funding agencies (like the NIH (National Institutes of Health), NSF (National Science Foundation), DOD (Department of Defense) and AHA (American Heart Association), and industry), to chairing sessions at conferences, to holding offices on professional boards and committees.

Faculty credentials and experience are summarized in **Table 6-1** at the end of this Criterion 6. Abbreviated resumes for all faculty who teach in the BSBME program are contained in Appendix B.

1. ***Faculty Workload***

Complete Table 6-2, Faculty Workload Summary and describe this information in terms of workload expectations or requirements.

The faculty workload summary is provided in **Table 6-2** at the end of this Criterion 6. The 100% instructional workload per semester is 12 credits. However, teaching load has been capped at 9-10 credits per semester for teaching faculty, with the balance of time allocated to service assignments (e.g., curriculum development, accreditation). Further reduction is the norm for tenured/tenure-track faculty members, which allows a significant percentage of time to be devoted to research and other activities (e.g., administration, advising, chairing in and membership in PhD committees, teaching of independent studies, institutional and professional service).

The teaching load requirements for the BSBME program have been, in general, lower than for other FIU engineering programs. This is because the BSBME curriculum includes life science courses and courses taught by other engineering departments, and because BME does not teach service courses for other departments. The teaching load for tenured/tenure-track BME faculty has been typically limited to nine to 12 credit hours per year (i.e., three to four courses per academic year) (**Table 6-2**). Effort has been made to keep the teaching load of the assistant professors and new faculty recruits lower than that for the senior faculty. Teaching assignments are higher for full-time instructors. Course assignments are made each year by the chair of the department, based on curriculum needs. Class sizes (per section) are typically around 50 students. A teaching assistant is typically assigned to classes with high student enrollment and always to the laboratories to support instructional activities.

1. ***Faculty Size***

Discuss the adequacy of the size of the faculty and describe the extent and quality of faculty involvement in interactions with students, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners including employers of students.

The faculty size is adequate to ensure high-quality faculty involvement in interactions with students, student advising and counseling, university services activities, professional development, and industrial and professional practitioners. As the student body has grown, the university has invested in the biomedical engineering program, allocating funding for new faculty hires. Since the last ABET review, the department added five new tenure track faculty (two associate professor-level and three assistant professor-level positions). Unfortunately, one of the new hires (McPherson) left in 2018, following his wife who found a tenure-track faculty position elsewhere. As of March 2022, this position remained unfilled. As of Fall 2021, undergraduate student headcount was 351 (see Table D-4 of Appendix D for details). The department currently has 14 primary faculty members, of which 12 are tenured or tenure-track. Dr. Riera Diaz also serves as Interim Chair (0.5 FTE admin), Dr. McGoron is Associate Dean of Academic Affairs (0.5 FTE admin), Dr. Godavarty is Undergraduate Program Director, and Dr. Ramaswamy is the Graduate Program Director. Two faculty members (Brown and Christie) are in non-tenure-earning instructor lines.

We also utilize adjunct faculty (with degrees in Biomedical Engineering or related fields) to supplement the instructional needs of the department (e.g., when full-time faculty are on official leave). An adjunct faculty member (Shahrestani) has assisted with coordinating our Senior Design course sequence since 2005. Because of his significant industry experience, including regulatory and design, he has been a consistent and valuable resource. In Spring 2022, a research assistant professor (Hillen) was moved to the adjunct faculty position to teach a BME undergraduate/graduate cross-listed elective (BME 4211 Orthopedic Biomechanics). The resume of each adjunct is included in Appendix B. In addition to the primary faculty, one full-time staff member is allocated as a lab manager for the undergraduate labs. Yun Qian has a PhD in chemistry and extensive experience in coordinating undergraduate laboratory courses, as well as experience at federal National Labs.

**C.1 Tenure and promotion process**

Promotion to associate professor with tenure indicates significant accomplishment in scholarship, teaching, and service worthy of status as a member of the senior faculty. Candidates for tenure should demonstrate a commitment to FIU’s mission and goals and be willing to continue to contribute to the excellence of the university’s reputation. The candidate must demonstrate strong commitment to excellence and creativity in teaching and student learning (with qualifications and experience for teaching a variety of courses), a commitment to guiding and advising students, and a commitment to providing students with opportunities for involvement in research projects. The candidate should demonstrate quality, consistency, and productivity, in research achieving national/international recognition through well-respected, peer-reviewed journals and/or other venues that are consistent with national professional recognition. Candidates should demonstrate success at funded research, and evidence of a course of professional development that at the minimum establishes their independent scholarly standing or increasing leadership roles in collaborative/team-based scholarship. They should have a record of substantial professional service (e.g., leadership in regional, national, or international professional societies; organizing conferences; serving on editorial boards; service to schools, agencies, companies, and community organizations) and evidence of service to the department, college or university (e.g., participation in collegial governance.)

Details for the tenure process at FIU can be found at <https://academic.fiu.edu/docs/TP%20MANUAL%2017%20Nov%202020.pdf>.

Briefly, the tenure candidate is evaluated by external evaluators and by the department, the chair, the college tenure committee, the Dean of the college, the Provost, and the President of the university. Except for employees who, by virtue of prior service credited at the time of appointment, are eligible for consideration earlier, an employee must be considered for tenure during the sixth year of continuous service in a tenure-earning position. The department’s tenure committee, consisting of all tenured faculty with at least 50% appointment in the department, provides an initial evaluation of the applicant’s file. The department’s and chair’s evaluations are forwarded to the college tenure committee, which provides a recommendation in favor or against granting tenure to the applicant. The committee then forwards the recommendation to the Dean of the college, who provides his or her evaluation to the Provost. The Provost provides a recommendation to the President, who finally submits his or her recommendation to the university’s Board of Trustees for approval. At each stage of the process the candidate is offered an opportunity for rebuttal.

Non-tenure-track (NTT) faculty serve as lecturers, instructors, clinical professors, research professors, and professional practice professors. The Department of Biomedical Engineering currently has two NTT faculty (one associate teaching professor and one teaching professor. Appointment and promotion guidelines for clinical, research, and professional practice professors are established by schools and colleges. All appointment and promotion guidelines must be approved by the Provost. Assistant teaching professors are generally expected to hold the terminal degree in their field. Promotion is based on the contribution to the academic mission of FIU. Assistant teaching professors typically teach undergraduate courses and may, with appropriate qualifications, teach graduate courses. It is not expected that faculty will receive an initial appointment as associate teaching professor or teaching professor. These are positions typically obtained through promotion from assistant or associate teaching professor, respectively. Such promotion will not be considered prior to the start of the sixth year of continuous service at the lower rank. Promotion is reviewed at the department committee, chair, dean, and provost levels. There is no college committee review for promotion in the NTT track.

**C.2 Interactions with Students**

We take pride in the close relationship that exists between the faculty and students of the biomedical engineering program at FIU. Besides the normal opportunities for interaction that include class time and office hours, BME faculty members interact with undergraduate students in a variety of settings. Many of our undergraduate students work as assistants in faculty research laboratories. We have two departmental scholarship programs that promote this activity. The FIU-BME Wallace H. Coulter Endowment supports the Coulter Undergraduate Research Excellence (CURE) program. Details of this program can be found at: <https://bme.fiu.edu/research/coulter-undergraduate-research-excellence-program-cure/>. We also have the FIU-BME Norman H. Weldon Biomedical Engineering Undergraduate Student Research Internship program. This program supports two to five undergraduate students for one summer (i.e., 12-weeks) to work on a research project in a faculty member’s laboratory. Many students in the university’s Honors College have the option of taking two semesters of research towards satisfying their requirement in the Honor’s College. Some students are paid directly from faculty grants; other students volunteer in faculty research laboratories outside of any of these programs.

The university participates in the Ronald E. McNair program. This program supports students from disadvantaged backgrounds who have demonstrated strong academic potential for doctoral study through involvement in research and other activities. The goal of the McNair program is to provide enriching scholastic experiences that prepare eligible scholars for doctoral education. The McNair program works closely with students as they complete their undergraduate requirements. Participants are given the unique opportunity of developing the highest-level academic and research skills needed for successful admission to and completion of a PhD program. McNair scholars are eligible for the following services until they complete their baccalaureate degree: academic counseling, financial aid assistance, mentoring, research opportunities, seminars, summer internships, and tutoring.

Since 2011, the Department has hosted an “Undergraduate Research Day.” This event includes talks by an invited speaker, judged poster presentations of research conducted by the undergraduates in BME department laboratories or other science laboratories at FIU, and a reception. Over the past four years, we have organized “Meet Our Alumni” events, in which four or five BSBME alumni currently working in industry or pursuing advanced graduate or medical education are invited to meet with senior BSBME students via a moderated session conducted by the Senior Design Project course (BME 4908) instructor (Christie). The entire event is extensively attended by undergraduate students, graduate students, and faculty. Each Fall and Spring semester, students interact with faculty and industry members at a reception celebrating the presentation of Senior Design Capstone projects.

The department also hosts a Thirst for Science event series. The first Thirst for Science event was held on February 15, 2018. The events in this series seek to gather scientists, engineers, and interested members of the lay public in informal settings to discuss topics from a range of scientific disciplines. Speakers at the events are instructed to give informal, accessible talks suitable for a general audience. We have held 17 events to date, including one virtual event hosted during the COVID-19 pandemic (additional details available at <https://bme.fiu.edu/about/events/thirst-for-science/>).

The department also has five professional student society chapters. All of the societies have good standing with the university’s student governance organization, have regular meetings that are well attended, and are extremely active. The five student societies are:

* **Biomedical Engineering Society (BMES).** Dr. Joshua Hutcheson is the current faculty advisor for BMES. Since 2000, the BMES continues its mission to educate its members with respect to biomedical engineering. Their members are guided in the role and responsibilities that they will have in their profession and society in general. The BMES organizes many activities that faculty members also participate in. Some of such activities include an annual softball match between the BME faculty and students and a Chocolate with the Chair event, which is a student-faculty mixer. The BMES chapter students regularly attends the annual national BMES meeting. The major activities organized by this student chapter since 2018-2021 include Chocolate with the Chair, Evening with Industry, BMES Buddies Social, Resume and Cover Letter Workshop, Circuits for Fun, and volunteer opportunities at the Engineering Expo, a college-organized K-12 outreach event held during Spring semesters. In 2018-2019, BMES received the Outside Outreach Award given by the National BMES (from more than 160 student chapters across the country) for developing science, technology, engineering, and math (STEM) skills in K-12 and early college students.
* **Alpha Eta Mu Beta (AEMB) FIU chapter.** Dr. Michael Christie is the current faculty advisor for the AEMB chapter at FIU. Since 2007, the chapter continues its mission at the intersection of service, excellence, and leadership, expanding from ten members to more than160 members (approximately 10 new members per calendar year). The chapter captures a dynamic snapshot of the dynamic BME environment, the drive of our students to learn, and the perpetual commitment to exploring new boundaries. While at core a biomedical engineering honors society, the AEMB FIU chapter activities are open to all engineering students that seek to broaden their understanding of engineering innovation and technology in health care. AEMB hosts and participates in a variety of events to deliver our students the opportunity to build a professional network and successful future for themselves. Major activities during 2018-2021 included hosting various professional development and leadership activities (e.g., prepare for career expo, federal jobs overview, how to brand yourself, resume writing), technical skills activities (e.g., ANSYS (Analysis System) simulation workshops, Matlab workshops, Solidworks workshops), attending various conferences (e.g. Annual BMES (Biomedical Engineering Society) Meeting, BEYA (The Black Engineer of the Year Awards) STEM conference), and organizing social events (Friday night Funkin’, Skribbl. Io game night). The chapter has also hosted TED-style talks and collaborated with other student societies to host events with industry. In addition, AEMB is actively involved in volunteering during the Engineering Expo.
* **SPIE (Society of Photo-Optical Instrumentation Engineers).** The SPIE Student Chapter at FIU was established August 2019 under the leadership of faculty advisor Dr. Jessica Ramella-Roman. The mission of the SPIE student chapter is to serve all students in FIU interested in learning about optics and photonics. The organization provides seminars on multidisciplinary topics; participates in community service with local schools in order to enhance STEM education; and promotes networkingwith the optics community by hosting guest speakers, attending conferences, and providing a platform of communication between students and faculty. The chapter has participated in events such as the Engineering Expo, a Phon with Photonics event focused on biophotonics research, and STEM nights in local schools showing practical uses of optics research.
* **IEEE Engineering in Medicine and Biology Society** (**EMBS)**. The IEEE EMBS group was established in Fall 2015. The current faculty advisor for this society is Dr. Markendoya Pulugurtha Raj. The mission of this society is to help students and the community in the fields of biomedical engineering, biotechnical engineering, medicine, and biological sciences. The various activities performed by this student chapter in the past three years include hosting an Industry Seminar Series (which invited guest speakers from industry), participating in skill-developing activities via Model Mayhem (to model medical devices on Solidworks), engaging in outreach activities in collaboration with Diversity and Student Success in Engineering and Computing (CD-SEEC) via Engineers on Wheels (EoW) catering K-12 events, and hosting social activities including game nights and virtual escape room gatherings.
* **IEEE Electronic Packaging Society (EPS)**. The IEEE EPS group was established in 2020 at FIU. The founder and current faculty advisor is Dr. Markendoya Pulugurtha Raj. The focus of this student chapter is research, design, and development of revolutionary advances in microsystems packaging and manufacturing. Both undergraduate and graduate students are active members of this society. This student chapter is primarily involved in inviting industry experts in the field of electronics and packaging. Since 2020, the chapter organized a total of 11 seminars given by industry experts.

**C.3 Student Advising**

The department has two half-time undergraduate professional academic advisors - Maria Monje Ramos and Saradia-Laure Lerouge to assist students with the administrative aspects of advising (e.g., official transfer to the program, registration for courses, application for degree). Faculty also provide career and academic guidance to students. Students initiate contact with BME faculty via the interactions with faculty described above. It is the philosophy of the department that our primary duty is to the students and that mentoring is innate to our profession. Thus, all BME faculty members take every opportunity to provide guidance to our students.

**C.4 Service Activities**

BME faculty members are all actively involved in service to the department, college, university, and professional societies. All faculty members (except the chair) serve on either the Undergraduate or Graduate Program committees. Other examples of service within the department include participation on the Tenure and Promotion, and Search and Screen committees, as well as other ad hoc committees at the department level. The department is represented on all college committees (i.e., Faculty Council, Library Committee, Curriculum Committee, Tenure and Promotion Committee), and we have representatives on key university committees or units (i.e., FIU Research Foundation; the Institutional Animal Care and Use Committee; and Advance Women, Equity and Diversity). These committee assignments are fairly distributed among all faculty members, though assistant professors typically do not serve on committees outside of the department.

In addition to normal committee assignments, BME faculty have been extremely active in BSBME program development and assessment. The faculty are unanimously committed to growing the excellence of the program and have made a concerted effort to make continuous improvements by thoughtful course and process development (as described in Criterion-2 and Criterion-4).

**C.5 Interactions with Industry**

The mission of the BME department is to integrate academia, clinical medicine, and the biomedical industry into all of our activities. The curriculum provides ample opportunity for our faculty and students to interact with the clinical medicine and biomedical industries. All primary faculty in the department have a patent portfolio (<https://bme.fiu.edu/research/patents/>) and several have research partnerships with industry. Recently, the department offered seed funding of up to $10K through its Wallace H. Coulter Endowment for collaborative research between the BME primary faculty and commercialization efforts via Coulter MedTech grants. The FIU Office of Technology Management and Commercialization (<https://research.fiu.edu/ored/otmc/>) and StartUp FIU (<https://startup.fiu.edu/>) provide guidance to faculty in their entrepreneurial efforts.

Undergraduate and graduate students participate in translational research activities and benefit from the industrial collaborations of the faculty. In 2021, the department established a year-long MedTech track within CURE, where students work closely with the FIU Technology Management and Commercialization office to participate in intellectual property protection, entrepreneurship, and commercialization. This track supplements our efforts to increase industry involvement in our department through our Industry Advisory Board (IAB) and our annual Industry Night (i.e., an annual IAB meeting), where students can meet with industry representatives, network, and seek feedback on finding a career in industry.

In addition, in most semesters, 100% of capstone projects are sponsored by industry/clinical partners.

The BME department’s IAB is a model for partnering with the biomedical industry in its education and research programs. The objectives of this partnership are to customize research and development at FIU BME consistent with the next-generation biomedical industry needs; create an interdisciplinary workforce with technical vision, leadership skills, and communication skills; and accelerate the commercialization of research breakthroughs. An industry seminar series was initiated in 2020, organized by the EMBS student chapter. In addition, the annual IAB meeting in Fall semesters allows students to interact with industry representatives and learn of their ongoing research and development efforts.

Faculty/department interaction with industry occurs through:

**1)** **Clinical/Industry/Academic Advisory Committee:**

This board comprises core executive members who advise on the research and education programs at FIU. It includes clinical, industry, and academic members who provide regular guest lecture. The list of member companies represented can be found at <https://bme.fiu.edu/biomedical-engineering-advisory-committee/>. The current core industry members are: Jeremy Ollerenshaw (Beta Blue Inc), Slobodan Stevanov (SHL Pharma), Kamau Pierre Scientist (Sanofi-Aventist), Shabnam Namin (Vivex Biologics), Bhavani Jayachandran (Beckman Coulter), and Robert Sixto (formerly with Zimmer Biomet).

**2)Partnership for Senior Design Projects:**

The Senior Design Capstone Projects are, typically, nearly 100% sponsored by companies or clinical professionals each year. This allows considerable opportunities for the department and faculty to interact with industry and clinical professionals.

Some members include: Duvian Rojas (Bioengineering Research), Girish Wable (Jabil), Himanshu Bhatt (Apyx Medical), and Joe Condon (Auxadyne).

**3)Research collaboration and partnership through project sponsorship and in-kind support:**

Some members of the department’s IAB donate to the FIU Foundation to support research of their interest. Many companies work with in-kind collaboration through design and qualification services. Some members sponsor one-on-one research contracts. FIU BME conducts online symposia or on-site meetings every six months to present our industry-relevant projects. Student mentoring and student-industry interactions to hone student communication and leadership skills, and to provide opportunities for to perform translational research, are a key part of IAB-driven research projects. These meetings coincide with our Industry Career Day. The meetings consist of three parts: faculty presentations on selective research themes, industry-faculty discussion, and career networking with students. The partnership has 3 tiers:

* Tier 1 – Confidential Research Contracts and Research Center memberships (IUCRC-Industry-University Cooperative Research Centers Program, Cell-met – Cellular Metamaterials, Paths-up- The Precise Advanced Technologies and Health Systems for Underserved Populations). Cell-met and Paths-up are NSF ERCs (Engineering Research Centers).
* Tier 2 – Gift Checks to Foundation
* Tier 3 – Research project mentoring and in-kind support

1. ***Professional Development***

Many of our faculty members have attended research and training workshops, and all regularly attend conferences in their field of research every year. Faculty receive 5% of the indirect costs from grants on which they are the Principal Investigator from the Office of Research and Economic Development, which can be used for travel and other professional development activities. The college provides $1000 per year for faculty as part of the annual departmental budget for travel and $500 to each newly recruited faculty member for discretionary use for meeting with mentors. Through the Wallace H. Coulter Foundation endowment, the Department has provided support for publication costs and for faculty travel, and $300-$500 to offset costs for each PhD student to travel to professional meetings.

Representative professional development activities for each faculty are provided below:

* *Michael Brown*. Dr. Brown regularly attends seminars on the FIU campus at the Herbert Wertheim College of Medicine (HWCOM) from leading clinical researchers across the country and served on the FIU HWCOM Admissions Committee for eleven years in order to remain current on what students need to do to gain successful entry to medical school. He is a member of BioFlorida and regularly signs up for and views webinars hosted by the organization. He has attended many International Symposium on Endovascular Therapy (ISET) meetings held annually in Miami. He views video simulcasts of live surgeries together with his students to keep up to date with the latest innovations using new medical devices. He visits local companies and medical facilities such as Heartware (Medtronic), MAKO Surgical (Stryker), Innovia, Beckman Coulter, Baptist Hospital, South Miami Hospital, Mount Sinai Hospital, BioHeart, BioTissue and DePuy (now Zimmer-Biomet) and talks with company executives and engineers to see what they are looking for in students they hire. He also attends the Coulter Series Lectures in the BME department; regularly reads the *New England Journal of Medicine*, *Medscape Cardiology,* and *Nature Medicine;* and participates in continuing medical education programs presented in association with these entities on the web. He also subscribes to *Genetic Engineering* and *Biotechnology News*. He has assisted on two publications on teaching undergraduate BME courses.
* *Michael Christie.* Dr. Christie is a member of the Prehealth Professions Advising committee at FIU. His responsibilities include general advising for prospective medical students and interviewing all FIU students who are applying to medical, dental, pharmacy, or related professional schools. He serves as a journal article editor for *Annals of Biomedical Engineering Journal*, as well as chapter and book editor for Springer Verlag and CRC publishers. Dr. Christie has attended Senior Design Faculty Training at NASA’s Kennedy Space Center and has incorporated many of NASA project strategies in his capacity as faculty mentor of senior design teams. He also serves as a board member for the Ronald E. Mcnair Undergraduate Research program at FIU. Dr. Christie is the College of Engineering and Computing representative to the Undergraduate Council of the university, where he is engaged in curriculum development and approval activities. He is the co-faculty advisor for FIU’s chapter of the national Society for Black Engineers, and since Fall 2019, has served as the faculty mentor for the AEMB chapter at FIU. In the past three years, Dr. Christie has been continuously engaged with student-centered professional development. In 2018, he earned hybrid teaching (05% online and 50% in-person) certification and in 2020 he earned the remote teaching badge He was a member of NSF I-Corp local and regional cohorts 2018. In 2020, he attended the Southern Biomedical Engineering Society conference. In 2020, he attended the Southern Biomedical Engineering Society conference, and attended the Annual Biomedical Research Conference for Minority Students in 2016.
* *Zachary Danziger*. The focus of Dr. Danziger’s research is the development of neural engineering solutions to treat disorders of the nervous system centered on neural control of movement in two areas: the lower urinary tract and brain-computer interfaces. He was recognized by FIU through their award of Top Scholar in 2021, and through the award of Outstanding Postdoctoral Mentor in 2019. Dr. Danziger holds a provisional patent, chairs the BMES committee on ethics, and co-chaired an international conference on biomedical ethics in 2018 (ICEBEM 9). He has provided guest lectures at FIU on the topic of research ethics and serves as an ad hoc reviewer for multiple peer-reviewed journals and on National Science Foundation grant review panels. He has also been involved in improving ethics education and responsible conduct of research in Biomedical Engineering being a part of a national BME ethics community of practice initiative that is funded by National Science Foundation.
* *Anuradha Godavarty* Dr. Godavarty’s research interests are in developing low-cost, compact near infrared optical imaging devices and applying them for various clinical applications including diabetes wound monitoring, cancer therapeutics, and cardiovascular perfusion studies. She served as a guest editor on a special issue “Smartphone, Wearable, or Hand-Held Diagnostic Bioimaging Sensors/Devices” for *Biosensors* journal in 2020, has served as a reviewer for more than 35 peer-reviewed journals, and has served as a grants reviewer for several grant agencies. Dr. Godavarty attends several conferences, including the annual SPIE Photonics West Conference and biennial OSA (or Optica) Biomedical Congress Meetings. She serves as a program committee member for the Clinical and Translational Biophotonics division of the Optica Biomedical Photonics Congress (in 2020 and 2022), and 29th Southern Biomedical Engineering Conference (2013). She has also served as session chair (or co-chair) at several conferences, including Global Wound Care Congress (2016), 13th Annual Conference of Society for Brain Mapping and Therapeutics (2016), and OSA Biomed Photonics Congress (2020). Dr. Godavarty has participated in Denice Denton Emerging Leaders Workshop (2016), Bystander Leadership program (2019), ABET symposium (2021), FIU remote teaching workshop (2020), FIU Hiring/Faculty recruitment workshop (2021), and several cybersecurity workshops (2021). Concerning commercialization efforts, Godavarty participated in a 14-week Accelerator program offered by StartUp FIU in Spring 2017. In Fall 2020, she participated in an NSF-sponsored regional ICorps program and a Female Founders Program. In Spring 2021, she was funded by NSF for her National ICorps program, involving a 7-week course on commercialization efforts.
* *Shuliang Jiao*. Dr. Jiao’s research interests are mainly focused on the development of innovative technologies for imaging and treatment of blinding eye diseases using technologies such as optical coherence tomography, photoacoustic microscopy, and multimodal imaging. Dr. Jiao attended the Hybrid Teaching training in 2020, 7th International OCT Angiography and “En Face” OCT Congress in 2019 (Rome, CME-accredited), International Conference on Optical Instruments and Technology in 2019 (Beijing). Since 2015, he has participated in SPIE Photonics West/BIOS and the ARVO annual meeting.
* *Wei-Chiang Lin*. Dr. Lin’s research interests are in biophotonics, medical imaging, and instrumentation, with recent explorations into wearable/implantable sensors and motion tracking.Dr. Lin attended the FIU hybrid course workshop and received the hybrid course instructor certificate in 2020. He also completed the FIU Assessment Certificate Course in 2019 to obtain knowledge and skills related to assessing student learning and measuring program effectiveness. He participated in the FIU Evaluating Teaching Project in 2019 to develop assessment tools for faculty teaching evaluations. Finally, he attended the Institute for Project-based Learning at WPI in 2016 to learn project-based learning and implemented this concept in various courses (e.g., BME 1008C), as well as the Orthotics and Prosthetics track of the Master of Science in Biomedical Engineering program.
* *Anthony J. McGoron*. Dr. McGoron’s research interests are in drug delivery and drug transport modeling towards cancer theranostics applications. Dr McGoron attended the FIU Assessment Conference in 2019, the Institute for Academic Leadership Department Chairs Workshop in 2017, the Southeast Regional Learning Assistant Workshop in 2017, the FIU Faculty Innovation for Student Success Showcase in 2017 and 2019, the FIU Online Academic Leadership Summit in 2022, and training for teaching in the new modality Online Live in 2022. He has attended several national and international scientific conferences. He provided invited lectures in China, Brazil, and within the United States. He is a member of the conference-organizing committees of the annual Southern Biomedical Engineering Conference, GMEPE/PAHCE, Society of Personalized Nanomedicine and the Miami Thyroid Oncology Conference meetings. He is Editor-In-Chief of *Critical Reviews in Biomedical Engineering* and serves on the editorial board of several international scientific journals. He regularly reviews proposals for the NIH and DOD CDMRP programs. He served as treasurer of the FIU Sigma Xi chapter for one term and vice president for two terms. He also serves as a Vice President of the Miami Cancer Research Center, a scientific and charitable organization that performs and supports cancer research, organizes educational events, and provides support for cancer care and the institutional and individual level. He serves as an ABET program evaluator.
* *Sharan Ramaswamy.* Dr. Ramaswamy’s research expertise is in the areas of cardiovascular regenerative medicine, mechanobiology, and mechanics. He is a fellow of the American Heart Association (AHA) and the American Society of Mechanical Engineering (ASME). In addition, he served as a Fulbright Specialist to the Karolinska Institute, Sweden, in Summer 2019. He is an advisor to several graduate and undergraduate students and has participated in significant outreach efforts to high school students in the Miami-Dade County Public School System in Miami, Florida. Dr. Ramaswamy currently serves as a faculty fellow for the Office to Advance Women, Equity and Diversity (AWED) at FIU and is the current equity advisor for the College of Engineering and Computing. Dr. Ramaswamy has served/serving as a guest editor for *Frontiers in Cardiovascular Medicine* and *BIOENGINEERING*. During his time at FIU, he has served as journal reviewer for more than 100 manuscripts. Dr. Ramaswamy has extensive entrepreneurship experience, having served as a principal investigator of National Science Foundation (NSF), regional and national I-Corps grants and is the PI of a current NSF: partners for innovation-technology transfer grant (NSF:PFI-TT). He also served previously (May 2019 – March 2021) as a SBIR/STTR grant reviewer for the National Institutes of Health (NIH), Cardiovascular and Surgical Devices study section. Finally, besides his core teaching responsibilities at FIU, Dr. Ramaswamy has been actively engaged in entrepreneurship and scientific writing educational efforts.

* *Jessica Ramella-Roman*. Dr. Ramella-Roman’s research interests are in biophotonics with a focus on the investigation of non-invasive methodologies for the diagnosis of disease based on light-tissue interaction. She is developing new imaging methodologies combining polarization sensitive techniques and non-linear microscopy for various clinical applications (e.g., pre-term labor, cervical cancer). Dr. Ramella-Roman has attended several faculty-mentoring sessions since joining FIU in Fall 2013. These included courses on implicit bias, culture of inclusion, undergraduate student development and mentoring, graduate student development and mentoring, discrimination in the workplace workshop, training on the development of online courses (which she applied to the development of her current course EEE 4202C) and workshops for Quality Matters (QM) certification of hybrid courses, a Research Experience for Undergraduate Training Research Experience for Teachers training, and several more. She was on a year-long sabbatical at Ecole Polytechnique in Paris, conducting research on the new field of Polarized Second Harmonic Generation from Spring 2021 to Fall 2022. Since 2014, Dr. Ramella-Roman has attended at least three international conferences per year, including SPIE Photonics West, OSA Biomed and ARVO (either in-person or remotely due to COVID-19). She is currently the program track chair for SPIE Photonics West Tissue Optics, Laser-Tissue Interaction, and Tissue Engineering and program chair for the OPTICA Biophotonics conference.
* *Jorge Riera*. Dr. Riera currently serves as interim chair of the BME department. Dr. Riera’s research is focused on developing methods to integrate different modalities of brain imaging for the understanding of multicellular signaling in the healthy and dysfunctional neocortex.In the last two years, Dr. Riera’s professional development activities have been to: (a) continue expanding his network of U.S. collaborators by applying to multi-institutional grants and participation in conferences to promote his research activity, (b) assimilate strategic plans from BME graduate programs in other U.S. universities, and (c) develop skills to promote a safe and diverse working environment in the department, college, and university. To that end, he has successfully developed collaborative research projects with Yale University, University of Minnesota, and Vanderbilt University. He has submitted two Letters of Intent for large collaborative projects with Canadian institutions (i.e., York University and McGill University). He continues to attend online workshops on how to propose comprehensive research proposals based on multidisciplinary, collegial, and collaborative interactions with other researchers in the field. To expand networking activities, he has also given invited talks in several national (e.g., University of Miami, Georgia Tech, Yale University) and international (e.g., York University, Universidad Técnica Federico Santa María, Sungkyunkwan University) institutions. He has attended multiple conferences (SfN, 2019/2020; American Epilepsy Society, 2019; HBM, 2019; Global Brain Consortium, 2019; IMBioC, 2020, APS, 2020). Serving for 4 years as a permanent member in a NIH study section (BMIT-B/EITA) was also very helpful to develop collaborations and connections with US colleagues in the area of Brain Imaging. As part of career development, he has had two sabbatical terms: MIT (Summer 2018) and Yale University (Fall 2020). Also, his students have presented studies at different meetings (BME graduate and undergraduate research days; FURC; NCUR, GSAW). He attended several seminars and workshops aiming to enhance FIU diversity environment (e.g., Faculty Bystander Leadership 2020). He also participated as panelist in a workshop about Diversity in BME organized by the BME Council of Chair (CoC) in 2019. He attended the Denice Denton Leadership conference in 2016. He has increased his presence in U.S. scientific societies (e.g., Society for Neuroscience, American Physiology Society, IEEE, Human Brain Mapping Society, USA National Academy of Inventors). He was the BME Graduate Program Director from 2018 – 2021. He has attended several workshops and orientation days by the FIU University Graduate School (UGS) aimed at increasing effectiveness of the graduate program directors.
* *Nikolaos Tsoukias*. Dr. Tsoukias’ research interests include computational medicine and biology, systems physiology, cardiovascular engineering, and biotransport. Since joining FIU, Dr. Tsoukias has attended training workshops, including grant writing workshops (“Grant Writers' Seminars & Workshops LLC”) and workshops on microcirculatory experimentation (“Living Systems, VT”). He received training and served as a mentor for the undergraduate BMES Chapter of FIU. He received training on the development of online courses and the use of relevant software (Blackboard, Canvas) and developed online and remote courses. During a year of sabbatical leave (2016-2017), he visited the laboratories of Dr. Segal at the University of Missouri; Dr. Bezerianos at the University of Patras, Greece; and Dr. Nelson at the University of Vermont to conduct research, receive training, and promote collaborative activities in the areas of microcirculatory experimentation and cell electrophysiology. He utilized intramural funding to promote cardiovascular research at the department of biomedical engineering and to enhance research infrastructure for cardiovascular and cell/tissue engineering research and teaching/training activities. Between 2015 and 2018 he worked as a part-time faculty at an international institution (National Technical University of Athens) to develop a biomedical engineering concentration within the school of chemical engineering and undergraduate and graduate courses. He participated as a mentor in the “Frontiers in Physiology Professional Development Fellowship” program organized by the American Physiological Society. He co-organized and participated as a member of the scientific committee in several international conferences. He currently serves as an outside mentor for two postdoctoral fellows (Dr. A Gonzalez and Dr. O Harraz) as part of an NIH-supported training grant at University of Vermont, participates in the editorial board of three journals, and serves as a member in the Nominating Committee of the Microcirculatory Society. He attends, on average, three international conferences per year, including annual participation to the Experimental Biology and the Biomedical Engineering Society’s meeting.
* *James Schummers* Dr. Schummers’ research involves using multimodal, multiscale imaging of cellular activity in the brain in vivo. He has given numerous invited seminars both in the U.S., as well as internationally in Japan, Germany, Spain, and Mexico. He has taught courses in two-photon microscopy at the IBRO Latin American Training Programme (LATP) in Queretero, Mexico. He is a member of the Society for Neuroscience and has attended the annual Society for Neuroscience conference nearly every year since 1997. He has served on several study sections for the NIH Brain Initiative. His students have presented their research both locally at FIU undergraduate and graduate research forums, and at national conferences, including SfN and BMES. At FIU, he has attended courses in active learning, Remote Instruction and the Hybrid Instruction Courses, and became a certified hybrid instructor. He has participated in the STRIDE workshop and Diversity Advocate Training at through FIU AWED.
* *Joshua Hutcheson*. Dr. Hutcheson’s research focuses on the mechanical and molecular contributors to vascular calcification and aortic valve disease, and he is working on developing non-invasive techniques to diagnose and treat these pathologies. Dr. Hutcheson’s work has been published in more than 40 peer-reviewed publications and seven book chapters. He has also co-edited a book on ‘Cardiovascular Calcification and Bone Mineralization’ and serves as an associate editor for *Frontiers in Cardiovascular Medicine* and editorial board member for the *Journal of Cardiovascular Development and Disease*. Dr. Hutcheson regularly attends and chairs sessions at meetings of the American Heart Association, the American College of Cardiology, the Biomedical Engineering Society, the World Congress of Biomechanics, the International Society for Applied Cardiovascular Biology (ISACB), the Heart Valve Society, and the North American Vascular Biology Organization. He also serves on the executive committee of ISACB and organized the International Conference of Tissue Engineered Heart Valves at the Heart Valve Society 2022 meeting. Dr. Hutcheson has completed DEI training programs offered by the National Science Foundation-Engineering Research Center on Precise Advanced Technologies and Health Systems for Underserved Populations (PATHS-UP) and Bystander Leadership training from FIU (2019). In recognition of his efforts in cardiovascular medicine, Dr. Hutcheson was named the “Stop Heart Disease Researcher of the Year” by the Florida Heart Research Foundation in 2018. His work has been funded through grants from the American Heart Association, the Florida Heart Research Foundation, PATHS-UP, the National Science Foundation I-Corps Program, and the National Institutes of Health.
* *Hamid Shahrestani.* Mr. Shahrestani has been an adjunct faculty member in the Department of Biomedical Engineering at FIU since January 2001. As a member of the BME Advisory Committee, he was a major contributor to establishing the curriculum for the Department of Biomedical Engineering in 2002. He was nominated for the FIU ‘Adjunct Faculty Excellence in Teaching’ award in 2016. He taught the “Data Evaluation Techniques” course from 2001-2003. He has taught “Design of Biomedical Systems and Devices” as well as “Project Organization” courses since 2003. Hamid has delivered numerous lectures related to ‘Systematic Problem-Solving Techniques’ (2013), ‘Design of Experiments’ (2014), ‘Principles of Design Excellence’ (2016), ‘Test and Safety Standards’ (2017), ‘International Standards and Regulations’ (2018), ‘Strategies, Techniques and Approach to Mechanical and Electrical Design and Development’ (2020). He is also the president and CEO of Qualtech Engineering Consulting (QEC) firm providing consulting services to major BME device developers and manufacturers globally, such as Johnson and Johnson, Boston Scientific, and Medtronics, St. Jude Medical.
* *Brian Hillen.* Dr. Hillen’s research focus is in neural and biomechanical responses to conditions such as spinal cord injury and amputation. He has been a research assistant professor in the Adaptive Neural System Laboratory at FIU since 2012. In Spring 2022, Dr. Hillen joined BME as an adjunct faculty member. He has assisted with preparation of multiple funded grants to NIH and DOD in the past four years and has mentored four graduate students in collaboration with his research team (and Dr. Ranu Jung), working together on abstracts and publications and ensuring student complete successful dissertation defenses. Dr. Hillen attended the Society for Neuroscience conference in 2012 and 2015, as well as the Annual Computational Neuroscience Meeting in 2014 and 2015. He also attended the Amputee Coalition National Conference in 2020 and 2021. Dr. Hillen helped create and teach a graduate BME physiology course in 2014 and has designed and put in proposals for three additional courses in the past two years, which have all been approved.

***Professional Development Leave and Sabbaticals:*** Sabbaticals are granted to increase tenured faculty members' value to the university through enhanced opportunities for planned travel, research, writing, professional renewal, study, formal education or other experiences of professional value. Sabbaticals are not granted as a reward for service. Full-time tenured employees with at least six years of fulltime, continuous service with FIU are eligible for competitive full-pay sabbatical leave, non-competitive sabbaticals, and two-thirds pay sabbatical leave. A tenured employee who is compensated through a contract or grant may receive a sabbatical leave only if the contract or grant allows a sabbatical and the employee meets all other eligibility requirements. Professional development leave provides employees who are not eligible for sabbatical leaves (i.e., NTT faculty) with leave opportunities to increase the employee’s value to the university through enhanced opportunities for professional renewal, educational travel, formal education, research, writing or other experience of professional value, not as a reward for service. Employees with at least six years of full-time continuous service at FIU, except those who are serving in tenure-earning or tenured positions, are eligible for professional development leaves. An employee who is compensated through a contract or grant may receive a professional development leave only if the contract or grant allows for such leaves and the employee meets all other eligibility requirements.

1. ***Authority and Responsibility of Faculty***

Describe the role played by faculty members with respect to course creation, modification, and evaluation, their role in the definition and revision of program educational objectives and student outcomes, and their role in the attainment of the student outcomes. Describe the roles of others on campus, e.g., dean or provost, with respect to these areas.

**E.1 Leadership Responsibilities**

The Department Chair has the ultimate leadership responsibility for all academic programs. The Undergraduate Program Director works closely with the Department Chair and the Undergraduate Program Committee, which comprises the Undergraduate Program Director, the undergraduate advisors, and multiple members of the faculty. The Undergraduate Program Committee meets once a month during the academic year (Fall and Spring semesters) to discuss all undergraduate-related activities. Curriculum changes proposed by the Undergraduate Program Committee are discussed among the entire faculty during regular faculty meetings or at semi-annual faculty retreats. If approved, curriculum changes are then sent to the College of Engineering and Computing Curriculum Committee, and ultimately to the Dean and the University Curriculum Committee for approval before implementation. The Department Chair has management responsibilities for this entire process, relying on the Undergraduate Program Director for assistance.

Annual teaching assignments are determined by the Department Chair in consultation with the undergraduate and graduate advisors and the faculty. The number of courses assigned to each faculty may be reduced based on significant academic year effort on extramural grants, institutional and professional service, and the needs of the department.

**E.2 Responsibility of Faculty Regarding Courses, Student Learning Outcomes, and Program Educational Objectives**

The entire faculty is involved in course creation, modification, and evaluation. Required undergraduate courses are evaluated at a yearly retreat in which the program outcomes data are analyzed. Course outcomes surveys are completed by the students for each required undergraduate course at the end of each semester. These surveys are analyzed at the retreat, and course modifications are made at that time with the input from the entire faculty. Learning outcomes for any course may only be modified after evaluation by the entire faculty, or after consultation with the Department Chair, the Undergraduate Program Director, and all instructors that regularly teach that course. The selection of required textbooks is also made in consultation with all faculty teaching the course.

Individual faculty may propose a new course, which is discussed at a faculty meeting. New courses or modifications to existing courses are submitted to the College of Engineering and Computing Curriculum Committee, after being approved by the BME faculty and the Chair. New courses, or modifications to courses, that are approved by the college’s Curriculum Committee are reviewed by the college Dean and reviewed by the University Curriculum Committee before implementation. The same process is required for changes to the academic program. To ensure consistency and quality in the courses taught, individual faculty that are assigned a particular course share their lecture notes and discuss their student assignments and exams. In addition, students evaluate course outcomes, as well as the course instructors at the end of each semester. Teaching evaluations are reviewed by the instructor and the department chair as part of the yearly faculty evaluation. Course outcomes are evaluated yearly at the faculty retreat.

Student Learning Outcomes (SLOs) are evaluated based on the primary and secondary outcome measures acquired in the academic year and discussed during the annual departmental retreat (end of Spring semesters). All faculty participate in these discussions to assess if the student outcomes are attained. If they are not attained, all the primary and secondary outcome measures are evaluated (including course outcomes) and these are used to develop action items and make appropriate improvements to the curriculum to address the needs to meet the student outcomes. The same process is carried out for the Program Educational Objectives (PEOs) that are discussed at the annual retreat and discussions carried out towards improving the overall program objectives (if and as needed). In addition, faculty participate in the regular faculty meetings and the undergraduate committee meetings towards continuous improvement efforts to student outcomes across the year.

***Table 6-1. Faculty Qualifications***

**Biomedical Engineering**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Faculty Name | Highest Degree Earned- Field and Year | Rank 1 | Type of Academic Appointment2  T, TT, NTT | FT or PT3 | Years of Experience | | | Professional Registration/ Certification | Level of Activity4  H, M, or L | | |
| Govt./Ind. Practice | Teaching | This Institution | Professional Organizations | Professional Development | Consulting/summer work in industry |
| Anthony McGoron | Biomedical Eng PhD, 1991 | P | T | FT | 0 | 22 | 22 | None | H | H | L |
| Anuradha Godavarty | Chemical Eng, PhD, 2003 | ASC | T | FT | 0 | 17 | 17 | None | L | M | L |
| Brian K. Hillen | Bioengineering, PhD, 2012 | A | NTT | PT | 0 | 7 | 10 | None | L | L | L |
| Hamid Shahrestani | MS-Systems Engineering, MS, 2000 & MS-Engineering Management, 2000 | A | NTT | PT | 39 | 19 | 19 | Yes5 | L | M | H |
| James Schummers | Systems Neuroscience PhD, 2003 | ASC | TT | FT |  | 3 | 3 | None | L | L | L |
| Jessica C. Ramella-Roman | Electrical Eng, PhD 2004 | ASC | T | FT | 4 | 18 | 9 | 1 | H | M | M |
| Jorge Javier Riera Diaz | Physics, PhD, 2000 | ASC | T | FT | 0 | 18 | 9 | None | H | M | L |
| Joshua Hutcheson | Biomedical Eng, PhD, 2012 | AST | TT | FT | 0 | 6 | 6 | None | H | M | L |
| Leonel Lagos | Civil/Env. Engineering, PhD, 2007 | ASC | TT | FT | 25 | 6 | 6 | PMP6 | H | M | H |
| Markondeya Raj Pulugurtha | Materials Science and Eng, PhD, 1999 | ASC | TT | FT | 17 | 3 | 3 | None | H | H | H |
| Michael E. Brown | MD, 1989  Biochemistry, PhD, 1987 | TP | NTT | FT | 14 | 10 | 10 | None | L | L | L |
| Michael C. Christie | Materials Science and Eng, PhD, 1991 | ACTP | NTT | FT | 0 | 12 | 10 | None | H | M | L |
| Nikolaos M. Tsoukias | Engineering, PhD, 2003 | P | T | FT | 0 | 18 | 18 | None | H | H | L |
| Ranu Jung7 | Biomedical Eng, PhD, 1991 | P | T | FT | 0 | 19 | 3.5 | None | H | H | H |
| Sharan Ramaswamy | Biomedical Eng, PhD, 2003 | ASC | TT | FT | 3.67 | 13 | 12 | None | L | M | L |
| Shuliang Jiao | Electronic Physics, PhD, 1992; Biomed. Eng., PhD, 2003 | P | T | FT | 0 | 9 | 1 | None | H | H | M |
| Wei-Chiang Lin | Biomedical Eng, PhD, 1997 | ASC | T | FT | 2 | 17 | 17 | None | L | M | L |
| Zachary Danziger | Biomedical Eng, PhD, 2011 | ACT | T | FT | 0 | 6 | 6 | None | H | M | M |

Updated information is to be provided at the time of the visit.

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor TP = Teaching Professor ACTP = Associate Teaching Professor A = Adjunct O = Other

2. Code: TT = Tenure Track T = Tenured NTT = Non Tenure Track

3. FT = Full Time Faculty or PT = Part Time Faculty at the institution

4. The level of activity, high, medium or low, reflects an average over the year prior to the visit plus the two previous years.

5. Kepner-Tregoe 6-Sigma Black Belt

6. PMP- Project Management Professional

7. Left FIU in Dec 2021

***Table 6-2. Faculty Workload Summary (to update)***

**Biomedical Engineering**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Faculty Member (name) | PT or FT1 | Classes Taught (Course No./Credit Hrs.) Term and Year2 | | Program Activity Distribution3 | | | % of Time Devoted  to the Program5 |
| Teaching | Research or Scholarship | Other4 |
| Anthony McGoron6 | FT | BME 4311/3 Credits  BME 6645/3 Credits  BME 4531/3 Credits7  BME 5505C/3 Credits7 | Fall 2021  Fall 2021  Spring 2022  Spring 2022 | 30 | 20 | 50 | 50 |
| Anuradha Godavarty | FT | BME 4562/3 Credits  BME 5560/3 Credits  BME 6905/3 Credits | Fall 2021  Fall 2021  Spring 2022 | 40  10 | 14  30 | 46  60 | 100  100 |
| James Schummers | FT | BME 3721/3 Credits | Fall 2021 | 31 | 39 | 30 | 100 |
| Jessica C. Ramella-Roman8 | FT | Sabbatical | Fall 2021  Spring 2022 | 0 | 100 | 0 | 100 |
| Jorge Javier Riera Diaz | FT | BME 4422/3 Credits  BME 6330 (linked with BME 4332)/3 Credits  BME 6421/3 Credit | Fall 2021  Spring 2022  Spring 2022  Spring 2022 | 39  41 | 23  21 | 38  38 | 100  100 |
| Joshua Hutcheson | FT | BME 5410/1 Credit  BME 3632/3 Credits  BME 4908/3 Credits  BME 4230/3 Credits  BME 4908/3 Credis | Fall 2021  Fall 2021  Fall 2021  Spring 2022  Spring 2022 | 37  29 | 54  54 | 9  17 | 100  100 |
| Markondeya Raj Pulugurtha | FT | BME 5803/3 Credits  BME 3721/3 Credits | Fall 2021  Spring 2022 | 25 | 45 | 30 | 70 |
| Michael E. Brown (Teaching Professor) | FT | BME 3403/3 Credits  BME 3404/3 Credits  BME 4011/1 Credit  BME 6019/1 Credit  BME 5990/1 Credit  BME 3403/3 Credits  BME 3404/3 Credits  BME 4011/1 Credit  BME 6019/1 Credit  BME 5993/1 Credit | Fall 2021  Fall 2021  Fall 2021  Fall 2021  Fall 2021  Spring 2022  Spring 2022  Spring 2022  Spring 2022  Spring 2022 | 75 | 0 | 25 | 100 |
| Michael C. Christie  (Associate Teaching Professor) | FT | BME 4050L 3 Credits (3 sections)  BME 4100 /3Credits  BME 4908/3 Credit  BME 4930/0credit  BME 4940 /1-3 Credits  BME 4949/1 Credit  BME 4050L/1 Credit  BME 4100/3 Credits  BME 4260/3 Credits  BME 4908/3 Credits  BME 4930/0 Credit  BME 4940/1-3 Credits  BME 4949/1 Credit | Fall 2021  Fall 2021  Fall 2021  Fall 2021  Fall 2021  Fall 2021  Fall 2021  Spring 2022  Spring 2022 Spring 2022  Spring 2022  Spring 2022  Spring 2022  Spring 2022 | 80  89 | 0  0 | 20  11 | 100  100 |
| Nikolaos M. Tsoukias | FT | BME 1054L/1 Credit  BME 6705/3 Credit  BME 1054L/1 Credits  BME 2740/3 Credits | Fall 2021  Fall 2021  Spring 2022  Spring 2022 | 40 | 50 | 10 | 100 |
| Ranu Jung9 | FT | IDH 4905-U13/2 Credits  Left FIU | Fall 2021  Spring 2022 | 5 | 35 | 60 | 100 |
| Sharan Ramaswamy | FT | BME 4332 (link to 5336)/3 Credits  BME 3632/3 Credits | Fall 2021  Spring 2022 | 33  25 | 40  40 | 27  35 | 100  100 |
| Shuliang Jiao | FT | BME 4050L/1 Credit (2sections)  BME 6565/1 Credit  BME 4051L/1 Credit (3 sections) | Fall 2021  Fall 2021  Spring 2022 | 50  25 | 35  55 | 15  20 | 100  100 |
| Wei-Chiang Lin | FT | BME 1008/2 Credits (2 sections)  BME 1008/2 Credits  BME 6563/3 Credits | Fall 2021  Spring 2022  Spring 2022 | 50 | 30 | 20 | 100 |
| Zachary Danziger | FT | BME 2710/3 Credits  BME 6717/3 Credits | Fall 2021  Spring 2022 | 32 | 55 | 13 | 100 |

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For 2021-2022.
3. Program activity distribution in percent of effort in the program.
4. Others includes service or administrative activities.
5. Out of the total time employed at the institution.
6. Associate Dean for Academic Affairs
7. Course is team taught with each instructor responsible for 1/3 of the course.
8. Indicates sabbatical leave, administrative effort etc.
9. Left FIU in Dec 2021.

***Table 6-3. Course Instructors***

|  |  |  |
| --- | --- | --- |
| **Required BSBME Course** | **Primary Instructors** | **Secondary Instructors** |
| BME 1008C Intro to Biomedical Engineering | Wei-Chiang Lin | Jorge Riera Diaz |
| BME 2740 BME Model & Simulation | Nikolaos Tsoukias, Zachary Danziger | Anthony McGoron |
| BME 3632 BME Transport | Sharan Ramaswamy  Joshua Hutcheson | Anthony McGoron, Anuradha Godavarty,  Nikolaos Tsoukias |
| EEL 3110C Circuit Analysis and Lab | ECE1 Faculty (Gustavo Roig) | ECE Faculty |
| EGM 3503 Applied Mechanics | MME2 Faculty | Leo Lagos |
| BME 3403 Engineering Analysis of Biological Systems I | Michael Brown | Jorge Riera |
| BME 3404 Engineering Analysis of Biological Systems II | Michael Brown | Jorge Riera |
| BME 3721 Data Evaluation Principles | James Schummers, Markendoyaraj Pulugurtha | Wei-Chiang Lin, Anthony McGoron |
| BME 4011 Clinical Rotations | Michael Brown | Jessica Ramella-Roman |
| BME 4050L Lab I | Shuliang Jiao | Michael Christie |
| BME 4051L Lab II | Shuliang Jiao | Michael Christie |
| BME 4100 Biomaterials | Michael Christie | Sharan Ramaswamy |
| BME 4503C Medical Instrumentation Design | Jessica Ramella-Roman | Wei-Chiang Lin |
| BME 4800C Des Bio System Dev | Hamid Shahrestani (adjunct) | Michael Christie |
| BME 4908 Sr. Design Project | Michael Christie | All BME Faculty (serve as advisors) |

|  |  |  |
| --- | --- | --- |
| **Elective BSBME Course** | **Primary Instructors** | **Secondary Instructors** |
| BME 4211 Orthopedic Biomechanics | Michael Christie | Sharan Ramaswamy |
| BME 4260 Engineering Hemodynamics | Michael Christie | Sharan Ramaswamy |
| BME 4311 Molecular Engineering | Anthony McGoron | Adjunct |
| BME 4320 Biomechanics of Cardiovascular Systems | Joshua Hutcheson | - |
| BME 4332 Cell & Tissue Eng | Sharan Ramaswamy | - |
| BME 4422 Biophysics of Neural Computation | Jorge Riera | - |
| BME 4531 Medical Imaging (Online course) | Anthony McGoron, Jorge Riera, Wei-Chiang Lin | Anuradha Godavarty |
| BME 4562 Introduction to Biomedical Optics | Anuradha Godavarty, Wei-Chiang Lin | Shuliang Jiao, Jessica Ramella-Roman |
| BME 4211 Orthopedic Biomechanics | Brian Hillen | Michael Christie |
| BME 4230 Biomechanics in Cardiovascular Systems | Joshua Hutcheson |  |
| EEL 3135 Signals and Systems | ECE1 Faculty |  |
| EEE 4510 Introduction to Digital Signal Processing | ECE1 Faculty |  |
| EGM 3311 Analysis of Engineering Systems | MME2 Faculty |  |
| EGN 3365 Materials in Engineering | MME2 Faculty |  |
| EML 3036 Sim Software for Mechanical Engineers | MME2 Faculty |  |
| EML 4804 Introduction to Mechatronics | MME2 Faculty |  |

1MME – Department of Mechanical and Materials Engineering

2 ECE- Department of Electrical and Computer Engineering

# CRITERION 7. FACILITIES

## Offices, Classrooms and Laboratories

Summarize each of the program’s facilities in terms of their ability to support the attainment of the student outcomes and to provide an atmosphere conducive to learning.

The various program facilities that are used to support the attainment of the Student Learning Outcomes (SLOs) and provide an atmosphere conducive to learning include: office space for administrators, faculty, staff, and teaching assistants; classrooms; instructional laboratories and associated equipment dedicated for BSBME program; research laboratories and equipment available for BSBME research activities (via the CURE program as described in Criterion-2) and senior design projects (as needed); and other laboratory facilities outside the BME department (such as engineering manufacturing center and animal care facilities.

The Engineering Center (EC) provides state-of-the-art computer facilities, computer-equipped classrooms, and dedicated undergraduate teaching laboratories for the program to provide hands-on experiences to students. The Modesto Maidique Campus (MMC) also provides classroom space, as well as a university-wide computer support system. These educational facilities, in conjunction with research laboratories at both locations, allow delivery of an educational experience for the undergraduates that includes didactic classroom teaching, structured laboratory-based education, and opportunities for undergraduate research. A shuttle system (branded the CATS system) runs between the EC and MMC on a regular schedule.

Details of the space, resources, and support available to the Bachelor of Science in Biomedical Engineering (BSBME) program are provided below.

**A.1 Offices (Administrative, Faculty, Clerical, Teaching Assistants)**

Offices(such asadministrative,faculty, clerical, and teaching assistants) and any associated equipment that is typically available there.

**Table 7.1** summarizes the Biomedical Engineering (BME) departmental office space details. Each faculty member has an individual office: most are centrally located within the Biomedical Engineering Department suite (EC 2600), but some faculty members whose research laboratory spaces are at MMC additionally have office space on that campus. All doctoral students, some of whom are teaching assistants (TAs) for the undergraduate classes, are provided open cubicle space outside faculty offices within the departmental suite. Each faculty member is also provided an office computer and a networked printer. Each student cubicle is equipped with a computer and access to a shared printer. All faculty and students also have access to a remotely accessible shared drive portal maintained by the College of Engineering and Computing, which provides regularly backed-up storage space for both individual and shared department use.

**Table 7.1 The Biomedical Engineering department offices**

|  |  |  |
| --- | --- | --- |
| **Room Number** | **Area ft sq** | **Use** |
| EC 2600 | 220 | Reception |
| EC 2601 | 182 | BME small teleconferencing room  Program Support Office |
| EC 2602 | 224 | Chair’s Office |
| EC 2602A | 140 | Staff Coordinator Office |
| EC 2603 | 37 | Chair’s Storage Room |
| EC 2605 | 43 | Kitchen/Break Room |
| EC 2609 | 61 | BME Storage Room |
| EC 2611 | 196 | Program Lab Manager Office |
| EC 2612 | 190 | Faculty Office |
| EC 2613 | 270 | Faculty Office |
| EC 2614 | 265 | Faculty Office |
| EC 2672 | 252 | Faculty Office |
| EC 2673 | 252 | Faculty office |
| EC 2674 | 265 | Faculty Office |
| EC 2675 | 264 | Faculty Office |
| EC 2676 | 197 | Faculty Office |
| EC 2677 | 177 | Faculty Office |
| EC 2680 | 447 | Large Conference Room |
| EC 2685 | 180 | T.A. Tutoring/BMES Office |
| EC 2690 | 97 | Adjunct office |
| EC 2990 | 329 | Faculty Office |
| EC 1244 | 118 | Research Scientist Office & Records Room |
| EC 1245 | 129 | Research Scientist Office |
| EC 1246 | 118 | Research Scientist Office |
| EC 1248 | 116 | Research Professor office |
| EC 2442 | 266 | Faculty Office |
| AHC4-330 | 120 | Faculty Office |
| AHC4-332 | 120 | Faculty Office |
| AHC4-333 | 190 | Faculty Office |
| AHC4-334 | 132 | Faculty Office |

**A.2 Classrooms and associated equipment**

Classrooms and associated equipment that are typically available where the program courses are taught.

**A.2.1 Classrooms**

**Table 7.2** provides a brief summary of the general assignment classroom resources of the EC. Computer-equipped classrooms have an instructor-station PC driving a ceiling-mounted projector; the PC is networked, and internet-connected so that any instructor can access material on network accounts; instructors can also access general College of Engineering and Computing software for instructional purposes. The rooms indicated by an asterisk (\*) are computer labs with a computer workstation for each student. Computer workstations are fully integrated into the internet and local area network with university- and college-supported software (described in Section B and **Table 7.7**). All other classrooms contain a ceiling-mounted projector and are hardwired for internet access. Many faculty members have laptop computers to use in the classroom. In addition, the Engineering Information Center (EIC) can provide a laptop for instructors to use for teaching. The BME department maintains two laptops and two projectors for loan for department activities and uses the EIC equipment as backup or in case of peak demand.

Although EC classrooms are all “general assignment” resources, and technically shared with the rest of the university, the center is located approximately one mile from the main campus, and scheduling preference is given to engineering classes. Indeed, most engineering classes are held in the EC. If needed, classrooms can also be scheduled at the MMC through a university-wide classroom scheduling system. In addition, the EC has many student work rooms/conference rooms, some with open access and others reserved by faculty, staff, and students through an electronic scheduler accessed from administrative offices.

**Table 7.2 General Assignment Classroom Facilities in the EC**

|  |  |  |
| --- | --- | --- |
| **EC Room Number** | **Design Seating** | **Computer-Equipped** |
| EC 3239 | 50 | Yes\* |
| EC 3278 | 30 | Yes\* |
| EC 2330 | 42 | Yes\* |
| EC 2410 | 40 | Yes |
| EC 2420 | 39 | Yes |
| EC 2440\*\* | 40 | Yes |
| EC 2710 | 39 | Yes\* |
| EC 2807 | 13 | Yes\* |
| EC 2830 | 13 | Yes\* |
| EC 2832 | 29 | Yes\* |
| EC 2840 | 30 | Yes\* |
| EC 2940 | 35 | Yes\* |
| EC 2975 | 24 | Yes |
| EC 1104 | 56 | Yes |
| EC 1105 | 56 | Yes |
| EC 1107 | 56 | Yes |
| EC 1109 | 43 | Yes |
| EC 1110 | 43 | Yes |
| EC 1112 | 83 | Yes |
| EC 1113 | 43 | Yes |
| EC 1114 | 43 | Yes |
| EC 1115 | 116 | Yes |
| EC 1116 | 43 | Yes |

\* Computer labs with workstations for students and for the instructor

\*\*EC 2440 is equipped with a dedicated video conferencing system. The remaining classrooms do have “Limited-Service Video Conferencing” capabilities via the classroom computer. With “Limited-Service Video Conferencing” the instructor connects to Zoom via the All-In-One classroom computer and uses the onboard webcam and microphone. The instructors will therefore need to remain close to the classroom computer to ensure that remote students can hear them clearly.

**A.2.2 Common Study Areas**

EC 2685 BMES Office: The Biomedical Engineering Society (BMES) student chapter is located in room EC2685. This 180-square-foot office is provided with office furniture to accommodate BMES officers/students. The room is available for student study and for graduate TAs to hold office hours if needed.

EC1100W1: West lobby Common Study area is a 1,021-square-foot area with high-top tables and chairs for group and collaborative work. There are also regular tables where student can gather and work on projects. This area also has loungers with armrests for students to use for individual study.

EC 2851: The 4,257-square-foot Panther Pit is available to students 24/7 for individual or group study. The cafeteria in the Panther Pit is open to provide hot meals and sandwiches weekdays during regular working hours (9am-5pm). Tables and chairs to accommodate up to 112 students are provided. Recreational equipment includes a billiard table and electronic dartboard. Plasma screens have been placed around the cafeteria to provide students with information about scholarships, job opportunities, student society activities, etc.

EC 2600W1: This common study area is available to all students in the college. It is located by the south door of the BME department suite and is convenient for dining, group study, and social gatherings. It has cafeteria tables and chairs sufficient to accommodate up to six students at a time.

EC2900W5: This common study area along the south end of the second-floor EC building contains loungers and tables for individual and group study. Large windows provide a peaceful view to the grassy area outside, which is conducive to focused concentration.

EC 3200 and EC 3300: These common study areas are furnished with chairs, lounge chairs, and small tables sufficient to accommodate 30 students.

EC3300W1: This quiet study area with private booths for uninterrupted individual study is located at the north end of the third-floor of EC building. The area overlooks the Operations/Utilities building and the Titan America lab.

EC3800W6 and 3700W4: These common study areas along the south end of the third-floor EC building has views overlooking the grassy area outside. The area has high-top tables and chairs for individual seating.

**A.2.3 Equipment (Instructional Laboratories)**

The layout of the BME teaching facilities (rooms EC 2350, EC 2355, and EC 2360) is given in **Figure 7.1**.

EC 2350: The BME Undergraduate Creativity Lab has four student workstations and one instructor desk, all equipped with computers. The Creative Lab provides space and tools including 3D printers, a projection system, computers and software (e.g., MatLab and Solid Works) for use in preparing senior design projects, and creative engineering solutions for complex problems in biomedicine.

EC 2360: The BME Undergraduate Teaching Laboratory has ten student workstations and one instructor’s desk, all equipped with computers. The computer on the instructor’s desk is connected to an 80-inch Toshiba TV with 3D features for presenting lectures. A conference table with tablets and available seating for 15 also supports lectures. This lab houses equipment, devices, and software to support teaching of BME undergraduate lab courses BME 4050L and 4051L. Major equipment and devices include BIOPAC MP-36 systems, PASCO strain-stress apparatus, Beckman Coulter cell and particle counter, Brookfield viscometer, spectrophotometer, portable glass fiber spectrometer, and National Instrument data acquisition systems. Major software includes MatLab and LabView. **Table 7.3** summarizes the major equipment for these two lab courses (BME 4050L and BME 4051L).

EC 2355: This is the additional teaching area to main teaching lab EC 2360. This lab houses a refrigerator, optical table, oven, UV-Vis spectrophotometer, and five student workstations. One workstation is equipped with a computer.

**Figure 7.1 demonstrates the layout of BME teaching facilities: EC 2350, 2355, and 2360.**

Diagram

Description automatically generated

**Table 7.3 List of Major Instructional Equipment for BME 4050L and 4051L**

|  |  |  |
| --- | --- | --- |
| **Name of Equipment** | **Protocol** | **Qty** |
| BIOPAC MP 36 system | BIOPAC physiological protocols, BME 4050L | 10 |
| BIOPAC practical lab kit for remote learning | BIOPAC physiological protocols, BME 4050L | 30 |
| NI cDAQ-9172/cDAQ-9178 compact DAQ chassis | Bone mechanics, BME 4050L | 7 |
| NI 9237 strain/bridge input module | Bone mechanics, BME 4050L | 7 |
| LONOVE soldering iron station kit | Bone mechanics, BME 4050L | 2 |
| Brookfield DVII+ cone and cup viscometer | Rheology, BME 4050L | 6 |
| PASCO AP-8214A platform | Stress-strain biomechanics, BME 4051L | 8 |
| PASCO PS-2104 force sensor | Stress-strain biomechanics, BME 4051L | 8 |
| PASCO PS-2120 rotary motion sensor | Stress-strain biomechanics, BME 4051L | 8 |
| Sparklink Air interface | Stress-strain biomechanics, BME 4051L | 8 |
| Thermo Scientific Spectronicª 200E spectrophotometer | Ion chromatography, BME 4051L | 1 |
| Hollow fiber, MICROKROS 20CM 10K MPES 0.5MM | Membrane transport, BME 4051L | 10 |
| Thermo Scientific FH100 pump, peristaltic | Membrane transport, BME 4051L | 7 |
| Fisher Scientificª Isotempª digital stirring hotplates | Microsphere/Heat transport, BME 4051L | 8 |
| AmScope LED binocular digital compound microscope with 3D stage | Microsphere, BME 4051L | 8 |
| AmScope microscope digital camera | Microsphere, BME 4051L | 6 |
| Fisher Scientificª vortex mixer | Microsphere, BME 4051L | 7 |
| Accuspin 8C centrifuge | Microsphere, BME 4051L | 3 |
| Thermo Scientificª Sorvallª Legendª Micro 21 microcentrifuge | Microsphere, BME 4051L | 4 |
| Beckman Coulter Z2 particle counter & size analyzer | Microsphere, BME 4051L | 1 |
| CHEM4-VIS-FIBER VIS-NIR spectrophotometer (400-950nm) | Beer’s law, BME 4051L | 8 |
| Mastech MS8229 Auto-Range 5-in-1 digital multimeter | Nernst equation, Beer’s law, BME 4051L | 9 |
| OMEGA OM-DAQ-USB-2401 data acquisition system | Heat transport, Beer’s law, BME 4051L | 9 |
| FLAME-CHEM-UV-VIS Spectrometer, 200-850 nm | Heat transport, Beer’s law, BME 4051L | 1 |
| Prusa i3 MK3S 3D printer | Team project, Beer’s law, BME 4051L | 2 |
| Makerbot Replicator+ 3D printer | Team project, Beer’s law, BME 4051L | 1 |
| Mettler Toledoª NewClassic ML precision balances | Multiple protocols, BME 4050L & 4051L | 5 |
| Fisher Heratherm oven | Multiple protocols, BME 4050L & 4051L | 1 |
| Thorlabs optical table | Multiple protocols, BME 4050L & 4051L | 1 |
| OEK-STD Optics Educational kits | Optical protocol | 1 |
| PC 700 pH/Conductivity benchtop meter | Summer intern tasks | 7 |
| Varian Cary Vis UV spectrophotometer | Summer intern tasks | 1 |

**Table 7.4** summarizes the instructional laboratory areas and common study areas available at the EC, including the cafeteria, student study carrels space, and research laboratory space for supporting didactic education and the research experience for BSBME students. Student teams can choose to reserve a classroom or meet informally in one of the common areas.

**Table 7.4 Core-Curriculum and General Use Instructional Laboratories and Other Student Space available to Biomedical Engineering**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Location** | **Facility Role in Undergraduate Curriculum** | **Faculty in charge** | **Primary Use** | **Student Capacity** | **Area (ft2)** |
| EC 2350 | Undergraduate Creativity Lab | Jiao | Teaching | 5 | 344 |
| EC 2355 | Undergraduate Instructional Laboratory | Jiao | Teaching | 8 | 696 |
| EC 2360 | Undergraduate Instructional Laboratory | Jiao | Teaching | 20 | 1,108 |
| EC 2610 | Student Carrels | Riera | Graduate Student Desks | 26 | 500 |
| EC 2680 | BME Conference Room | Riera | Small Group Teaching and Meetings | 16 | 437 |
| EC 2685 | BMES Office | Riera | Student Society | 3 | 180 |
| EC 1100W1 | Common Study Area | Dean’s Office | Student Self-Study | 20 | 1,789 |
| EC 2600W1 | Common Study Area | Dean’s Office | Student Self-Study | 5 | 1,213 |
| EC 2300 | Multi-Function Meeting Room with Video-Conferencing Capabilities | Dean’s Office | Wallace H. Coulter Foundation Seminars/Senior Design EXPO/Graduate and Undergraduate Research Day | 30 | 1,027 |
| EC 2851 | Panther Pit & Cafeteria | Dean’s Office | Student Self-Study | 112 | 4,900 |
| EC 2900W5 | Common Study Area | Dean’s Office | Teaching | 50 | 1,672 |
| EC 3200 | Common Study Area | Dean’s Office | Student Self-Study | 15 | 800 |
| EC 3300 | Common Study Area | Dean’s Office | Student Self-Study | 15 | 800 |
| EC 3300W1 | Common Study Area | Dean’s Office | Student Self-Study | 15 | 884 |
| EC 3700W4 | Common Study Area | Dean’s Office | Student Self-Study | 12 | 884 |
| EC 3800W6 | Common Study Area | Dean’s Office | Student Self-Study | 15 | 699 |
| EC 3319 | Tissue Culture Lab | Riera | \*Teaching/Research | 4 | 327 |
| EC 3477 | Tissue Engineering Lab | Hutcheson | \*Teaching/Research | 6 | 638 |

\* Two faculty research labs are used to teach a laboratory practicum in the BME 4332 Cell and Tissue Engineering course.

**A.3** **Other Laboratory Facilities**

Laboratory facilities including those containing computers (describe available hardware and software) and the associated tools and equipment that support instruction. Include those facilities used by students in the program even if they are not dedicated to the program and state the times they are available to students. Complete Appendix C containing a listing of the major pieces of equipment used by the program in support of instruction.

The other laboratory facilities that are used by students in the program but are not dedicated to the BSBME program include the BME research laboratories, engineering manufacturing center, and animal care facility. Details of all these facilities are described below.

**A.3.1 Equipment (Research Laboratories)**

The research labs provide the opportunity for students performing senior design projects sponsored by individual faculty members to design and prototype their concepts. They also provide the opportunity for undergraduate students to conduct elective independent research as part of their educational experience. The Coulter Undergraduate Research Excellence (CURE) Program is a program seeking to promote undergraduate research in biomedical engineering through an incentivized mentoring program. Students in the CURE Program commit to 15 hours per week in a research laboratory. A summary of BME research laboratories and its space and capacity is given in **Table 7.5**. The equipment and tools used in these research laboratories that contribute to the above efforts for senior design projects and/or undergraduate research is provided in **Appendix C**.

**Table 7.5 List of BME Research Laboratory Space to Support Senior Design Projects (if needed) and Undergraduate Research Efforts**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Location** | **Facility Role in Curriculum** | **Faculty in**  **charge** | **Primary Use** | **Student Capacity** | **Area (ft2)** |
| EC 1660 | Bioelectronic and Electronic Packaging | Raj | Research | 5 | 520 |
| EC 2361 | TEMIM Lab | Ramaswamy | Research | 4 | 450 |
| EC 2367 | Cell and Tissue Culture | Ramaswamy | Research | 2 | 118 |
| EC 2370 | Imaging Core Facility | Riera | Research | 1 | 103 |
| EC 2372 | Imaging Core Facility | Riera | Research | 2 | 233 |
| EC 2374 | Imaging Core Facility | Riera | Research | 2 | 228 |
| EC 2371 | Cell Culture Facility | Hutcheson/Tsoukias | Research | 1 | 137 |
| EC 2990 | Ophthalmic Imaging/Electrophysiology | Jiao/Riera | Research | 4 | 329 |
| EC 2991 | Ophthalmic Imaging Lab | Jiao | Research | 2 | 237 |
| EC 3130 | Clinical (Optical) Imaging Laboratory | Godavarty | Research | 2 | 221 |
| EC 3140 | Adaptive Neural Systems Lab (until Fall 2021) | Jung | Research | 7 | 854 |
| EC 3160 | ***Applied Neural Interfaces Laboratory*** | Danziger | Research | 6 | 655 |
| EC 3315 | Cell & Tissue Engineering Core Facility | Riera | Research | 2 | 182 |
| EC 3315A | Physiology Lab - I | Tsoukias | Research | 1 | 41 |
| EC 3317 | Physiology Lab - I | Tsoukias | Research | 5 | 550 |
| EC 3319 | Cell & Tissue Engineering Core Facility | Riera | Research | 4 | 327 |
| EC 3365 | Optical Imaging Laboratory | Godavarty | Research | 6 | 678 |
| EC 3370 | Biotransport Lab | McGoron | Research | 6 | 612 |
| EC 3390 | Biomedical Optics Lab | Lin | Research | 3 | 367 |
| EC 3391 | Biomedical Optics Lab  Darkroom 1 | Lin | Research | 1 | 110 |
| EC 3392 | Biomedical Optics Lab  Darkroom 2 | Lin | Research | 1 | 118 |
| EC 3477 | Cardiovascular Matrix Remodeling Lab | Hutcheson | Research | 6 | 638 |
| OE 129-132 | Ophthalmic Imaging Lab | Jiao | Research | 10 | 1,300 |
| OE 132 | BME Shared Lab | Jung/Danziger/Ramella  /McGoron/Riera | Research | 3 | 323 |
| OE 134A | BME Shared Lab | Jung | Research | 2 | 105 |
| AHC4 507 | BME Shared | Jung/Danziger/Hutcheson/  Tsoukias/Riera/Schummers | Instrumentation  Shop | 3 | 328 |
| AHC4 510C | BME Shared | Danziger/Hutcheson | Research | 6 | 598 |
| AHC4 512 | Neuro Mass Dynamic Lab | Riera | Research | 4 | 385 |
| AHC4 516 | Medical Photonics Lab | Ramella-Roman | Research | 3 | 254 |
| AHC4 518 | Neural Engineering Lab | Tsoukias | Research | 3 | 273 |
| ACH4 520 | Visual Cortical Circuits Lab | Schummers | Research | 3 | 270 |
| ACH4 522 | Visual Cortical Circuits Lab | Schummers | Research | 6 | 689 |
| VH 333 | Medical Photonics Lab | Ramella-Roman | Research | 6 | 639 |

**A.3.2 Engineering Manufacturing Center (EMC)**

BME undergraduates can access the Engineering Manufacturing Center’s (EMC) Student Machine Shop. The center’s main mission is to educate and train students in manufacturing engineering. The center supports the College of Engineering and Computing in the following areas:

1. **Instruction:** The center staff teaches Level-1 and Level-2 Manufacturing modules within the EML 3301L and EMA 3702L courses, which are required for Mechanical Engineering majors, but open to all engineering students. The lecture component, Manufacturing Processes (EIN 3390), is taught by the Mechanical Engineering Department. The lab component is taught by and at the center’s facility.
2. **Project Support:** The center helps students to prepare their Senior Design Capstone Experience or other related class projects. High-quality capstone projects are essential for ABET accreditation and the center plays a large part in providing the needed resources. The center is directly involved with supporting students with engineering design, cost estimation, fabrication planning, manufacturing, and assembly as needed.
3. **Research Support:** The center provides expert advice to all the FIU researchers and students on the fabrication of parts and experimental setup when they need it. Such requirements may entail very small-scale precision manufacturing of high-strength alloys and other exotic materials, design of jigs, fixtures, tooling or other hardware used in engineering / scientific experimentation, rapid prototyping of complex product designs, dimensional data acquisition/reverse engineering, computer aided-design, as well as traditional shop manufacturing. Depending on the situation, parts may be manufactured, or the researchers are directed to the most appropriate facility. When necessary, the quality of the outsourced parts is evaluated to help the researchers.
4. **Interdisciplinary activities:** The center staff mentors and assists many multidisciplinary teams throughout the academic year. Students from different departments team together to work on their capstone or other project ventures. The student machine shop supports these activities, allowing qualified students 24/7 access to various pieces of machining equipment for fabricating senior design and research-based projects. SAE Mini-Baja, Formula SAE, ASCE Concrete Canoe and Bridge competition teams, as well as student groups and faculty from mechanical, industrial, electrical, biomedical, and civil engineering programs make use of the facility. Such interdisciplinary projects have included the FIU Solar House, Mini-Baja competition, the Wall of Wind project, and other interdepartmental efforts.

**Equipment and Staff of EMC**

The 1,250-square-foot shop houses modern computer numerical control machines, several rapid prototyping systems, and coordinate measurement equipment. In addition, it hase a large variety of manual machine tools, hand tools, and inspection equipment. The 750-square-foot student machine shop houses two vertical knee mills, CNC vertical knee mill, two drill presses, two band saws, an engine lathe, two welders, pedestal grinder, and various hand tools and cutting tools (e.g., end mills, drills, wrenches, hammers). Various hand tools and equipment are also available for sign-out at the main EMC shop.

In addition, the center’s equipment and facility is maintained and operated by a highly experienced individual, Mr. Richard Zicarelli, who is very capable in manufacturing and instruction/training of students. His 45+ years of private industry experience in sectors such as aerospace, injection molding, toolmaking, and fabrication, is rarely found in a university environment. This knowledge is extremely valuable not only to FIU’s researchers but to the engineering students being trained at the center. FIU researchers and students alike see the center as a high-value engineering resource for fabrication having high quality.

## A.3.3 Animal Care Facility

FIU’s Animal Care Facility is registered as a research facility with the United States Department of Agriculture (USDA) in accordance with the Animal Welfare Act and Regulations. The FIU Animal Care Facility is inspected by the USDA to ensure that all activities involving research animals are in compliance with all applicable laws and regulations. Several faculty performing animal research use the animal facility. BSBME students performing research with these BME faculty use these animal facilities as needed for their projects as well.

Dr. Horatiu V. Vinerean, Director and Attending Veterinarian, [Laboratory Animal Research](https://research.fiu.edu/ored/lar/), is responsible for a uniform comprehensive veterinary care program for all FIU facilities and oversight for the entire FIU biomedical research program. The Attending Veterinarian provides assistance to research personnel and investigators on usage, procurement and general handling and care of animals; review of animal use protocols; monitoring of the occupational health program for employees; and supervision of the employees and activities.

FIU also has a full-time Facility Supervisor, Amable Tellez, who supports the Attending Veterinarian by triaging ill animals, carrying out treatment plans, and monitoring post-surgical cases, in addition to managing husbandry duties.

Several faculty performing animal research, use the animal facility. The BME undergraduate students performing research with these BME faculty will use these animal facilities as needed for their projects as well.

**A.4 Other Programs and Resources at FIU**

The other programs and resources/tools available to support the attainment of SLOs and to provide an atmosphere of conducive learning including the disability resource center and the STEM transformation institute in the College of Arts, Sciences & Education at the university level, and the Center for Diversity and Student Success in Engineering and Computing (CD-SSEC) at the college level. The support provided by these resources are described below.

**A.4.1 Disability Resource Center (at the University Level)**

The aim of the Disability Resource Center (DRC) at FIU is to guide and support students with disabilities throughout their college experience, from transitioning into FIU to graduating from university, the DRC’s goal is to help students be successful. Serving as the one-stop shop for students’ disability service needs, the DRC provides the resources to facilitate a smooth transition to university life. By providing one-on-one consultation throughout students’ academic journey, our DRC staff are a specialized resource for students. Through the generous gifts of various donors, the DRC administers annual scholarships of $70,000 to support over 30 students with disabilities each year on behalf of donors. The Johnson Scholarship Foundation is a private foundation whose mission is to assist disadvantaged people to obtain an education. The foundation believes that education can empower individuals to improve their quality of life. The Theodore R. and Vivian M. Johnson Scholarship is a State of Florida University System program, which is competitively awarded and available to undergraduate students with disabilities, enrolled at FIU.

**A.4.2 STEM Transformation Institute in College of Arts, Sciences & Education (at the University Level)**

The [STEM Transformation Institute](https://stem.fiu.edu/) at FIU ([stem.fiu.edu](http://stem.fiu.edu)) was founded in response to a national call for 100,000 new STEM teachers and an additional 1,000,000 STEM professionals, and is dedicated to improving institutional learning practices through evidence-based teaching. The Learning Assistant (LA) program is currently the largest LA program in the United States. Learning Assistants are undergraduate students, who, through the guidance of weekly preparation sessions and a pedagogy course, facilitate discussions among groups of students in a variety of classroom settings that encourage active engagement. LAs help transform courses by creating positive learning environments that encourage students to interact with one another by engaging in collaborative problem-solving activities. LAs will use questioning skills and involve all students in meaningful teamwork for greater learning outcomes. BME 2740, BME 3721, and BME 3632 are a few BSBME courses students can choose to LA. Even though the LA experience will be different for each discipline and course, the LA experience consists of similar goals regardless of the course they are LA-ing for. In addition to supporting student learning in your course, LAs also:

* **Participate in LA Seminar (SMT 3931):** New LAs are required to take a 1-credit, 2-hour course during the first semester they serve as LAs. This course helps LAs gain a deeper understanding of teaching and learning guided by evidence-based STEM education research.
* **Attend required weekly meetings with the lead course instructor**: In these meetings, the faculty and the LAs plan for the upcoming week, prepare for supporting students engagement with class activities, exchange feedback, and reflect on the previous week.
* **Individual preparation**: LAs review concepts and activities prior to the planning meeting with the faculty and in preparation for the upcoming week. LAs do so on their own and are ready to bring questions and ideas to the planning meeting.

There are 18 state-of-the-art classrooms with total capacity of 1,485 designed and built to house active learning at a financially sustainable scale at STEM Transformation Institute. All these classes require faculty to commit to active learning - to putting down the textbooks and tackling scientific challenges with hands-on approaches. These classrooms represent one way FIU and the STEM Transformation Institute are committed to expanding the reach of our active learning initiatives. Below in **Table 7.6** is a summary of these classrooms.

**Table 7.6 Summary of classrooms with Active Learning Initiatives**

| **Room Number** | **Capacity** |
| --- | --- |
| AHC5 201/203 | 98 |
| AHC5 212A/B | 54 |
| GL 132 | 42 |
| GL 139 | 60 |
| GL 165 | 85 |
| GL 166 | 42 |
| GL 245 | 72 |
| PG5 134 | 120 |
| PG5 155 | 270 |
| PG6 112 | 100 |
| PG6 114 | 48 |
| PG6 115 | 48 |
| PG6 116 | 174 |
| SASC 202 | 48 |
| SASC 251 | 48 |
| SASC 302 | 48 |
| SASC 351 | 48 |
| SASC 352 | 80 |

**A.4.3 Center for Diversity and Student Success in Engineering and Computing (CD-SSEC) (at the College Level)**

The mission of the Center for Diversity and Student Success in Engineering and Computing (CD-SSEC) is to provide prospective and current students of the college with opportunities and services that will enhance their academic experiences and increase their rate of success in the school and their future careers. The office will support the college through recruitment, retention and enrichment programs, such as mentorship, undergraduate research opportunities, peer-to-peer tutoring, internship, and pre-college outreach activities. Programs within CD-SSEC aim to promote STEM workforce development and improve the academic experience and success of our students within the FIU College of Engineering and Computing and our local K-12 community. We connect students to scholarship opportunities, student organizations, tutoring, undergraduate research, and more. We embrace our multicultural environment and the diversity in thoughts, beliefs, and ideas. We aspire for innovation, creativity, ingenuity, equity, and inclusion. We incorporate evidence-based scientific learning and teaching methods in our services and programs.

## B. Computing Resources

Describe any computing resources (workstations, servers, storage, networks including software), in addition to those described in the laboratories in Part A, which are used by the students in the program. Include a discussion of the accessibility of university-wide computing resources available to all students via various locations such as student housing, library, student union, off-campus, etc. State the hours the various computing facilities are open to students. Assess the adequacy of these facilities to support the scholarly and professional activities of the students and faculty in the program.

**B.1 Computing Resources**

Computing resources are provided by the FIU Division of Information Technology (DoIT) in the computing labs at MMC, and by the Engineering Information Center (EIC), which is located on the second floor of the College of Engineering and Computing building. The DoIT is the central technology service provider at FIU. The EIC is an outstanding asset to the education of all students in the College of Engineering and Computing. It is fully supported by the college and centralized so that all students, faculty, and staff have access to all of the hardware and software.

**B.1.1 DoIT Support at the University Level**

The DoIT provides central resources, training, and services to support all FIU student, faculty, and staff access to technology and to support the use of technology regardless of the location of the user. Numerous services, described below, are available through the Division of Information Technology:

* The Windows Enterprise Group/Support Center comprises a call center for phone, chat, and the online AskIT portal (which provides self-help options 24 hours per day, 7 days per week); a library services desk for in-person technical support; and a field team for remote and desk-side technical support for FIU-owned technology. The Support Center tracks real-time usage statistics and monthly user satisfaction statistics; these data aid in determining Support Center staffing requirements and in guiding efforts toward service improvement.
* Media and Instructional Technology Services consists of academic imaging services, and provides event, studio, and research photography and digitization of materials for preservation. This unit also offers academic video services, recording lectures, events, and promotional videos. The department facilitates educational technology services; provides training via workshops or individual sessions for technologies used in the classroom; and enhances teaching and learning by supporting students, faculty, and staff. The department houses a media equipment and operations unit, which ensures continuity of classroom instruction through technical instructional support (e.g., remote course capture, video conferencing, equipment rentals).
* The Operations and Enterprise Systems department oversees computer labs for instructional and student use on campus and eLabs (virtual lab offerings). This unit also houses the Instructional and Research Computing Center, which provides technologies to enhance academic curricula and research via high-performance computing, virtual computing labs, and a video wall for large-screen, high-resolution presentations.
* The Center for Internet Augmented Research and Assessment measures and assesses FIU’s effectiveness in the use of technology, seeking to augment the rate of discovery for researchers by fostering domain-specific tailoring of internet technologies that support student and faculty research. This center performs and supports high-quality research and enhances student learning and academic excellence. Annual assessment data are gathered and analyzed in the areas of faculty support, student engagement, grant funding, and network utilization.

The DoIT grants each student, faculty member, and staff member an account for the general use of computing resources managed by the division, including FIUMail for faculty and staff; Gmail (Google email) for students; network connectivity and registration; wireless access; PantherSoft (comprising Campus Solutions, Human Resources, Financials, ImageNow, MyFIU, and FIUMobile); Active Directory; LinkedIn Learning; and Canvas Learning Management System. The division provides and maintains a redundant, resilient network to allow users access to FIU’s resources and to the internet. This network supports Voice-over-Internet-Protocol (VoIP) phones for emergency communications. As a research university, FIU is a member of the high-speed regional networks Florida Lambda Rail and Internet2. The institution provides a high-speed wireless network in all indoor locations on campus (including housing complexes) and in outdoor areas of assembly.

**Information Technology Equipment and Facilities**

The DoIT manages information technology facilities and services, including computer laboratories, technology-enhanced classrooms, remote application delivery, and kiosks. One open computer laboratory on the main Modesto A. Maidique Campus contains approximately 30 primarily Windows-based computers. Another open computer laboratory on the branch Biscayne Bay Campus contains approximately 50 primarily Windows-based computers. Additionally, a Citrix-based virtual lab provides remote access to software applications for all students, faculty, and staff.

The DoIT supports additional academic computing facilities equipped with Windows-based computers; these include faculty resource centers, training centers, and FIU testing centers which have locations at the main Modesto A. Maidique Campus and the branch Biscayne Bay Campus. Additionally, the division maintains numerous kiosks between the main and branch campuses, which support various purposes, including registration and academic advising.

The DoIT also provides FIU faculty and staff with instructional computer labs equipped with state-of-the-art workstations (MAC and PCs) that allow access to software applications, Internet access, and printing capabilities. DoIt also has eLabs provided to FIU faculty, staff, and students with software applications available within the Open lab for students. DoIT Instructional & Research Computer Center (IRCC) open computer labs are available to currently registered students. These labs are equipped with PC computers. Logon access to the computers with your FIU username and password. The labs are setup for pay-to-print using your FIU OneCard, which can be recharged online or using any major credit card.

Besides computing labs, other instructional technology tools include course capture/distance learning, iClicker, the availability of instructional designers who can assist faculty in defining the most effective integration of technological tools to enrich the teaching/learning experience including video and audio production for specific purposes such as delivering a seminar or guest speaker, laboratory safety procedures, etc. Zoom is FIU's supported web conferencing application; it provides delivery of real-time course lectures and meetings. All registered FIU students have access to free software training sessions for the Microsoft Office suite of programs and Photoshop; opportunities that can help them refine the software skills required for course work or future job placement.

**B.1.2 Other Support at the University Level**

Other computational resources also include a new high performance computing facility (Panther Cluster) at FIU’s Instructional & Research Computing Center (IRCC, <http://ircc.fiu.edu/>). The cluster has 1500 Intel-based cores; 2.8 TB of total memory (including high memory nodes ranging from 32GB – 384GB per core; 56 Gbps Infiniband nodes and 250 TB high performance parallel storage (GPFS) and a small GPU cluster. This High-Performance Computational (HPC) resource allows faculty, along with their students, to examine more complex scientific and engineering problems that would otherwise be impossible to solve without this large-scale computing power. In many cases, being able to tackle large-scale problems requires the ability to process and store large data sets. To accommodate this need, large, long term, and fast storage for processing data is available through the IRCC. Below is a list of hardware and storage:

**Panther Cluster**

* **Hardware**
  + 1500 Intel based cores
  + High Memory Nodes. Range from 32 GB – 384 GB per node
  + 56 Gbps Infiniband nodes
  + 470 TB High performance parallel storage (Lustre)
  + GPU nodes
  + Visualization nodes for remote interactive graphical software
* **Storage**
  + Scratch space
    - Temporary 47 TB of High Performance Parallel Storage (Lustre) for shared scratch space
  + User home directories
    - Uses shared Parallel Storage (Lustre)
  + Long-term archival storage available
  + Off-site backup of data available

**B.1.3 EIC Support at the College Level**

The EIC serves the teaching, learning, research, and academic communities of the College of Engineering and Computing. It is responsible for developing and implementing the college’s information systems strategy. The center manages an array of MicroFocus, Windows, and UNIX network servers. These servers provide PCs and UNIX workstations with application services, data storage facilities, electronic mail, and network information services (Engineering Information Network, EINET). The center serves as the college’s primary medium for data communications and software support services. All of the college’s information systems are connected via the EINET, serving many different functions, most notably providing:

1. Researchers with connectivity to the center’s computational resources;
2. Faculty, staff, and students with access to the college’s Netware, Windows, and UNIX file and application servers;
3. External connectivity for the college’s distance learning programs;
4. Access to the internet;
5. Web development and hosting capabilities; and
6. Wireless connectivity.

Through the EINET, the EIC has developed an advanced computing environment with the inherent strengths of concurrent collaborative engineering applications. It is an environment that provides faculty, staff, and students with the capacity to share valuable resources, fostering an atmosphere where collaboration and instruction grow.

The EIC-maintained facilities augment the computer labs on site that are maintained by DoIT. EIC maintains eight computer labs, which are EC 2330, EC 2710, EC 2807, EC 2830, EC 2832, EC 2840, EC 3239, and EC 3278. These labs are equipped with 282 all-in-one (AIO) computers and 42 laptops in total. Each of the 282 computers is 23 inches and is equipped with a keyboard and mouse; 12 of these are Intel Core i7-8700 @ 3.20 GHz, 16GB Dual-Channel DDR4 @ 1333 MHz, 256GB M.2 drive, 1TB SSD, CD-DVD-RW Optical Drive. 148 of these are Intel Core i7-9700 @ 3.00 GHz, 32GB Single-Channel DDR4 @ 665 MHz, 256GB NVMe drive, 1TB SSD, CD-DVD-RW Optical Drive. 40 of these are Intel Core i7-9700 @ 3.00 GHz, 16GB Dual-Channel DDR4 @ 1333 MHz, 256GB M.2 drive, 1TB SSD, CD-DVD-RW Optical Drive. 75 of these are Intel Core i5-4570S @ 2.90 GHz, 8GB Single-Channel DDR4 @ 665 MHz, 500GB NVMe drive, CD-DVD-RW Optical Drive. Each lab is also furnished with a HP LaserJet P4515 B/W printer, and an overhead projector and screen. One of the labs also contains an HP Color LaserJet CP5525. All the equipment is connected to the EINET. These labs are also used as e-classrooms when used for teaching purposes. BME 2740 (Modeling and Simulation) and BME 3721 (Data Evaluation Principles) are held in an EC computer lab to allow students to gain hands-on experience during and after the class. These rooms are also equipped to support webcasting and video conferencing as a part of what is called the “Access Web.” Further, the EIC maintains several conference rooms (e.g., EC 2300) for faculty support; these rooms contain multimedia/computer equipment and can also be used as classrooms.

The EIC workstations have an extensive array of engineering software installed including Adobe, ArcGIS, Arena, AutoCAD Civil and AutoCAD Map, Microsoft Visual C++, Mathematica, Mathcad, MATLAB, Primavera, etc. Beyond the labs, access to the internet and to the EINET is available to any engineering student or staff via the wireless network deployed in the EC building. Access to the computers is controlled by individual accounts. There is no limit on time for computer use. Additionally, most of the EIC software applications can be accessed remotely 24/7 by any member of the FIU Engineering community using a Citrix portal. This means that students and faculty can run in their personal laptops or desktops any of these software applications from anywhere at any time, provided they have access to appropriate internet connectivity.

The EIC also provides students and faculty with a Remote Desktop Portal (<https://eic.fiu.edu/services/remote-computer-access/>). This portal allows users to sign into any of the lab computers from anywhere they choose. All that is needed is internet connection. This is a great feature, as it gives users the convenience of using the lab computers, and all the software and applications it has. The Remote Desktop Portal is easily found under services in the EIC website, with instructions logging in remotely.

Novell is a platform that allows college students, faculty, and staff to access EIC computers with an internet connection using their Novell login credentials, whether within the College of Engineering and Computing’s building or remotely. Novell is updated on a weekly basis. EIC also provides shared drive (H: drive and other departmental shared drives) services to college students, faculty, and staff. After logging in with their Novell credentials, users can access their data folder saved on H: drive and other shared drives, whether within College of Engineering and Computing building or remotely.

See **Table 7.7** “EIC Inventory” for a list of the existing equipment, software, and remote software applications available using Citrix Portal, located in EIC.All the equipment is in working condition and connected to the EINET.

**Table 7.7 EIC Inventory**

| **Room** | **Qty** | **Equipment** | **Description** |
| --- | --- | --- | --- |
| 2330 | 1. 1 2. 42 3. 1 4. 1 5. 4 6. 1 7. 1 8. 1 9. 1 10. 1 11. 1 12. 1 13. 1 14. 1 | 1. Computer 2. Laptops 3. Printer 4. Confidence Monitor 5. TV 6. Projector 7. Course Capturing 8. Crestron 9. Blu-Ray 10. Doc-Cam 11. HDMI Cable 12. VGA Cable 13. Ethernet Cable 14. Aux Cable | 1. Instructor computer; Intel Core i5-7600 @ 3.50 GHz, 8GB Dual-Channel DDR4 @ 1200 MHz, 256GB NVMe drive, CD-DVD-RW Optical Drive 2. Intel Core i5-7200U @ 2.50 GHz, 8GB Single-Channel DDR4 @ 665 MHz, 500GB NVMe drive, CD-DVD-RW Optical Drive 3. HP LaserJet P4515 B/W 4. Functions as second monitor and shows ongoing course recording 5. Samsung; Functions as an extra display for PC, Doc-Cam, etc. through Crestron 6. Panasonic PT-RZ370 LED Projector 7. Records class for online students; Front and back cameras for recording 8. Allows the user to select various input sources to project through the projectors and/or TVs 9. Allows for playback of Blu-Ray format discs 10. Allows for projection of physical documents 11. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 12. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 13. Located next to instructor computer; Allows for a connected device to obtain a network connection 14. Located next to instructor computer; Connect any device with a 3.5mm audio jack to play audio through room speakers |
| 2710 | 1. 46 2. 1 3. 1 4. 1 5. 1 6. 1 7. 1 8. 1 9. 1 10. 1 11. 1 12. 1 13. 1 14. 1 | 1. Computers 2. Printer 3. Confidence Monitor 4. Projector 5. Course Capturing 6. Crestron 7. Blu-Ray 8. DVD 9. VCR 10. Doc-Cam 11. HDMI Cable 12. VGA Cable 13. Ethernet Cable 14. Aux Cable | 1. One instructor computer; Intel Core i5-9600 @ 3.10 GHz, 32GB, 1TB SSD. 45 student computers; Intel Core i5-4570S @ 2.90 GHz, 8GB Single-Channel DDR4 @ 665 MHz, 500GB NVMe drive, CD-DVD-RW Optical Drive 2. HP LaserJet P4515 B/W 3. Functions as second monitor and shows ongoing course recording 4. Panasonic PT-RZ370 LED Projector 5. Records class for online students; Front and back cameras for recording 6. Allows the user to select various input sources to project through the projectors and/or TVs 7. Allows for playback of Blu-Ray format discs 8. Allows for playback of DVD format discs 9. Allows for playback of video tapes 10. Allows for projection of physical documents 11. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 12. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 13. Located next to instructor computer; Allows for a connected device to obtain a network connection 14. Located next to instructor computer; Connect any device with a 3.5mm audio jack to play audio through room speakers |
| 2807 | 1. 12 2. 1 3. 1 | 1. Computer 2. Printer 3. Projector | 1. Intel Core i7-8700 @ 3.20 GHz, 16GB Dual-Channel DDR4 @ 1333 MHz, 256GB M.2 drive, 1TB SSD, CD-DVD-RW Optical Drive 2. HP LaserJet P4515 B/W 3. Panasonic PT-FW300 LCD Projector |
| 2830 | 1. 50 2. 1 3. 1 4. 2 5. 2 6. 1 7. 1 8. 1 9. 1 10. 1 11. 1 12. 1 13. 1 14. 1 | 1. Computer 2. Printer 3. Confidence Monitor 4. TV 5. Projector 6. Course Capturing 7. Crestron 8. Blu-Ray 9. Doc-Cam 10. Polycom 11. HDMI Cable 12. VGA Cable 13. Ethernet Cable 14. Aux Cable | 1. One instructor computer; Intel Core i5-9600 @ 3.10 GHz, 32GB, 1TB SSD, 49 student computers; Intel Core i7-9700 @ 3.00 GHz, 32GB Single-Channel DDR4 @ 665 MHz, 256GB NVMe drive, 1TB SSD, CD-DVD-RW Optical Drive 2. HP LaserJet P4515 B/W 3. Functions as second monitor and shows ongoing course recording 4. Functions as an extra display for PC, Doc-Cam, etc. through Crestron 5. Panasonic PT-RZ370 LED Projector 6. Records class for online students; Front and back cameras for recording 7. Allows the user to select various input sources to project through the projectors and/or TVs 8. Allows for playback of Blu-Ray format discs 9. Allows for projection of physical documents 10. Supports video conferencing with users within and outside of FIU 11. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 12. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 13. Located next to instructor computer; Allows for a connected device to obtain a network connection 14. Located next to instructor computer; Connect any device with a 3.5mm audio jack to play audio through room speakers |
| 2832 | 1. 50 2. 1 3. 1 4. 2 5. 2 6. 1 7. 1 8. 1 9. 1 10. 1 11. 1 12. 1 13. 1 14. 1 | 1. Computer 2. Printer 3. Confidence Monitor 4. TV 5. Projector 6. Course Capturing 7. Crestron 8. Blu-Ray 9. Doc-Cam 10. Polycom 11. HDMI Cable 12. VGA Cable 13. Ethernet Cable 14. Aux Cable | 1. One instructor computer; Intel Core i5-9600 @ 3.10 GHz, 32GB, 1TB SSD. 49 student computers; Intel Core i7-9700 @ 3.00 GHz, 32GB Single-Channel DDR4 @ 665 MHz, 256GB NVMe drive, 1TB SSD, CD-DVD-RW Optical Drive 2. HP LaserJet P4515 B/W 3. Functions as second monitor and shows ongoing course recording 4. Functions as an extra display for PC, Doc-Cam, etc. through Crestron 5. Panasonic PT-RZ370 LED Projector 6. Records class for online students; Front and back cameras for recording 7. Allows the user to select various input sources to project through the projectors and/or TVs 8. Allows for playback of Blu-Ray format discs 9. Allows for projection of physical documents 10. Supports video conferencing with users within and outside of FIU 11. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 12. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 13. Located next to instructor computer; Allows for a connected device to obtain a network connection 14. Located next to instructor computer; Connect any device with a 3.5mm audio jack to play audio through room speakers |
| 2840 | 1. 41 2. 1 3. 1 4. 5 5. 1 6. 1 7. 1 8. 1 9. 1 10. 1 11. 1 12. 1 | 1. Computer 2. Printer 3. Confidence Monitor 4. TV 5. Course Capturing 6. Crestron 7. Blu-Ray 8. Doc-Cam 9. HDMI Cable 10. VGA Cable 11. Ethernet Cable 12. Aux Cable | 1. One instructor computer; Intel Core i5-9600 @ 3.10 GHz, 32GB, 1TB SSD., 40 student computers; Intel Core i7-9700 @ 3.00 GHz, 16GB Dual-Channel DDR4 @ 1333 MHz, 256GB M.2 drive, 1TB SSD, CD-DVD-RW Optical Drive 2. HP LaserJet P4515 B/W 3. Functions as second monitor and shows ongoing course recording 4. Functions as an extra display for PC, Doc-Cam, etc. through Crestron 5. Records class for online students; Front and back cameras for recording 6. Allows the user to select various input sources to project through the projectors and/or TVs 7. Allows for playback of Blu-Ray format discs 8. Allows for projection of physical documents 9. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 10. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 11. Located next to instructor computer; Allows for a connected device to obtain a network connection 12. Located next to instructor computer; Connect any device with a 3.5mm audio jack to play audio through room speakers |
| 3239 | 1. 51 2. 1 3. 1 4. 1 5. 2 6. 1 7. 1 8. 1 9. 1 10. 1 11. 1 12. 1 13. 1 | 1. Computer 2. Printer 3. Confidence Monitor 4. TV 5. Projector 6. Course Capturing 7. Crestron 8. Blu-Ray 9. Doc-Cam 10. HDMI Cable 11. VGA Cable 12. Ethernet Cable 13. Aux Cable | 1. One instructor computer; Intel Core i5-9600 @ 3.10 GHz, 32GB, 1TB SSD. 50 student computers; Intel Core i7-9700 @ 3.00 GHz, 32GB Single-Channel DDR4 @ 665 MHz, 256GB NVMe drive, 1TB SSD, CD-DVD-RW Optical Drive 2. HP LaserJet P4515 B/W 3. Functions as second monitor and shows ongoing course recording 4. Functions as an extra display for PC, Doc-Cam, etc. through Crestron 5. Panasonic PT-RZ370 LED Projector 6. Records class for online students; Front and back cameras for recording s 7. Allows the user to select various input sources to project through the projectors and/or TVs 8. Allows for playback of Blu-Ray format discs 9. Allows for projection of physical documents 10. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 11. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 12. Located next to instructor computer; Allows for a connected device to obtain a network connection 13. Located next to instructor computer; Connect any device with a 3.5mm audio jack to play audio through room speakers |
| 3278 | 1. 31 2. 2 3. 1 4. 1 5. 1 6. 1 | 1. Computer 2. Printer 3. Projector 4. Doc-Cam 5. HDMI Cable 6. VGA Cable | 1. One instructor computer; Intel Core i5-9600 @ 3.10 GHz, 32GB, 1TB SSD. 30 student computers; Intel Core i5-4570S @ 2.90 GHz, 8GB Single-Channel DDR4 @ 665 MHz, 500GB NVMe drive, 1TB SSD CD-DVD-RW Optical Drive 2. HP LaserJet P4515 B/W;   HP Color LaserJet CP5525   1. Panasonic PT-RZ370 LED Projector 2. Allows for projection of physical documents 3. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system 4. Located next to instructor computer; Connect a laptop to display through projector or TV through the Crestron system |

**Software Status Report (2021)**

The following is a list of the available software, applications on the EIC Computer Labs as of July 2021.

|  |
| --- |
| * Abaqus 2021 * Advanced Design System 2021 Update 2 * Alice 3 3.6.0.1 * Altair FEKO 2017.2 (Local 64-bit) * ANSYS Discovery * ANSYS Electromagnetics Suite 2021 R1 * ANSYS Fluent 2021R1 * ANSYS Mechanical Structures 2021 R1 * Apache NetBeans IDE 12.0 * ArcGIS Desktop 10.6 * Arduino * Autodesk AutoCAD 2022 - English * Autodesk Navisworks Freedom 2020 * Autodesk Navisworks Manage 2020 * Autodesk Revit 2022 * Bluebeam Revu eXtreme x64 20 * Cisco AnyConnect Secure Mobility Client * Citrix Workspace 2106 * CodeBlocks * Comsol 5.6 * Cygwin64 Terminal 3.2 * Dassault Systemes SIMULIA Established Products 2021 * Dassault Systemes SIMULIA Isight 2021 * Digilent Software * Erlang OTP 22 (10.6) * FARO LS 1.1.700.0 (64bit) * FileZilla Client 3.54.1 * Genesis 18.0 * GRANTA EduPack 2021 R1 * IBM SPSS Statistics 27 * K-Lite Codec Pack 16.2.5 Full * Mathcad 15 M045 * MATLAB R2021a * Microsoft Office Professional Plus 2019 - en-us * Microsoft OneDrive * Microsoft Project Professional 2019 - en-us * Microsoft Teams * Microsoft Visio Professional 2019 - en-us * Minitab Statistical Software (x64) - 20.3.0.0 * modeFRONTIER 2017R5 * National Instrument Labview 2021 SP1 * National Instrument Elvismx 19.0 * National Instrument Multism 14.2 * Notepad++ (32-bit x86) * Npcap * On-Screen Takeoff * OneNote for Windows 10 * PDFCreator * Primavera P6 Professional * PSpice Student 9.1 * PuTTY release 0.75 (64-bit) * SketchUp Pro 2021 * SOLIDWORKS 2020 SP05 * TRIMBLE CM TOOLS WINEST 15.10 * USBPcap 1.5.4.0 * Visual Studio Community 2019 * VRAND License Server * WinPcap 4.1.3 * WinSCP 5.19 * Wireshark 3.4.6 64-bit * Wolfram Mathematica 12.3 * Xilinx Design Tools Vivado HL Design Edition 2020.2 (C:\Xilinx) * Zoom |

**Remote Software Applications Available using Citrix Portal.**

The following applications are available to all the students using EIC computer labs or from anywhere 24/7:

* Abaqus CAE 2017
* ADS 2016
* ANSYS Electronics Desktop 2019 R1
* ANSYS SIwave 2019 R1
* ArcCatalog 106
* ArcGlobe 106
* ArcMap 106
* AutoCAD 2014
* AutoCAD 2018
* Autodesk AutoCAD Civil 3D as AutoCAD 2014
* Bluebeam Revu 20
* Excel 2013
* Genesis File Editor 160 64-bit
* GRANTA EduPack 2020
* HCS7
* IBM SPSS Statistics 21
* LabVIEW 2014 SP1 64-bit
* LEAP Bridge Concrete
* LEAP Bridge Steel
* Magaya
* Mastercam 2020 HLE
* Mathcad 15
* MATLAB R2015a
* MATLAB R2018a
* Mechanical APDL 2019 R1
* Microsoft Visio 2010
* MicroStation V8i SELECTseries 3
* Minitab 17 Statistical Software
* Minitab 18
* Minitab 19
* modeFRONTIER 2017R5
* Multisim 141
* Navisworks Manage 2019
* Navisworks Simulate 2019
* Notepad
* On-Screen Takeoff 3
* Outlook 2013
* Primavera P6 Pro R1712
* Process Simulator
* Quick Bid 4
* Revit 2014
* Revit 2018
* SAP BusinessObjects Dashboards
* SAP HANA Studio
* SAP Logon
* SAP Lumira
* SOLIDWORKS 2017
* Thermo-Calc
* Visio 2013
* Visio 2016
* Visual Studio 2013
* Wolfram Mathematica 112
* Word 2013
* Workbench 2019 R1
* Xilinx

**B.2 Accessibility of Facilities and Services**

The EIC academic computer labs are open Monday to Friday from 7:00 AM to 6:30 PM with staff support, and are closed for national holidays, other FIU important dates (such as winter and summer breaks) and may be closed for special maintenance or cleaning. However, EIC offers two labs which are accessible 24/7, including holidays – EC 2807 and EC 3278.

Each semester, students have issued accounts in the EIC computer labs based on course enrollment. Students receive an account automatically at the beginning of each term if they are enrolled in a College of Engineering and Computing course, which is eligible to use our labs. Students who are not enrolled in at least one engineering course will have their computer accounts disabled.

A student who is auditing a course, finishing work to satisfy an incomplete grade, or working on a project that is not related to a specific course can have an account enabled in the labs with the approval and by request of their sponsoring faculty. The sponsoring faculty will need to request the account on behalf of the student by submitting a ticket on [EIC help desk](https://eic.fiu.edu/services/help-desk/). College faculty can have accounts enabled in any EIC lab on request.

There is no time limit placed on computer use. During the peak usage times (final exams periods) EIC further extends the hours of operation. Doors are wide enough to permit access by wheelchairs and a number of work surfaces with 29” floor clearance allow handicapped access for experiments if required.

Other programs and services include:

* printing services: printing services are available for all students and staff within the college, whether it’s for class or senior design projects or other events and conferences. Large format poster printing services, as well as 3D printers are available. More information and request forms can be found at: <https://eic.fiu.edu/services/printing/>.
* laptop loaner program: to further enhance the student’s educational pursuits, Dell laptop computers are available for check out to any Engineering student in good standing currently enrolled in a College of Engineering and Computing course. Laptops are made available to the student on a first come first served basis. Detailed checkout procedures and forms can be found at; <https://eic.fiu.edu/services/laptop-loaner-program/>.

## C. Guidance

Describe how students in the program are provided appropriate guidance regarding the use of the tools, equipment, computing resources, and laboratories.

The guidance and training provided to using the undergraduate laboratory, computing resources, and equipment/tools in machine shop is described below.

**C.1 Undergraduate Courses**

Two faculty members and four TAs are assigned to each BME lab course (BME 4050L and 4051L). The faculty members and TAs instruct students on the proper use of equipment and guide them through the process of all exercises. Each student is required to finish the following training courses and submit their certificates to the faculty member before they are allowed to get access to the lab: (1) Laboratory Hazard Awareness, (2) Hazard Communications, and (3) Small Spills and Leaks.

**C.2 Computing Resources**

The EIC has an excellent, dedicated, and talented staff, which includes a Director/ Systems analyst, Data Communications Specialist, Hardware Specialist, Multimedia Producer, Office Manager, and several part-time student/technicians.

Support staff is available at any time to assist faculty and students in the use of all hardware and software. The EIC also houses a program library and documentation for anyone who needs additional information about a specific application. The center employs on-call personnel for emergency situations.

The BME department offers a tutorial session for BME 2740 (Biomedical Engineering Modeling and Simulation) and BME 3721 (Biomedical Engineering Data Evaluation Principles) for using the computers and software.

**C.3 Equipment/tools in the Machine Shop**

Room OU-117 is the EMC’s student machine shop, which allows qualified students 24/7 access to various pieces of machining equipment. SAE Mini-Baja, Formula SAE, ASCE Concrete Canoe and Bridge competition teams, as well as student groups and faculty from the BME, Civil Engineering, Electrical and Computer Engineering, and Mechanical Engineering departments all use the facility for fabricating senior design and research-based projects.

In order for students or faculty to gain access to the machine shop they must have prior experience in the proper use of equipment from either a course offered by an educational facility, or from their place of employment. Access is granted by the student filling out the form “RELEASE AND ASSUMPTION OF RISK AGREEMENT for STUDENT MACHINE SHOP (OU-117)” which was prepared with the assistance of FIU’s General Counsel and Environmental Health and Safety (EHS) department. The student is screened by the EMC Coordinator, who determines whether access should be granted and which pieces of equipment a student is or is not allowed to use.

Upon approval, the student’s Panther ID identification card is activated, which allows the student to swipe the card into the electronic door lock. Access is usually granted on a per-semester basis, unless prior approval is received for a longer period of time. The student is briefed on the safety rules governing the use of the student machine shop and is shown where the safety manual, first aid kit, emergency response policy, emergency phone and sign-in log are located. The student machine shop is regularly monitored by FIU EHS personnel as well as the EMC Lab Coordinator. In addition, video surveillance is also used to monitor the room. The Center has an excellent safety record to date.

Professional assistance is offered to all students by the EMC Lab Coordinator, who provides consultation, instruction and guidance as needed by the students. Fee-based fabrication is also available to the students, faculty, and research departments through the EMC. Fees cover materials, consumables, and some equipment maintenance costs.

## D. Maintenance and Upgrading of Facilities

Describe the policies and procedures for maintaining and upgrading the tools, equipment, computing resources, and laboratories used by students and faculty in the program.

**D.1 Planning Laboratory Courses**

The undergraduate advisor provides information as to the number of students projected to enroll in the labs, based upon those in the program pipeline. The number of sections of the lab courses required and the overall plan of the lab course itself and the space and personnel required is gated by this information. To continuously provide a state-of-the-art experience for the students, the design of the undergraduate laboratory course is formally decided and amended by faculty at regular faculty meetings or at the annual retreat. Equipment selection is researched by individual faculty and the laboratory manager. Budget is received from departmental funds or from the Dean’s Office to support the growth of the program. Alternative equipment choices are presented to the chair who, upon consultation with faculty and staff, approves purchases.

**D.2 Facilities and Equipment Resources Plan**

The BME instructional facilities consist of 3 labs, where multiple stations of equipment for lab experimental protocols are provided for undergraduates. Details for facility spaces and equipment can be found in Section A.

The lab manager does routine maintenance of teaching laboratory equipment, with assistants from TAs. The lab manager checks to see that equipment is present and working before and after each semester, calibrates instruments regularly, checks and purchases lab supplies frequently, renews service contracts with suppliers annually, as well as returns equipment to the manufacturer for repair or calls in on-site service. TAs monitor the usage of equipment, as well as stock level of lab supplies during and in between classes. TAs report any malfunctions of equipment or low-level lab supplies to the lab manager immediately, and the lab manager takes actions accordingly.

**D.3 Maintenance Plan**

**D.3.1 Personnel Available for Equipment and Instrumentation Maintenance**

The laboratory manager is available to do routine maintenance for instructional laboratory equipment. Calibration services or repair for laboratory equipment is contracted with outside vendors as needed.

**D.3.2 Service Budget**

The maintenance and supplies budget for all instructional equipment derives from a fee assessed on all students registered for the course and from departmental operating expense funds. The budgets (Lab Fee and Equipment Fee derived from the tuition) for lab supplies, equipment maintenance, as well as new purchases of equipment are reviewed annually by the lab manager, to evaluate if revenue (tuition collected) and expense is balanced. Slight adjustments to tuition may be proposed by the lab manager and approved by the Dean’s Office if needed. In addition, proposed by the lab manager and instructors, and reviewed and approved by the Department Chair, funds from the Department and Coulter Foundation may be available to address the needs of large amount payments for purchases of equipment. The software resources are managed by the EIC (refer to Criterion 7 B. Computing Resources, section title: Software Status Report [2021]). The laboratory manager is available to any member of the faculty to assist in emergency maintenance.

**D.4 Plan and Resources for Sustainable Facilities**

Instructional laboratories fall into three general categories: 1) Computer labs for use by all students in all courses and programs; 2) instructional labs for College of Engineering and Computing core courses; and 3) instructional labs for program courses. Since the last ABET assessment, a total amount of $28,667.78 in departmental funds plus $23,115.50 in Coulter funds was used to purchase computers (upgrade), BIOPAC home kits, as well as optical equipment and devices to improve and enhance the lab resources, facilitate remote learning during the pandemic period, and to develop a new optic protocol for undergraduates.

**D.4.1 Type and number of support personnel available to install, maintain and manage departmental software and networks.**

The EIC director supervises a support staff including an office manager, two senior systems analysts, a tech lab manager and three network field engineers.

Support staff is available at any time to assist faculty and students in the use of all hardware and software. The EIC also houses a program library and documentation for anyone who needs additional information about a specific application. The center employs on-call personnel for emergency situations.

Division of Information Technology (DoIT) provides significant technical resources for internet connectivity and enterprise software, such as Panthersoft, which supports both academic record keeping and financial systems software. DoIT is directed by the University VP for IT and CIO. DoIT’s extensive Services include training, network connectivity hardware installation and maintenance, VOIP, webmail and Panthersoft support.

The EIC maintains a library of software which can be installed in the departmental computers by EIC technicians and utilized in BME undergraduate lab courses, such as Solid Works, MatLab, and Labview. The Department lab manager supervises teaching assistants who can be assigned to perform minor tasks such as relocating equipment.

**D.4.2 Type and number of support personnel available to install, maintain and manage laboratory equipment.**

Major new laboratory equipment, such as fume hoods, special air handling equipment, or special gas lines and plumbing is installed by outside contractors supervised and directed by the FIU Facilities Management Department. Facilities Management assigns a project manager to the EC to handle major and minor projects. Facilities management maintains major equipment and performs building maintenance principally by assigning pool technicians to handle ad hoc repairs.

The BME Department Laboratory Manager provides or outsources routine maintenance of laboratory equipment as required by the equipment maintenance and replacement process.

Outside contractors or the original equipment vendors are engaged to service and calibrate equipment such as centrifuges, spectrometers, DI water system and pipetters. The department has manometers for calibration of pressure gages and weight sets for calibrating balances. Calibration materials for other lab equipment such as pH meters and osmometer are stocked as needed. In some cases, oscilloscopes and other small electronics are calibrated and repairs may be done in house by arrangement with the Electrical Engineering Department Shop.

## Overall Comments on Facilities

All students, faculty and laboratory managers are required to take the University level safety training courses on Laboratory Safety and Hazard Management. Courses are available online at: <http://ehs.fiu.edu/Training/Pages/Lab-Safety-Training.aspx>. The primary investigators (PIs) and/or laboratory managers train the teaching assistants in the use of laboratory equipment and tools. They in turn supervise undergraduate student use of the tools in the labs. Specialized training from EMC, AMERI (Advanced Materials Engineering Research Institute), or other such facilities is provided by the staff in those facilities. The fume hoods are inspected by the Environmental Health and Safety division yearly. The Department laboratory manager calibrates and checks the equipment used in the undergraduate laboratories.

## E. Library Services

Describe and evaluate the capability of the library (or libraries) to serve the program including the adequacy of the library’s technical collection relative to the needs of the program and the faculty, the adequacy of the process by which faculty may request the library to order books or subscriptions, the library’s systems for locating and obtaining electronic information, and any other library services relevant to the needs of the program.

**E.1. Library Staffing**

The FIU University Library system includes four individual libraries and several service centers. The Green Library at the Modesto A. Maidique Campus houses the majority of the research and archival collections, including the Sound & Image Department, Special Collections & Archives, Government Information, and the Digital Collections Center. The Hubert Library at the Biscayne Bay Campus primarily consists of undergraduate-level materials, with focused research collections for degree programs hosted at BBC. The College of Law Library and College of Medicine Library are located on the Modesto A. Maidique Campus; their primary clientele are students in the respective professional programs.

The College of Engineering & Computing is primarily served by the Green Library, located on the Modesto Maidique Campus. The Green Library houses undergraduate, research and archival collections, including the Sound & Image Department, Special Collections & Archives, Government Research Information Department and the Digital Collections Center. During the Fall and Spring semesters, the Green Library is open 24 hours, Monday through Friday, and holds weekend hours. During the summer sessions, the library is open approximately 92 hours a week. A librarian-monitored webchat is available approximately 60 hours a week. The CATS Bus shuttle system runs between the EC and MMC on a regular schedule.

Library staff across the FIU Libraries system includes the FIU Dean of Libraries, two Associate Deans, over 39 specialized librarians, and over 61 technical staff. They provide excellent professional service to the entire FIU community including the College of Engineering and Computing (CEC) programs. A complete listing of library personnel is available at <https://library.fiu.edu/about/staff-directory>.

In addition to the services provided to the entire FIU community, the FIU Libraries staff includes the following librarians and other personnel who work closely with, and provide specialized services to CEC departments.

* The Science and Engineering Librarian, with over 22 years of experience, provides reference, research assistance, instruction and other direct services to faculty and students; works on developing and managing the FIU Libraries collections and online resources in the engineering area; and serves as liaison between the FIU Libraries and the College of Engineering and Computing. The Science and Engineering Librarian participates in the Library Committee of the College of Engineering and Computing.
* The Collection Development Librarian, with 20 years of experience, collaborates with the Science and Engineering Librarian and CEC faculty to assess and strengthen the FIU Libraries collections and online resources in allthe areas of engineering and computing..
* The Department Head of Access Services, coordinates access services (e.g. circulation and course reserves) to the CEC including Interlibrary Loan and Intercampus Loan services.
* The Department Head of the Geographic Information Systems/Remote Sensing Center, with over 20 years of experience, provides consulting services and collaborates with CEC faculty BME faculty and students on grant proposals and special projects employing GIS and RS technology and software.
* Online Learning Librarian, with over 18 years of experience, coordinates library services for students and faculty participating in online engineering and computing courses.

All FIU librarians are members of the FIU faculty and are required to hold a master’s degree from an American Library Association-accredited program. Accreditation is in accordance with the Association of College and Research Libraries standards which state that “the master’s degree in library science from a library school program, accredited by the American Library Association, is the appropriate terminal professional degree for academic librarians”.

FIU librarians have academic (non-tenured) status with a well-defined process for promotion in rank from Instructor to University Librarian. Position descriptions are up to date, with each librarian required to complete an annual assignment and work plan at the beginning of the academic year and an annual report, updated curriculum vitae, and evaluation process at the end of the academic year. About half of the librarians have a second masters degree. Technical staff members are also required to complete an annual review process.

**E.2. Library Technical Collection**

The combined holdings of the FIU University Libraries consist of approximately 2 million volumes, across physical and electronic mediums—along with substantial collections of federal, state, local, and international documents. In terms of electronic collections, the library has online access to articles from more than 120,000 journals, 418,000 electronic books, 500 databases, and 25,000 online streaming videos.

The library’s resource budget is financed in the Education & General category through Academic Affairs. The numbers below show a five-year overview of the resource budget:

FY17 – 2016-2017 $7,556,275.71

FY18 – 2017-2018 $7,934,330.85

FY19 – 2018-2019 $7,852,169.77

FY20 – 2019-2020 $7,885,773.47

FY21 – 2020-2021 $7,838,476.05

**Monographic Materials.** The library’s approval plan gives broad subject coverage across the disciplines studied at FIU. For all Science and Engineering subjects, the approval plan covers university press titles. The library currently has an e-preferred plan for delivery of titles in the sciences and engineering; for this plan, the electronic book is purchased instead of a print book if the e-book is published within 8 weeks of the print run. This reduces the workflow of cataloging, shelfing, and transporting print materials and also allows broader access to students regardless of their location and time schedule.

The FIU Libraries have been increasing the number of contracts with electronic book providers for the past several years, especially in the fields of Science, Engineering and Technology. The library currently has access to over 215,000 online books, including general titles, reference resources, and specialized collections. Electronic collections include titles by Elsevier, Emerald, Springer, Wiley, Taylor & Francis and Gale as well as aggregate collections from EBSCO, EBL, and ebrary. The vast majority of FIU’s electronic book collections have been published within the last 15 years. The Library also has a subscription to the ASTM Standards and Engineering Digital Library.

In 2014 the library also began demand-driven acquisitions programs through several vendors. These programs allow the library to provide catalog records and access to a large number of electronic books, but a purchase of the book is initiated only if it is utilized by the library patrons. To date more over 30,000 titles have been made accessible through the demand-driven program, with approximately 2,000 titles having received sufficient use to warrant a purchase.

**Reference materials.** Engineering reference materials are primarily purchased in online format but may be physically housed at the Green Library or ELS if no electronic format is offered. Hundreds of individual online STEM reference titles, such as the Encyclopedia of Tissue Engineering and Regenerative Medicine and the Handbook of Nanoscience, Engineering, and Technology, as well as online reference collections such as CredoReference and Gale Virtual Reference Library offer easy access to extensive content in all areas of STEM.

**Conference Proceedings.** FIU’s access to the following online series includes conference proceedings across various Engineering disciplines.

**Online Databases.** The library’s collections of databases and other online resources, about 500 in number, adequately cover the needs of all the engineering and computing programs. Subscribed databases include: *Scopus, Derwent Innovations Index, ACM Digital Library* (includes *Computing Reviews* and the *ACM Guide to Computing Literature*), *Computer and Information Systems Abstracts*, *Gale Computer Database, IEEE/IET Electronic Library, Applied Science and Technology*, *Current Contents Connect,* *ProQuest SciTech Collection*, *INSPEC*, *NTIS,* *Electronics and Communications Abstracts*, *Engineering Index* (Compendex), *EI Village*, *MathSciNet*, *ANTE: Abstracts in New Technologies and Engineering*, and *Web of Science Core Collection*.

**Streaming Video Resources.** The FIU Libraries have an expanding collection of streaming videos, which can be accessed on or off campus, available in a variety of subject areas Approximately 25,000 titles are currently available. The primary streaming services are FMG *Films on Demand Academic Master Collection* and assorted collections from Alexander Street Press. Currently there are approximately 24,000+ videos listed for engineering and computing.

In 2015 the library also began a demand-driven acquisitions programs for streaming videos through Kanopy. Similar to the e-book demand driven programs, this service allows the library to provide catalog records and access to over 20,000 videos, but a license for the video is initiated only if utilized by the library patrons.

**Journals.** The FIU Libraries have access to articles from over 75,000 online journals through various vendors. Online journal content can be accessed from the library catalog or through the E-journal Portal, which utilizes the SerialsSolutions platform. Although many of the online journals are available cover-to-cover, some titles may only have selective content available through aggregator databases. The library retains print subscriptions to titles that are either unavailable online or for which the cost for conversion to online is prohibitive.

The FIU Libraries have cover-to-cover subscriptions to titles in the following electronic journal packages of importance to all the engineering and computing: Elsevier ScienceDirect, SpringerLink, Wiley-Blackwell, ASCE Library, ASME Digital Collections, ACM Digital Library, IEEE/IET Electronic Library, INFORMS: Institute for Operations Research and the Management Sciences, Nature Online + Archive, Cambridge Journals Online, De Gruyter, IGI Global, and Emerald Press.

The Discovery service, Primo, which combines monographs and journals, reports the following subject areas and their respective journal counts:

* Science and Technology: 11,751,792
* Technology: 6,022,813
* Life Sciences and Biomedicine: 4,320,907
* Physical Sciences: 4,042,302
* Engineering: 3,681,283
* Exact Sciences and Technology: 2,663,681
* Computer Science: 1,268,123

**Purchasing Additional Materials.** The FIU Libraries endeavor to purchase all books requested by the faculty for their teaching and research needs, within certain parameters. As a general rule the library does not acquire textbooks, particularly at the undergraduate level. In addition, the Science and Engineering Librarian is granted an annual allocation to enhance the collection in accordance with user needs. Faculty and librarians may order books in either print or electronic versions via an online form at <https://poseidon.fiu.edu/libacq/facultyMaterialsRequestform.cfm>. The Science and Engineering Librarian is available to assist faculty with understanding the ordering and acquisitions processes and through the College of Engineering and Computing Library Committee solicits feedback and participation in the library’s acquisitions and serials purchases.

The recommendation for the acquisition of new journals and databases rests in the FIU Libraries’ Collections Advisory Committee. Faculty, with the assistance of their library liaison, may propose new resources to the committee. New recurring expenditure requests are closely scrutinized to determine the Libraries’ ability to maintain continuing access. License agreements are subject to the approval of the Office of General Counsel and University Purchasing Department.

**Reserve Services and Materials.** Course reserves for most materials are available online. Materials that cannot be placed on electronic reserve because of copyright or other digital limitations are housed at GL. Students are able to check out these materials for use within the building. Electronic reserve materials are available 24/7 on any Internet accessible computer in PDF format.

**Interlibrary (ILL), Intercampus (ICL) Loan Services and UBorrow.** The FIU Libraries have a daily courier service that provides Intercampus Loan opportunities between the various libraries. Intercampus delivery is available for print and audiovisual materials, including books received from other libraries through interlibrary loan. Materials may be shipped to pick-up points at the Green Library, Hubert Library, or the FIU @ I-75 location. Books requested through Intercampus Loan are generally received within 24-48 hours of the request. Articles in electronic format are delivered to patrons’ desktops in PDF format.

The FIU Libraries are a member of a number of resource-sharing networks for Interlibrary Loan, including: RAPID ILL, Florida State University System Libraries, Southeast Florida Library Information Network, Association of Southeastern Research Libraries, Center for Research Libraries, LYRASIS, and the Global Interlibrary Loan Framework (for Asian materials). The FIU Libraries generally use ILLIAD and Odyssey services to deliver materials electronically to patrons. The Florida State University System has a patron-initiated borrowing service called UBorrow. UBorrow allows patrons from FIU to request a book loan from other State University System libraries without mediation by library staff. The estimated turnaround time for non-returnables (mainly books) is approximately 3-5 days, regardless of originating location.

**CEC Library Committee.** The library committee of the College of Engineering and Computing (CEC) provides a forum where representatives from each CEC unit, including the department of Biomedical Engineering (BME), provide input on how library services may be tailored to the needs of the CEC units. The CEC Library Committee is chaired by an elected CEC faculty member for a period of two years, and committee membership includes the Science & Engineering Librarian. The CEC Library Committee chair represents the CEC on the University Faculty Senate Library Committee and reports to the CEC Faculty Council. The BME faculty representative on the CEC library committee assists BME faculty members and students with their questions or concerns with respect to library operations. The representative may liaise with appropriate library personnel for assistance, or may raise these concerns at the CEC Library Committee meetings. The CEC Library Committee has been an essential collaborator in developing the collections and improving services that benefit BME faculty and students, as well as coordinating forums for the Science & Engineering Librarian to inform faculty and students of available resources and services.

**E.3. Library Electronic Access**

The FIU Libraries’ collections of databases and other electronic resources are available at all times from all on-campus and off-campus locations. Off-campus access is provided through a user-authentication proxy server. An “Off-Campus Access” button linked to the authentication login page is prominently displayed on all library web pages.

From the FIU Libraries main page at <http://library.fiu.edu>, users can access all the tools needed to do research and access information. These include the catalog, course reserves, research and subject pages where databases are listed, online reference services, interlibrary and intercampus loan services, and more.

The catalog allows users to search and locate/access the FIU Libraries’ extensive collection of print and electronic books, serials, indexes and databases, as well as multimedia resources, government documents, FIU thesis and dissertations, and special and digital collections representing a variety of subjects, and covering all FIU academic programs including Engineering. The catalog also contains records for all materials in the Center for Research Libraries (Chicago) collection, the Eastern Academic Scholar’s Trust (EAST), and serves as a gateway to the holdings of Florida’s eleven State University Libraries, all of which are available via interlibrary loan.

Databases, electronic journals and books, and other online resources are not only accessible through the catalog, but also through the Research portal of the FIU Libraries main page. The Research portal allows students to locate and access all online resources by title, subject and other criteria. e-Book links from the Research page allow users to search specific collections of electronic books from EBSCO, ProQuest, JSTOR, and other providers. The e-Journal Portal link from the Research page allows users to directly access e-journal collections such as ACM Digital Library and IEEE/IET Electronic Library (IEL).

Many of the databases (indexes) of journal articles to which the FIU Libraries subscribe offer at-least some full-text content. In most databases, articles that are not available in full text will have a visible FindIt@FIU link. The link opens a window allowing users to easily access articles that are available electronically at FIU, to search the catalog to see if the article is available in print, and to submit interlibrary loan requests for those articles not available at FIU. The same FindIt@FIU functionality is available on the FIU Libraries main page via Citation Linker for users who already have an article citation and wish to obtain access to the article without searching the databases.

Access to materials owned by the FIU Libraries, but not located at the Green Library, can be requested online via Intercampus Loan. Journal articles will be delivered to the user via email, while other materials will be transferred to the Green Library. Access to materials not owned by the FIU Libraries can be requested online via Interlibrary Loan. Journal articles will be delivered to the user via email, other materials will be transferred to the Green Library. Access to both the Interlibrary Loan and Intercampus Loan request forms is available from the FIU Libraries main page.

Reference services and research assistance are available via phone, email and chat services, as well as in person. Access to these services and details such as instructions, hours and contact information are available on the Ask Us portal of the FIU Libraries main page. The Science & Engineering Librarian offers individualized and group instruction in the use of databases, electronic journals and other resources.

The Geographic Information Systems (GIS) and Remote Sensing (RS) Center, located in the Green Library, was established in 1995. It supports research and teaching from many academic units in the areas of computerized cartography, GIS, RS, 3-D visualization, and spatial statistical analysis and modeling. The GIS-RS Center hosts all GIS and RS courses required for completion of the graduate and professional levels of the "GIS Certificate Program". The Center also serves as a geo-spatial data depository for South Florida and Latin America and Caribbean region.

# CRITERION 8. INSTITUTIONAL SUPPORT

## *Leadership*

Describe the leadership of the program and discuss its adequacy to ensure the quality and continuity of the program and how the leadership is involved in decisions that affect the program.

The leadership of the program and the university are adequate to ensure the quality and continuity of the program.

**Chief Executive Officer**: Kenneth A. Jessell, PhD, Interim President (since Jan 2022)

**Chief Academic Officer:**

Elizabeth M. Bejar, PhD, Interim Provost and Executive Vice President (Effective Mar 1, 2022)

**Official submitting completed questionnaire:** Dr. John Volakis, Dean and Professor, College of Engineering and Computing. The Dean of Engineering and Computing provides leadership in the college.

**Chairperson of the Department:** Dr. Jorge Riera-Diaz

The Chairperson has the ultimate leadership responsibility for all academic programs. Annual teaching assignments are determined by the chair in consultation with the undergraduate and graduate advisors and the faculty. The number of courses assigned to each faculty is allocated based on the curriculum needs of the department and individual faculty needs for significant academic year effort on extramural grants. Dr. Ranu Jung was the department chair from 2011 to December 2021. Dr. Riera-Diaz was appointed interim chair in mid-December 2021.

**Undergraduate Director of the** **Department:** Dr. Anuradha Godavarty

The Undergraduate Program Director works closely with the Department Chair and the Undergraduate Program Committee, which comprises the Undergraduate Program Director, the undergraduate advisors, and multiple members of the faculty. Curriculum changes proposed by the Undergraduate Program Committee are discussed among the entire faculty during a meeting. If approved, curriculum changes are then sent to the College Curriculum Committee, and ultimately to the Dean and the University Curriculum Committee for approval before program changes can be implemented. The Department Chairperson has management responsibilities for this entire process, relying on the Undergraduate Program Director for assistance.

## *Program Budget and Financial Support*

1.Describe the process used to establish the program’s budget and provide evidence of continuity of institutional support for the program. Include the sources of financial support including both permanent (recurring) and temporary (one-time) funds.

The Department of Biomedical Engineering (BME) receives an annual budget allocation from the College of Engineering and Computing, which receives its annual budget from the Florida International University (FIU) Academic Budget office based on a university-wide budget model. This model allocates funding for each unit based on the unit’s needs and size, the university’s goals and priorities, and the unit’s overall success as measured by various metrics, including number of FTEs generated, PhD production, external funding acquired, graduation rates, and other such factors. This permanent Education & General source of funding includes salary for faculty and staff, as well as discretionary spending that includes all other expenditures of the department (support of graduate students, salaries for adjunct instructors, laboratory maintenance and upgrade, faculty support, and so on).

Since 2013, the State University System of Florida under the direction of the Board of Governors implemented a performance-based funding model. In this model, allocation of funds from the state is calculated based on numerous performance metrics related to student success.

**Table 8.1** below includes top-level details of our College of Engineering and Computing’s overall budget for 6 years, from 2018 to 2023.

**Table 8.1: College of Engineering and Computing Budget**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Fiscal Year** | **2018-2019 1** | **2019-2020 2** | **2020-2021 3** | **2021-20224** | **2022-2023 5** |
| **Expenditure Category** |  |  |  |  |  |
| Operations (not including staff)6 | 1,598,608 | 1,567,553 | 1,802,611 | 2,191,498 | 2,191,498 |
| Travel7 | 505,613 | 368,273 | 38,803 | 216,264 | 216,264 |
| Equipment8 |  |  |  |  |  |
| (a) Institutional Funds | 548,949 | 317,149 | 411,053 | 924,877 | 924,877 |
| (b) Grants and Gifts9 | 740,149 | 776,949 | 1,905,035 | 4,649,232 | 1,058,753 |
| Graduate Teaching Assistants | 2,628,820 | 3,051,141 | 2,346,542 | 2,361,374 | 2,361,374 |
| Part-time Assistance10  (other than teaching) | 1,129,481 | 1,020,124 | 984,928 | 1,257,204 | 1,257,204 |
| Faculty Salaries | 28,841,718 | 25,443,380 | 26,026,866 | 26,688,544 | 26,688,544 |

**Notes (these same notes apply to all expenditure below for each program or department):**

1. Provide the statistics from the audited account for the fiscal year completed 3 years prior to the current fiscal year.
2. Provide the statistics from the audited account for the fiscal year completed 2 years prior to the current fiscal year.
3. Provide the statistics from the audited account for the fiscal year completed year prior to the current fiscal year.
4. This is your current fiscal year (when you will be preparing these statistics). Provide your preliminary estimate of annual expenditures, since your current fiscal year presumably is not over at this point.
5. Provide the budgeted amounts for your next fiscal year to cover the fall term when the ABET team will arrive on campus.
6. Categories of general operating expenses to be included here.
7. Institutionally sponsored, excluding special program grants.
8. Major equipment, including equipment used for education and research.
9. These funds were used to buy equipment for research purposes, but the equipment can also be used by undergraduates for educational purposes, as well.
10. Does not include graduate teaching and research assistant or permanent part-time personnel.

**Table 8.2** below includes top-level details of the BME departmental budget for 6 years, from 2018 to 2023.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Fiscal Year** | **2018-2019 1** | **2019-2020 2** | **2020-2021 3** | **2021-2022 4** | **2022-2023 5** |
| **Fund Type** | **Expenditure Category** |  |  |  |  |  |
| Recurring Funds | Operations (not including staff)6 | 18,752 | 44,597 | 73,192 | 73,007 | 73,007 |
| Travel 7 | 18,627 | 7,528 | 1,938 | 11,557 | 11,557 |
| Equipment8 |  |  |  |  |  |
| (a) Institutional Funds | 0 | 0 | 10,530 | - | - |
| (b) Grants and Gifts9 | 61,315 | 74,970 | 20,703 | 158,654 | 15,296 |
| Graduate Teaching Assistants | 254,523 | 339,532 | 224,897 | 275,832 | 275,832 |
| Part-time Assistance10  (other than teaching) | 17,163 | 3,916 | 8,115 | 2,118 | 2,118 |
| Faculty Salaries | 2,458,204 | 2,439,321 | 2,372,994 | 2,134,506 | 2,134,506 |
| Temporary funds | Startup | 536,383 | 225,498 | 106,460 | 214,886 | 214,886 |
|  | One-time funds (ABET)11 | - | - | - | 11,419 |  |

**Table 8.2: Department of Biomedical Engineering Budget**

1-10 As given for Table 8.1.

1. Non-recurring temporary funds allocated to each department, based on requests from the Chairperson and approval by the Dean. These funds provide extra support for undergraduate lab improvements, equipment, and furniture.

The BME department has received adequate funding in the past six years to support all its operations, including those necessary for the Bachelor of Science in Biomedical Engineering (BSBME) degree program. There are ample discretionary funds available for the administrators to support the program, and as all three sources of funding are essentially permanent, we expect to have continued support of the university administration to support our operations.

**B.1 Additional financial support via Coulter Endowment Funds**

The various forms of financial support to the BSBME program and the undergraduate students via the Coulter Endowment Funds in the BME department are given below and summarized in **Table 8.3**.

1. BME Undergraduate Excellence Scholarship: Students selected for a Biomedical Engineering Excellence Scholarship receive $5,000 over two years. Approximately ten undergraduate students are supported annually.
2. Coulter Seminar Series: The Coulter Biomedical Engineering Lecture Series Endowment has supported over 80 lectures in the Department since its inception. Lectures are attended by graduate and undergraduate students, faculty from across the University and industry partners. The complete list of invited lecturers can be found at <https://bme.fiu.edu/seminars/>. Funds are also used to promote the department and the lecture series through the BME newsletters, college-wide emails, and/or social media.
3. BME staff support: BME staff on temporary positions (or OPS) are hired for marketing, social media updates, and maintenance of the BME department website.
4. CURE Program: The Coulter Undergraduate Research Experience (CURE) program for BSBME students supports students via paid research experiences in BME faculty’s laboratories.
5. The annual BME undergraduate research day and CURE induction ceremony is funded by Coulter Endowment funds as well.

**Table 8.3 Additional BME Coulter Endowment budgets (2018-2023)**

Table

Description automatically generated

**Sources of Financial Support**

The BME program has five main sources of funds to support operations, travel, and equipment:

* Annual allocation of state funds to the department is shown in **Table 8.2**.
* Returned overhead from research contracts and grants. Principal investigators (PIs) will receive 5% of the F&A (facilities and administrative costs) produced by their grants. PIs can decide to share the F&A component of the bonus with the coinvestigators in the respective grants. Faculty will receive 10% of the salary savings amount produced by effort charged\* to externally funded grants. \*Academic year effort for faculty with 9-month assignments and calendar year effort for faculty with 12-month assignments (<https://research.fiu.edu/ored/faculty-research-incentive-plan/>)
* Faculty release funds from contracts and grants occurring during the nine-month academic year are partially returned to the department. The department policy is to return this portion to the faculty for use in their research and professional development.
* A College of Engineering and Computing lab fee is charged at $15-70 per lab course. These funds must be spent on supplies (including software) and provide the sustaining funds for upgrades and maintenance of the department’s instructional laboratories.
* Supplemental funds from the Wallace H. Coulter Foundation Endowment to the department allow support of laboratory supply and equipment, student scholarships, the Senior Design Expo and Undergraduate Research Day, seminar series, student society support and faculty development. The funds allocated vary from year-to-year. (Give average +/- SD in each category

Therefore, a total budget (excluding salaries) from the College of Engineering and Computing of about $73K is available each year to fund the operations, travel, and equipment needs of the department. However, this amount does not include all the money spent on instructional activities in the department, as explained below.

Besides, this we have a budget of $255,400 for other part-time services that include adjuncts, graduate assistants, and speakers.

The purchases, maintenance, upgrades, administration, and technical support for computer labs is centralized through the Engineering Information Center, substantially reducing the departmental requirement for funds to maintain computer labs and software. The department does need to maintain computers and software in its undergraduate experimental labs, design labs (at a smaller scale) and the graduate research labs and for faculty use for curricular activities. Consequently, the department does not need to hire its own network/software specialist(s) or even maintain an inventory for computer labs.

The above budget process allows the college and the departments to manage and deliver a high level of educational programs (undergraduate and graduate) offered by the department. Our university and college financial structure:

1. Provides for basic operations through a reliable, annual state allocation;
2. Reduces loads on the department to maintain its computer labs including hardware and software purchases, upgrades and support;
3. Provides for equipment upgrades and maintenance through a fee structure related to student credit hours and/or labs;
4. Makes need-based money available for major purchases, upgrades and renovations/refurbishing;
5. Provides incentives for faculty contract and grant research effort that rewards both the Department and the individual faculty member who secure research funds for the institution.

**B.2. Teaching Support by Institution**

Describe how teaching is supported by the institution in terms of graders, teaching assistants, teaching workshops, etc.

At the institutional level, there exists the Center for Advancement of Teaching (CAT) (<http://undergrad.fiu.edu/cat/>) which assists faculty members in various mechanisms and techniques that can be used in the classrooms. It provides many faceted services:

1. Workshop Series: Many workshops are organized to address fundamentals of effective classroom teaching, exploring new ideas and pioneering learning strategies, best practices in teaching, and dealing with institutional changes that faculty confront, e.g., large class sizes.
2. New Faculty Orientation: In the August orientation of new faculty, the center participates by providing a smooth transition to teaching for the new faculty.
3. Faculty Learning Groups: CAT facilitates the convening of small groups of faculty from across the disciplines to explore, apply, or extend the current research on learning.
4. Teaching Assistant Certification: This program is intended to equip graduate teaching assistants (GTAs) with the important basic skills for successful college teaching.
5. General Teaching Assistance: CAT assists faculty members in the redesign of a course or syllabus. Staff also discuss teaching challenges and possible solutions, collaborate as they explore teaching innovations, assist with designing new assessment measures, and so forth.
6. Teaching Observations: CAT staff can visit one’s class and respond to the learning environment, helping the instructor to gauge the levels of student engagement.

Beyond the resources just discussed, the department is generously allocated funds for graduate teaching assistants (GTAs).Tuition of all GTAs is paid for by the college through a combination of its own funds and a special allocation from the university for this purpose. The college has also been allocated fifty Latin American and Caribbean Scholarships requiring graduate students to pay only in-state tuition. For highly qualified students, a portion of the tuition can also be reimbursed in lieu of the students’ contributing to the departmental activities, including instruction. Many of these special opportunities for engineering students have been created because engineering education and research are considered top priorities of FIU. Currently, the university is emphasizing the expansion and enrichment of graduate education and research in science and engineering and it is making significant investments in this area. The department believes that the investment in graduate assistantship and research infrastructure significantly improves the quality of undergraduate education and enhances undergraduate research opportunities.

Every semester, the department’s endowment fund from Wallace H. Coulter Foundation provides a supplement to the final semester of the PhD students after they complete the dissertation year fellowship. These students support the department with teaching assistants (TA) and/or grading activities for BSBME undergraduate courses. The endowment has been a vital source, providing supplemental operational support for the department. We have been able to create marketing materials highlighting our achievements and recognizing the outstanding faculty and students. The endowment funds also supported the purchase of office furniture, computers, equipment, and supplies for incoming PhD students, who also serve as teaching assistants as needed.

**B.3 Resources to acquire, maintain, and upgrade infrastructures and facilities**

To the extent not described above, describe how resources are provided to acquire, maintain, and upgrade the infrastructures, facilities, and equipment used in the program.

A list of all equipment we currently use in the program is included in Appendix C (Equipment). Resources are summarized below.

The Biomedical Engineering Excellence Fund supports the general enhancement of FIU’s biomedical engineering education and research programs. For example, funds have been used to purchase major pieces of equipment that support both research and teaching such as:

* 2760VA (2484 Watts) Line Interactive Sinewave
* Core cell facility water filter
* Phase Contrast ADM ELWD 40x Ob, TE-C
* Phase Condenser product#M

Additional resources to acquire, maintain, and upgrade infrastructures and facilities include:

* One-time funds from Dean’s office for upgrade facilities prior to ABET visit - $11,419.00.
* BMES Undergraduate Travel Funds- $8,000 per year is allotted towards BME promotional activities with emphasis to recruit new students.
* Coulter Seed Funds were granted towards research projects, which could be used towards acquiring and maintaining facilities and/or equipment in the respective research laboratories, where undergraduate students also take part via the CURE program to do research.

*Funded by legislative appropriations, university budget, and private sources, FIU is currently in the process of constructing a new Engineering Building that will allow the expansion of the College of Engineering and Computing. Biomedical Engineering is expected to have significant space in this new building.*

**B.4. Adequacy of the resources**

Assess the adequacy of the resources described in this section with respect to the students in the program being able to attain the student outcomes.

For the period of this self-study, fortunately, our budget has been quite adequate to allow us to offer our entire curriculum as per the student needs and as dictated by increasing enrollments. The department budget, allocated by the College of Engineering and Computing and supplemented by the Wallace H. Coulter Endowment, is adequate to achieve the Educational Objectives of this program.

## *Staffing*

Describe the adequacy of the staff (administrative, instructional, and technical) and institutional services provided to the program. Discuss methods used to retain and train staff.

The BME program has adequacy of staff at all levels (university, college, and departmental) to support the program. The support received from campus organizations is considered to be adequate, reasonably available, and professional. These services provide adequate support to the faculty, staff, and students to meet the program objectives and learning outcomes described in Criterion 2 and 3, respectively. The staffing details across the various levels and type (administrative, instructional, and technical) are described in the following section.

**C.1 Staff at College, School, and Department Level**

Professional staff in the College of Engineering and Computing provide overall support to the department, besides the three staff members allocated to the department. The professional staff of the Office of the Dean assists with all administrative matters associated with each program and assures continuity of the programs.

**College of Engineering (Administrative)**

Director for Engineering Information Center, Steven Luis,

Executive Director for Development, Jamie Diptee-Bay

Assistant Director for Graduate Affairs, Mais Kayyali

Associate Director of Finance and Personnel, Adriana Marques

Associate Director of Academic Support Services, Bethania Cabrera

Assistant Director for Research Grants, Maria Benincasa

**School Staff (Administrative)**

The School of Biomedical, Materials, and Mechanical Engineering (BMME) at FIU engages the regional, national, and international engineering and science communities towards innovative and transformative discovery and technology development. The new school combines one of the oldest engineering disciplines (Mechanical) and two of the newest (Biomedical and Materials) providing a platform for multidisciplinary and transdisciplinary research and knowledge generation as well as graduate and post-graduate education and to facilitate the conduct of collaborative projects across colleges, universities, industry, and government agencies.

Mabel Fernandez, MBA (50%): Coordinator for the School of BMME; in charge of all departmental business, accounts management, purchasing, outreach, and support to the chair for departmental operations.

Karine Smith (50%): Program specialist for the School of BMME; in charge of all arrangements for departmental meetings, seminars, conferences, visiting lectures presentations, awards ceremonies, and other special events.

Keshmattie Jeewan (50%): Office specialist for the School of BMME; serves as primary contact for travel arrangements and purchases made though the university's financial system.

**Departmental Staff**

The BME department has two full-time career service employees who are responsible for the operations of the department, as well as the maintenance of teaching laboratories. This staffing is sufficient to serve the needs of the BSBME program.

***Administrative***

Claudia Estrada: Senior secretary; in charge of processing textbook ordering, classroom scheduling, student records, answering phone calls, calendars.

***Instructional and Technical Staff***

Yun Qian, PhD: Instructional laboratory manager; in charge of maintenance of all BME teaching laboratories, overseeing the laboratories and assuring laboratory regulatory compliance, developing standard operating procedures and laboratory manuals, and providing technical support in instructional lab projects.

**Student Advising Staff**

The entire university has moved from departmental advising to using dedicated advisers at departmental or college levels. We have a group of six professional departmental advisers who support advising function for all our undergraduate students.

**C.2 Adequacy of Support Personnel and Institutional Services**

In addition to the above full-time employees at the college and department level that provide support for operations, approximately 9.1 GTAs are currently working in the department. These students are responsible for assisting faculty in teaching the laboratory sections, grading papers and exams and in conducting problem-solving sessions for various courses. We have adequate GTAs to assist our faculty in the BSBME undergraduate courses.

FIU also provides a wide variety of other comprehensive support functions that successfully ensure the operation of the department and facilitate the achievement of our program objectives. The staffing resources and the institutional services provided by these various support functions are adequate for our program. Examples of these support functions are:

1. FIU Libraries. Support functions include those of the FIU Libraries, which are described in detail in Criterion 7. We have a dedicated science and engineering librarian. Staff resources are adequate. The combined holdings of the FIU Libraries consist of approximately 2 million volumes, across physical and electronic mediums—along with substantial collections of federal, state, local, and international documents. In terms of electronic collections, the library has online access to articles from more than 120,000 journals, 418,000 electronic books, 500 databases, and 25,000 online streaming videos. The FIU Libraries’ collections of databases and other electronic resources are available at all times from all on-campus and off-campus locations. Off-campus access is provided through a user-authentication proxy server. An “Off-Campus Access” button linked to the authentication login page is prominently displayed on all library web pages. From the FIU Libraries main page at <http://library.fiu.edu>, users can access all the tools needed to do research and access information. These include the catalog, course reserves, research and subject pages where databases are listed, online reference services, interlibrary and intercampus loan services, and more. The College of Engineering & Computing is primarily served by the Green Library, located on the Modesto Maidique Campus. The Green Library houses undergraduate, research and archival collections, including the Sound & Image Department, Special Collections & Archives, Government Research Information Department and the Digital Collections Center. During the Fall and Spring semesters, the Green Library is open 24 hours, Monday through Friday, and holds weekend hours. During the summer sessions, the library is open approximately 92 hours a week. A librarian-monitored webchat is available approximately 60 hours a week. The CATS Bus shuttle system runs between the EC and MMC on a regular schedule.
2. Division of Information Technology (DoIT). This unit is the central technology service provider at FIU. This unit provides instructional and open computer laboratories to all FIU students, faculty, and staff. The DoIT manages information technology facilities and services, including computer laboratories, technology-enhanced classrooms, remote application delivery, and kiosks. At the Engineering Center, there are eight computer labs, which are EC 2330, EC 2710, EC 2807, EC 2830, EC 2832, EC 2840, EC 3239, and EC 3278. Staff resources from DoIT are adequate.
3. Honors College. This college is a community of outstanding students and dedicated teachers and scholars. Students may pursue almost any major and complete the honors curriculum. The Honors College also offers four study abroad programs and manages the National Student Exchange Program. The staffing resources of Honors College and the services provided by this college to meet our students’ needs to complete the honors curriculum is adequate.
4. Career Services and Internships. This support unit works with students at all stages of their career development to enhance their access to information and opportunity as it pertains to the world of work. Staff resources and support from career services and internships unit is adequate.
5. Health Care and Wellness Center. This center provides access to quality health care to the FIU community and encourages healthy life styles through health promotion and education.
6. Office of Disability Services. This office seeks to assure the human, educational and legal rights of individuals with disabilities.
7. The Women’s Center. The center provides women with programs and services related to their intellectual, professional, social and emotional growth.
8. University’s Learning Center. The center provides academic enhancement resources and activities for the entire FIU community. Instructors and tutors help students improve their skills in mathematics and statistics, reading, oral presentation, writing, test-taking, and study skills.
9. Environmental Health & Safety and Risk Management. This department provides the leadership and direction necessary to assure identification, implementation and effective administration of programs designed to promote hazard recognition, avoidance, reporting and control, as well as compliance with various federal, state and local regulations.
10. The Academy for the Art of Teaching. This academy is dedicated to supporting and advancing the quality of classroom teaching at FIU. It serves both as a resource to the teaching community and a source for proactive programming focused on enhancing approaches, methodologies, and practices of teaching.

**C.3** **Methods to retain and train staff**

For all instructional and office staff members (not including the academic advisors), the university provides a good benefit package and a competitive salary package to retain them. The university mandates at least 20 hours of professional development time per year for each member of the staff. There are many seminars/workshops/lectures etc., organized on work-related topics as well as general topics of interest, and each employee is free to choose whatever interests him/her. A complete list of all our Human Resources policies at the university level is provided in <https://policies.fiu.edu/search/?subject=64>.

In addition to traditional on-campus worksite location, management has the ability to implement flexible work arrangements to retain staff and maximize human capital, service delivery, and strategic operational needs, since 2021-2022 (see <https://hr.fiu.edu/flexible-work/>).

**Hybrid:** Employee’s work is performed in a combination of remote and on-campus location(s).

**Compressed Work Schedule Option:** Employee works their assigned number of hours in less than 5 days in one week, or fewer than 10 days in one pay period.

**Flexible Work Schedule (Flextime):** Employee’s starting or ending time may be flexible.

**Temporary Alternative Work Site (Flex Place):** Employee works at an alternative work site for a defined period of time. This remote work option ranges from two (2) weeks to six (6) months.

**Remote:** Employee’s work is performed 100% from an approved remote location.

## *Faculty Hiring and Retention*

**D.1 Process for hiring of new faculty**

FIU conducts its employment practices in accordance with established policies and procedures for employee hiring and advancement. Pursuant to Florida Statute 110.105(2)(a), FIU ensures that “all appointments, terminations, assignments, and maintenance of status, compensation, privileges, and other terms and conditions of employment in state government shall be made without regard to age, sex, race, color, religion, national origin, political affiliation, marital status, or disability, unless a specific requirement constitutes a bona fide occupational qualification.”

The United Faculty of Florida (UFF) represents FIU faculty members, bargaining collectively with the FIU Board of Trustees (BOT) to establish terms and conditions of employment. By law, the United Faculty of Florida is the sole representative of faculty employees designated as those within the bargaining unit Faculty hiring is facilitated by the Office of the Provost–Planning and Finance, which works in close collaboration with the Division of Human Resources and the Office of Inclusion, Diversity, Equity, and Access. As stipulated in the Faculty Human Resources Manual, the authority to hire faculty requires the approval of the dean of the college or school. The BOT–UFF Appointment policy establishes the procedures governing the appointment of faculty, and requires that written letters of offer include rank and/or title, employment unit, length of the appointment, duties and responsibilities, percent of assigned full-time equivalent, and total compensation.

**D.2 Strategies used to retain current qualified faculty**

In addition to offering sabbaticals, leave time for professional development and study, and faculty mentoring opportunities (described in the response to section E below), FIU utilizes strategies to retain current qualified faculty. The Office of the Provost regularly reviews faculty compensation with college leadership and annually includes phased retention plans in budget plans. Retention packages include support for faculty research, funding postdoctoral positions for faculty, lab renovations, and start-up funds.

FIU was named one of the best colleges in the nation to work for, according to a survey by The Great Colleges to Work For® program. The university also achieved honor roll designation, with recognition in 11 out of 12 categories. FIU has received honor roll designation every year since 2016.

## *Support of Faculty Professional Development*

Describe the adequacy of support for faculty professional development, how such activities such as sabbaticals, travel, workshops, seminars, etc., are planned and supported.

FIU seeks to FIU provides numerous professional development activities and programs for faculty as teachers, scholars, and practitioners. Professional development activities and programs are coordinated by departments and schools, and by other units and offices across the university, including the Center for the Advancement of Teaching, Educational Technology Services, FIU Online, the Office of Academic Planning and Accountability, and the Office of Research and Economic Development.

To encourage and support high-quality teaching, FIU provides professional development in pedagogy to all faculty members. Many of these opportunities are offered through the Office of the Provost and the Center for the Advancement of Teaching and include new faculty support, teaching assistant orientations, workshops, consultations, course observations, midsemester feedback sessions, and a Certificate in University Teaching and Learning.

The Office of Research and Economic Development offers professional development activities, programs, and incentives to support faculty members who are conducting research and engaging in creative activity. The office provides numerous in-person and online professional development opportunities and trainings; information about these opportunities is readily available to faculty members via a Researcher Resources webpage.

To support faculty as practitioners, FIU offers professional development through enhanced opportunities for professional renewal, educational travel, formal education, research writing, and other experiences of professional value that advance job-related skills and knowledge. FIU also provides study leave and retraining, supports faculty engagement in outside activities that provide service to the community and enhance the reputations of faculty members, and facilitates a mentoring program to ensure the professional success of faculty members.

To support faculty in preparing and teaching Hybrid (50% online and 50% in-person) and fully online courses, the FIU Online offers professional service and support to train faculty, and provide online teaching platforms and resources. FIU Online program (<https://fiuonline.fiu.edu/>) is ranked the best online programs for Bachelor’s in 2022, and also provides multiple-day workshops for certified hybrid courses (Provost initiative in the past few years) and remote teaching opportunities (began during the pandemic in Summer 2020). Online course designers are assigned to each individual faculty who offer Online and Hybrid courses at both the undergraduate and graduate level. The FIU Online compensates faculty (one time) when they are Certified as instructors eligible to teach Hybrid courses ($1500), and also compensates the faculty teaching Online courses (based on the enrollment).

***Professional Development Leave and Sabbaticals***

The Professional Development Leave and Sabbaticals Policy in the collective bargaining agreement between the Board of Trustees (BOT) and United Faculty of Florida (UFF), stipulates the terms of professional development leave and sabbaticals. Faculty with at least 6 years of full-time continuous service at FIU (except those serving in tenure-earning or tenured positions) are eligible to apply for professional development leave; tenured faculty with at least 6 years of full-time continuous service at FIU are eligible to apply for competitive or noncompetitive sabbaticals. The number of available professional development leaves and sabbaticals are stipulated in the collective bargaining agreement. Faculty who are not covered by the collective bargaining agreement (e.g., faculty members in the colleges of law and medicine) and who are not eligible for sabbaticals, but who have at least 3 years of full-time continuous service at FIU, are eligible to apply for professional development pursuant to FIU Policy 1710.260 Professional Development Leave.

Faculty are notified about eligibility and application deadlines for professional leave and sabbaticals through written communication sent annually by the Office of the Provost. All applications for professional development leave and sabbaticals are reviewed by a committee in accordance with the procedures outlined in institutional policy and the collective bargaining agreement. The provost reviews and approves professional development leave and sabbaticals upon review of the applications and committee recommendations.

Three BME faculty members were granted sabbatical and their accomplishments since the last re-accreditation visit. Brief details are given below:

* Dr. Nikolaos Tsoukias, Sabbatical training on microcirculatory experimentation at laboratories of Dr. Segal at the University of Missouri, Dr. Bezerianos at the University of Patras, Greece, and Dr. Nelson at the University of Vermont (2016-2017).
* Dr. Jorge Riera, Sabbatical at Yale University (Fall 2020). However due to the pandemic, the plans were changed and instead the publication of a book titled “*Biophysics of Brain Imaging: Modeling, Fusion and Data Analytics*” was the main objective of his sabbatical.
* Dr. Jessica Ramella-Roman, Sabbatical Ecole Polytechnique Paris France (2021-2022)

***Other Study Leave and Retraining***

FIU also provides other study leave and retraining opportunities when appropriate [BOT–UFF Professional Development Leave and Sabbaticals policy]. For other study categorized as job-required, opportunities involve taking academic coursework or participating in professional development activities as part of the faculty member’s assigned duties. With job-related study, a faculty member may be permitted to attend up to 6 credit hours of coursework per semester or participate in an equivalent number of hours of professional development during the workday, provided that (1) the study is directly related to the faculty member’s assigned responsibilities and (2) that his or her supervisor determines the study will not interfere with normal operation of the department or unit.

When appropriate and subject to the provisions of the collective bargaining agreement, FIU also provides opportunities for retraining, including opportunities to enroll in tuition-free courses, to attend on-campus workshops, and to participate in other training. Training provided by the university’s Office of Educational Technology Services comprises on-campus workshops that feature instruction in university-wide software applications and technologies (including the university’s online learning management system) and online trainings available through LinkedIn Learning, which seek to advance the business, technology, and creative skills of faculty.

Departments, colleges, and schools provide additional funding for travel related to scholarship and professional development.

***Faculty Mentor Program***

In response to faculty requests for more consistent career advice and mentorship opportunities, the Office to Advance Women, Equity, and Diversity established a Faculty Mentor Program, which seeks to support FIU faculty members in achieving professional success. Mentors and mentees are paired at the beginning of each academic year according to research interests and discipline. The Faculty Mentor Program hosts numerous events, including workshops and roundtable discussions, and keynote speakers.

**Workshops for Faculty Teaching Global Learning-Designated Courses and Faculty Developing/Revising Courses for Global Learning Designation**

The Office of Global Learning Initiatives (<https://goglobal.fiu.edu/index.html>) conducts professional development workshops to advance interdisciplinary, problem-centered learning in FIU’s global learning (GL) courses and activities. Workshops are for faculty who are developing or revising courses for GL designation and faculty teaching GL-designated courses. Participants explore FIU’s GL outcomes, authentic assessments, active learning strategies, and multi-perspective content that can be implemented almost immediately in courses and activities across the curriculum and co-curriculum (<https://goglobal.fiu.edu/faculty-staff/gl-course-designation/index.html>)

Lead faculty developing/revising a course to GL course receive a $500 extra-state compensation stipend for completing a workshop upon submission of a global learning course proposal to the Faculty Senate [Global Learning Curriculum Oversight Committee](https://facultysenate.fiu.edu/committees/global-learning-curriculum-oversight/) (GLCOC).

**Professional Development in Teaching**

The Center for the Advancement of Teaching, CAT (<https://cat.fiu.edu/>) recognize and cultivate learning-centered, evidence based, and inclusive teaching throughout the university. They help faculty harness the excitement and innovation of ground-breaking research and bring it to the classroom setting, where learning becomes the proper object of our study. They promote student success at FIU by supporting the faculty as they foster a culture of teaching excellence.

CAT provides monthly workshops to assist new faculty in their transition to teaching at FIU. Workshops are held twice, in order to accommodate most faculty schedules.

New Faculty in this program are engaged in a Faculty Learning Community, with multiple opportunities for mentorship, as well as observing each other’s teaching and the teaching of veteran faculty. The program assists new faculty (including adjuncts) with evaluating teaching resources, course design, honing their presentation and communication skills, classroom strategies and many other vital techniques. It also creates opportunities for reflection and formative self-assessment.

***Workshops for Career Development***

The Office of advance women, equity, and diversity or AWED (<https://awed.fiu.edu/>) conducts workshops towards faculty career development (<https://awed.fiu.edu/faculty-career-development/index.html>). These workshops include: Faculty Mentor Program, STRIDE Workshops: Hiring, Tenure & Promotion, Hiring Leaders, Diversity Advocates, Provost's Council on the Advancement of Women and Minority Faculty, FIU Women Faculty Leadership Institute, Bystander Leadership Program, ADVANCE Florida Network: FIU, UCF, and USF (towards travel amongst Florida based universities for professional development to women in STEM), AWED Theater, Faculty Fellows/Equity Advisors, and Diversity Mentor Professorships

# PROGRAM CRITERIA

Describe how the program satisfies any applicable program criteria. If already covered elsewhere in the Self-Study Report, provide appropriate references.

Program criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline. These student learning outcomes are addressed in a number of courses and the outcomes evaluated as described in Criterion 3. The second specific ABET program criteria for Biomedical Engineering requires that the program curriculum must include experience in: (a) Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics; (b) Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems; (c) Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes; and (d) Making measurements on and interpreting data from living systems.

**Breadth and Depth in Curriculum**

The structure of the curriculum must provide both breadth and depth across the range of engineering and science topics consistent with the Program Educational Objectives (PEOs) and Student Learning Outcomes (SLOs). The first specific ABET program criterion for BME requires that the structure of the curriculum must provide both breadth and depth across the range of biomedical engineering topics.

Breadth of coverage is ensured by requiring students to take a set of courses covering the three fundamental disciplines of engineering sciences (EGM 3503 Applied Mechanics, EEL 3110C Circuit Analysis/Lab, BME 3632 BME Transport), along with the fundamental biomedical engineering science courses of BME 1008C Intro to Biomedical Engineering, BME 1054L Intro to BME Computing, BME 3403 and 3404 Engineering Analysis of Biological Systems I and II.

Depth is ensured by requiring the students to take advanced engineering courses (such as BME 4100 Biomaterials Science); advanced courses in biomedical engineering design (BME 4503C Medical Instrumentation Design, BME 4800C Design of Biomedical Systems and Devices); and by carefully selecting 18 credit hours of advanced electives (with minimum 9 credits of Engineering topics) that will complement the individual interests of each student and add depth of coverage to the fundamental courses that define the program breadth.

Additionally, the electives have been categorized as (i) science (CHM 2211 Organic Chemistry II BCH 3033 General Biochemistry I, CHM 3120 Analytical Chemistry, CHM 4304 Biological Chemistry I, CHM 4307 Biological Chemistry II, MCB 3020 General Microbiology, PCB 3063 Genetics, PCB 4233 Immunology, PCB 4023 Cell Biology, ZOO 3753 Histology); (ii) tissue engineering/pre-med (BME 4332 Cell & Tissue Engineering, BME 4311 Molecular Engineering, BME 4230 Biomechanics of Cardiovascular Systems); (iii) biosignals and systems; (BME 4401 Medical Imaging, BME 4562 Biomedical Optics, BME 4422 Biophysics of Neural Computation, EEL 3135 Signals and Systems, EEL 3657 Control Systems I, EEL 4510 Introduction to Digital Signal Processing); and (iv) and biomaterials and biomechanics (BME 4311 Orthopedic Biomechanics, BME 4260 Engineering Hemodynamics, EGM 3311 Analysis of Engineering Systems, EGN 3365 Materials in Engineering, EML 3036 Sim Software for Mechanical Engineers, EML 4807 Introduction to Mechatronics).

**Biomedical Engineering Student Learning Outcomes**

The second specific ABET program criteria for Biomedical Engineering requires that the program curriculum must include experience in:

(a) Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics;

(b) Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;

(c) Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes; and

(d) Making measurements on and interpreting data from living systems.

This demonstration must come through student learning outcomes. For each of the requirements listed above, we will show the corresponding FIU BME student learning outcome and a list of courses that contribute to that outcome. The full demonstration then comes via measurement of those student learning outcomes (see Criteria 3 and 4 for those measures and measurement process).

**(a) Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics;**

1. Corresponding FIU BME student learning outcome:

Student learning outcome A: An ability to identify, formulate, and solve complex engineering problems (including those associated with the interaction between living and nonliving systems) by applying principles of engineering, physical (calculus-based physics, chemistry) and life sciences (biology, human physiology), and mathematics (through differential equations and statistics).

2. Primary courses that contribute to student learning outcome #1 and this ABET program criteria:

* Applying principles of biology and human physiology, and chemistry:
  + BSC 1010 General Biology I (and lab)
  + CHM 2210 Organic Chemistry I (and lab)
  + BME 3403 Engineering Analysis of Biological Systems I
  + BME 3404 Engineering Analysis of Biological Systems II
* Applying principles of calculus-based physics, mathematics (through differential equations) and statistics
  + PHY 2048, 2049 – Physics I w/Calculus, Physics II w/Calculus
  + MAC 2281,2282,2283 – Calculus for Engineers I, II, III
  + MAP 2302 Differential Equations
  + STA 3033 Introduction to Probability Statistics
  + ESI 3215 Evaluation of Engineering Data
  + EEL 3310 Circuit Analysis

Applied physical sciences (physics)

* + EGM 3503 Applied Mechanics

Applied physical sciences (physics)

* Applying principles of engineering
  + BME 1008C Introduction to Biomedical Engineering

Basics of biomedical engineering

* + BME 1054L Introduction to Biomedical Engineering Computing

Computing basics for biomedical engineering

* + BME 2740 Biomedical Engineering Modeling & Simulation

Numerical methods, calculus, differential equations, optimization

* + BME 3721 Biomedical Engineering Data Evaluation Principles

Applied statistics, quality control, design of experiments

* + BME 3632 Biomedical Engineering Transport

Applied physical sciences (physics and chemistry), differential equations

* + BME 3403 Engineering Analysis of Biological Systems I

Cellular biology and physiology applied to biomedical engineering

* + BME 3404 Engineering Analysis of Biological Systems II

Systems biology and physiology applied to biomedical engineering

* + BME 4800C Design of Biomedical Systems and Devices

Analysis and design solving problems at the interface of engineering and biology

* + BME 4050L Lab I

Analysis and solving problems at the interface of engineering and biology

* + BME 4051L Lab II

Analysis and solving problems at the interface of engineering and biology

* + BME 4503C Medical Instrumentation Design (now BME 4503C)

Analysis and design solving problems at the interface of engineering and biology

**(b) Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;**

1. Corresponding FIU BME student learning outcome:

Student learning outcome A: An ability to identify, formulate, and solve complex engineering problems (including those associated with the interaction between living and nonliving systems) by applying principles of engineering, physical (calculus-based physics, chemistry) and life sciences (biology, human physiology), and mathematics (through differential equations and statistics).

2. Primary courses that contribute to student learning outcome #A and this ABET program criteria:

* + BME 1008C Introduction to Biomedical Engineering

Basics of biomedical engineering

* + BME 2740 Biomedical Engineering Modeling & Simulation

Numerical methods, calculus, differential equations, optimization

* + BME 3721 Biomedical Engineering Data Evaluation Principles

Applied statistics, quality control, design of experiments

* + EEL 3310 Circuit Analysis

Applied physical sciences (physics)

* + EGM 3503 Applied Mechanics

Applied physical sciences (physics)

* + BME 3632 Biomedical Engineering Transport

Applied physical sciences (physics and chemistry), differential equations

* + BME 3403 Engineering Analysis of Biological Systems I

Cellular biology and physiology applied to biomedical engineering

* + BME 3404 Engineering Analysis of Biological Systems II

Systems biology and physiology applied to biomedical engineering

* + BME 4100 Biomaterials

Engineered materials in the human body

* + BME 4011 Clinical Rotations for BME

Clinical applications of biomedical engineering problems, along with interaction associated between living and non-living systems

* + BME 4800C Design of Biomedical Systems and Devices

Analysis and design solving problems at the interface of engineering and biology

* + BME 4050L Lab I

Analysis and solving problems at the interface of engineering and biology

* + BME 4051L Lab II

Analysis and solving problems at the interface of engineering and biology

* + BME 4503C Medical Instrumentation Design (now BME 4503C)

Analysis and design solving problems at the interface of engineering and biology

**(c) Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes.**

1. Corresponding FIU BME student learning outcome(s):

Student learning outcome B: An ability to apply engineering design to realize/produce solutions that meet specified biomedical engineering problems and needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

AND

Student learning outcome G: An ability to acquire new knowledge as needed, using appropriate learning strategies in acquiring techniques and skills necessary for biomedical engineering practice; including the ability to model and perform engineering analyses of biomedical devices, systems, components, and processes.

2. Primary courses that contribute to student learning outcome B and/or G and this ABET program criteria:

* + BME 1008C Introduction to Biomedical Engineering

Basics of design in biomedical engineering

* + BME 2740 Biomedical Engineering Modeling & Simulation

Modeling related to biomedical engineering systems, components and processes

* + BME 3632 Biomedical Engineering Transport

Modeling related to biomedical engineering systems, components, and processes

* + BME 4800C Design of Biomedical Systems and Devices

Analyzing, designing and realizing biomedical engineering devices, systems, components, and processes

* + BME 4051L Lab II

Modeling of biomedical engineering systems

* + BME 4908 Senior Design Project

Analyzing, modeling, designing and realizing biomedical engineering devices, systems, components, and processes

**(d) Making measurements on and interpreting data from living systems.**

1. Corresponding FIU BME student learning outcome:

Student learning outcome F: An ability to develop and conduct appropriate experimentation to measure, analyze and interpret data from living and non-living systems, and use engineering judgment to draw conclusions.

2. Primary courses that contribute to student learning outcome #1 and this ABET program criteria:

* BME 3721 BME Data Evaluation Principles
* BME 4050L Biomedical Engineering Lab I
* BME 4051L Biomedical Engineering Lab II
* BME 4908 Senior Design Project

1. **Assessment of Program Criteria**

Program Criteria are assessed using the primary outcomes measures of the Senior Design Faculty Evaluation, Senior-1 Faculty Assessment, Undergraduate Laboratory Evaluation and The Graduate Exit Survey, as described in Criteria 4 – Continuous Improvement (Tables **4.4-4.7**). Program Criteria are also assessed directly from student work in individual BME courses as second outcome measures, along with Senior Design Project External Evaluations, and Self-Assessment Surveys (as indirect secondary measure). The results of these assessment measurements are found in the student learning outcome folders.

# accreditation policies and procedures manual

Describe how instructional and learning environments used by the program (including facilities, tools, and equipment) are safe for their intended purposes. (See the 2021-2022 APPM Section I.E.5.b. (1).) Examples of information may include efforts to keep laboratories clean and free of hazards, student training, personal protective equipment used by students, safety policies and procedures, enforcement of safety policies, and routine safety inspections.

Centrally, safety of instructional and learning environments falls under the FIU Department of Environmental Health and Safety (EH&S). The Department of Environmental Health & Safety protects the university community and its environment by ensuring FIU operations – from residential living to lab research – comply with all applicable regulations and best practices. EHS's skilled team members are available provide consultation and hands-on assistance. The FIU Department of Environmental Health and Safety supports a range of safety programs designed to provide a foundation, clear guidance, and resources to protect our community and our environment and support our university's functions. Many of the programs, trainings, and resources offered by EHS are documented at ehs.fiu.edu.

Our undergraduate courses (with a laboratory component or laboratory-based courses) typically require the students to complete a list of online safety courses offered by EH&S as one-time or recurring (after a year or more as appropriate) prior to any hands-on experience. For example, students attending BME lab courses (4050L and 4051L) are required to complete the following online safety training courses 1) Laboratory Hazard Awareness, 2) Hazard Communications, and 3) Small Spills and Leaks at [<https://develop.fiu.edu/>](https://develop.fiu.edu/). All students shall earn a certificate in each course before they may participate in laboratory experiments. Upon successful completion of the course a page showing that the student has completed the material is displayed. Evidence of completion (completion certificate) shall be a print-out from the training website showing mastery of the course material and submitted in Canvas. The certificates may be used in any FIU lab as evidence of lab safety training for purposes of employment. All undergraduate students participating in research laboratories towards undergraduate research experience are expected to comply with the respective laboratory safety protocols, which may also include online safety trainings/certifications as appropriate to the research environment and needs. Details of all safety policies are available at the EH&S website (ehs.fiu.edu).

## SUBMISSION ATTESTING TO COMPLIANCE

Only the Dean or the Dean’s Delegate can electronically submit the Self-Study Report.

ABET considers the on-line submission as equivalent to that of an electronic signature of compliance attesting to the fact that the program has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET’s *Criteria for Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the ABET *Accreditation Policy and Procedure Manual.*