

February 8, 2019

TO: College of Arts and Sciences Curriculum Committee

FROM: Marc McEllistrem, Director
Materials Science Program

RE: Request for Authorization to Implement a New Program

We request approval of a new Comprehensive Major: Biomedical Engineering (Code XXX-XXX) beginning with the 2020 Fall Semester. The attached Request for Authorization to Implement the new major was approved by the Materials Science Program on February 8, 2019.

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**REQUEST FOR AUTHORIZATION TO IMPLEMENT A BACHELOR OF SCIENCE
DEGREE IN BIOMEDICAL ENGINEERING
AT UNIVERSITY OF WISCONSIN-EAU CLAIRE
PREPARED BY UW-EAU CLAIRE**

ABSTRACT

The University of Wisconsin-Eau Claire proposes to establish a Bachelor of Science in Biomedical Engineering (BME). The BME program is consistent with the goals of the university's Strategic Plan and Academic Master Plan, and with its mission to provide students with a rigorous, intentional, and experiential undergraduate education experience. The BME program will complement UW-Eau Claire's strong program array in the sciences and mathematics, including its existing Materials Science and Engineering (MS&E) curriculum and infrastructure. The new program will take full advantage of UW-Eau Claire's collaboration with Mayo Clinic Health System, which will provide BME students with access to clinically relevant experiences that are unique to the US higher education system. BME graduates will be equipped to help address the increasing demand for biomedical solutions to serve the health care needs of an aging U.S. population. The comprehensive major will be comprised of 93 credits in a 128-credit degree, and students will be able to complete all university general education and other graduation requirements within a four-year degree plan.

PROGRAM IDENTIFICATION

Institution Name

University of Wisconsin-Eau Claire

Title of Proposed Program

Biomedical Engineering

Degree/Major Designations

Bachelor of Science

Mode of Delivery

Single institution, also with core engineering courses and electives accessible to students through the Northwest Engineering Consortium (NWECC), which includes UW-Stout and UW-River Falls. The BME curriculum will be offered primarily face-to-face, with possible online instruction of selected courses through the NWECC.

Projected Enrollments and Graduates by Year Five

Table 1 represents enrollment and graduation projections for students entering the BME program over the first five years. Through internal communication and marketing efforts, it is anticipated that 15 current UW-Eau Claire students will declare the BME major as their program of study in the first year of implementation (2020). Through an intentional and targeted communication plan during the 2019-20 student recruitment season, an additional 15 new students are expected to enroll at UW-Eau Claire in fall 2020 with BME as their declared program of study. University-wide, student retention rates after the freshman, sophomore, and

junior years are 82%, 75%, and 70%, respectively. Through its Enrollment Management division, the university is engaged in targeted student retention initiatives and those university-wide retention rates are expected to increase. However, for the MS&E program, data indicate that the number of students who transfer into the major each year approximately offsets the number of those who transfer to another academic program, and we expect similar trends for the BME program. Thus, we expect net attrition to be relatively small (2-3 students per year) and those expectations are reflected in Table 1. By the end of Year 5, it is expected that 87 students will be enrolled in the program and 45 students will have graduated with the BME degree.

Table 1: Five-Year Degree Program Enrollment Projections

Students/Year	2020-21	2021-22	2022-23	2023-24	2024-25
New Students	15	20	20	25	25
Continuing Students	15	28	46	56	62
Total Enrollment	30	48	66	81	87
Graduating Students	0	0	8	17	20

Tuition Structure

For the 2018-19 academic year, the resident tuition and segregated fees total \$4,408 per semester for full-time students (those enrolled in 12-18 credits per term). Of this total, \$3,681 is attributable to tuition and \$727 is attributable to segregated fees. Students who enroll in the BME program will pay this tuition rate during their freshman and sophomore years (up to 60 earned credits). Consistent with the tuition structure in the MS&E program, BME students will pay the engineering tuition rate in their junior and senior years. Using the 2018-19 academic year rate, the engineering tuition rate would be \$4,381 per semester for full time students enrolled in 12-18 credits per term. This amount is \$700 per semester above the 2018-19 (and planned 2019-20) resident tuition rate. Thus, the full cost of tuition for full-time students completing the BME program in four years is \$32,248.

Students enrolled part time, and who have earned less than 60 credits, will pay tuition and segregated fees of \$367 per credit (semester rate of \$4,408 divided by 12); part time students who have earned more than 60 credits will pay \$426 per credit (semester rate of \$5,108 divided by 12). The latter value reflects the additional \$700 per semester for junior and senior students enrolled in the engineering curriculum. Nonresident full-time students will pay \$9,068 per semester, or \$756 per credit, assuming they are enrolled in 12-18 credits per semester. Of this amount, \$8,341 is attributable to tuition and \$727 is attributable to segregated fees.

Department or Functional Equivalent

The BME degree program will reside within the Materials Science and Engineering Program at UW-Eau Claire. Like the MS&E program, the BME will be coordinated with other engineering degrees offered at UW-Stout and UW-River Falls through the NWEC.

College, School, or Functional Equivalent

College of Arts and Sciences of UW-Eau Claire

Proposed Term and Year of Implementation

Fall 2020

DESCRIPTION OF PROGRAM

Overview of the Program

The proposed major in Biomedical Engineering will be comprised of 93 credits, with an additional 35 credits needed to reach the 128 credits required for this Bachelor's of Science degree (note that some courses required by the major will contribute to UW-Eau Claire's 36-credit minimum required for the Liberal Education [LE] Core). Student internships and/or co-op experiences will be encouraged (and are also valued as High Impact Experiences by the university), but not required. A recently developed partnership with Mayo Clinic will provide "workplace" immersion experiences.

Student Learning Outcomes and Program Objectives

The proposed major is designed with ABET accreditation in mind and includes experiences required by the Engineering Accreditation Commission in their guidelines for Biomedical Engineering, which include:

- (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.

In addition, ABET also specifies student learning outcomes that each student from an engineering major should master as a graduate. Students should demonstrate:

- 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- 2. an ability to apply engineering design to produce solutions that meet specified 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, 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, analyze and interpret data, and use engineering judgment to draw conclusions
- 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The proposed major will provide students with a strong foundation in the sciences and math, as well as experiences relevant to many engineering curricula. The biomedical engineering experiences will include how medical devices interface to living organisms, how mechanical aspects of living organisms can be understood and augmented, and how materials foreign to an organism elicit a response and how such materials can be modified to be more biocompatible.

Program Requirements and Curriculum

Students new to UW-Eau Claire (including incoming Frosh and transfer students) will be eligible to declare a major in Biomedical Engineering upon admission. No preliminary exams (other than those already taken by students during admission to UW-Eau Claire) are required. Continued enrollment in the major will require that students maintain the same level of performance required of all UW-Eau Claire students to remain in “good standing”.

Table 2 illustrates the curriculum for the proposed major. The program requirements are comprised of 128 credits, of which a minimum of 93 credits are required by the major and a minimum of 36 credits are required to meet the university’s LE Core requirements (note that some credits can be counted towards both the major and the LE Core). The LE Core requires a minimum of 18 learning experiences in 12 areas (seven courses or learning experiences in four “Knowledge” areas, four courses or learning experiences in three “Skills” areas, four courses or learning experiences in three “Responsibility” areas, two courses or learning experiences in “Integration”, and the University Service-Learning requirement); these courses are collectively indicated in Table 2 as LE Core credits.

Table 2: Bachelor’s of Science in Biomedical Engineering Program Curriculum Courses required for graduation:

Credits beyond the major needed to meet university and degree requirements	35 credit(s)
Program prerequisites or support courses:	
<i>Biology</i> (Anatomy and Physiology; BIOL 214, 314)	8 credit(s)
<i>Chemistry</i> (Introductory and Organic; CHEM 105, 106, 109, 325, 326)	14 credit(s)
<i>Physics</i> (Introductory; PHYS 231, 232)	10 credit(s)
<i>Math</i> (Calculus, Differential Equations and Linear Algebra; Math 114, 215, 312)	12 credit(s)
<i>Computer Science</i> (Programming; CS 145 or 148)	4 credit(s)
Academic program or major course requirements:	
Introduction to Engineering (MSE 120)	2 credit(s)
Engineering Statistics (TBD)	4 credit(s)
Computer-Aided Design (MSE 256)	1 credit(s)
Statics (Phys 255)	3 credit(s)
Jr. Seminar (MSE 386, 387)	1 credit(s)
Sr. Capstone (MSE 486, 487)	4 credit(s)
Electric and Electronic Circuits (Phys 350)	4 credit(s)
Electronics (Phys 360)	4 credit(s)
Soft Materials (MSE 334)	4 credit(s)
Biomaterials (TBD)	3 credit(s)
Fundamentals of Biomedical Eng. (TBD)	3 credit(s)
Bioinstrumentation & Med. Device (TBD)	4 credit(s)
Biomechanics & Biomedical implants (TBD)	4 credit(s)
Sensors & Physiological Signal Monitoring (TBD)	4 credit(s)
Total Credits	128 credit(s)

Assessment of Outcomes and Objectives

The assessment process employs a three-year cycle, in which assessment data is collected in various courses in year 1, that data evaluated in year 2, and changes to the courses implemented in year 3. The assessment of student learning employs embedded assessment methods to collect data on student performance for the seven ABET-approved learning outcomes. These results are then compared to the program's average expected performance, and changes are implemented after discussion of the performance results. Data collected is both quantitative and qualitative. Quantitative data includes student performance in course-based assignments and lab assignments; qualitative data includes faculty perception of student work in teams and student-reported perceptions of their own learning. The assessment program is part of a larger plan for continuous improvement required for ABET accreditation, which program faculty will seek once a student has graduated from the proposed major.

Biomedical Engineering faculty also evaluate student performance in Liberal Education learning outcomes as part of the broader campus effort to collect such data and evaluate student success in the LE Core learning goals. This data is collected institution-wide using a previously developed (and periodically reviewed) assessment plan.

Diversity

Faculty in the MS&E program, which will serve as the academic home for the BME major, are fully committed to helping students overcome inclusion challenges in science and engineering, including persistent low participation by women, people of color, and members of other underrepresented groups. The program has actively used high impact practices, such as undergraduate research, to promote the academic success of students from underrepresented populations. Faculty and staff serve as role models and mentors to students through career counseling, academic advising, and research collaboration.

In terms of engineering disciplines, the gender balance for students graduating with a Biomedical Engineering degree is better than other engineering fields. Nationally nearly 43% of Biomedical Engineering bachelor degrees go to women, compared to less than 14% in mechanical and electrical engineering. This fits well with the goal of the Engineering program at UW-Eau Claire to increase the number of women graduating with an engineering degree. Unfortunately the data for underrepresented minorities indicates Biomedical Engineering has approximately the same distribution as the other engineering fields (less than 20%). [NCES IPEDS data compiled by DataUSA: <https://datausa.io/profile/cip/1405/>]

The existing MS&E program has a long history of supporting undergraduate research and including students from underrepresented groups in their research, and the BME program will provide these same supports as part of UW-Eau Claire's engineering curriculum. In addition to research stipends for students involved in collaborative projects with faculty, the program will continue to provide travel support for students presenting their research at conferences. This travel money is specifically intended to encourage students to attend professional conferences without the additional and disrupting worry of funding this expensive activity.

Since 2012, faculty in MS&E have accessed funds from the National Science Foundation's Louis Stokes Alliance for Minority Participation through sub-awards administered through UW-Madison. These awards provide students from underrepresented populations with additional opportunities to participate in collaborative research experiences with faculty. In addition, engineering faculty have engaged in research with underrepresented students from two-

year technical schools and the UW Colleges through a National Science Foundation Research Experiences for Undergraduates (REU) grant awarded to the chemistry department at UW-Eau Claire. This grant helps introduce research to students from two-year institutions, with the goal of encouraging these students to continue their education and obtain their bachelor's degree. In addition, many students in UW-Eau Claire's Ronald E. McNair scholars program have successfully completed, or are currently involved in, engineering related research with faculty members. The McNair scholars are part of a federally-funded TRIO program, which provides students from historically underrepresented groups with academic and scholarship support to help them achieve their goal of attending graduate school and obtaining an advanced degree.

Students in the BME program, like all other UW-Eau Claire students, will be required to complete the equity, diversity, and inclusivity learning outcome of the university's liberal education program. Two learning experiences are required in this outcome, one of which must also satisfy the UW System Design for Diversity requirement. These experiences provide students with opportunities to engage with perspectives, theories, practices, and populations different from themselves. All faculty and staff in the department, which includes two women and one person of color, are active in advancing the principles of equity, diversity, and inclusion. During annual performance reviews, each faculty and staff member is expected to provide evidence of their efforts to enhance equity, diversity and inclusivity on campus. Moreover, faculty in the program participated in a campus strategic initiative "EDI in STEM", which focused on developing resources, strategies, and professional development plans to advance inclusive practices and pedagogies, and to improve the campus culture influencing the persistence of women and minorities in STEM fields at UW-Eau Claire.

Collaborative Nature of the Program

The proposed BME program will be part of the Northwest Wisconsin Engineering Consortium (NVEC) in collaboration with UW-Stout and UW-River Falls. The consortium is designed to provide a cost-effective engineering education to the residents of western Wisconsin, produce an ongoing supply of engineering talent, and create an economic environment attractive to engineering-related industries. Key elements of the consortium include:

- design a science, mathematics and engineering curriculum that provides flexibility for students within the consortium, both in the first-year curriculum and in upper-level electives;
- eliminate institutional barriers to provide students a seamless experience, including the ability to readily transfer during the first two years of their undergraduate degree;
- enhance the ongoing collaborative efforts and identify opportunities that will benefit the students outside of the consortium;
- strengthen the connections with local industries and build a strong engineering community in western Wisconsin; and
- coordinate outreach activities.

Projected Time to Degree

A student can complete the BME degree, including all liberal education and other UW-Eau Claire graduation requirements, in eight semesters with an average load of 16 credits per semester and full-time enrollment. Students who transfer to UW-Eau Claire, and who were enrolled in an engineering program at one of the NVEC participating schools, can also complete the BME degree in eight semesters. The materials science program, which will serve as the

academic home for the BME degree, has a strong track record of graduating students in a timely manner; the average time to degree for materials science students graduating over the past three academic years is 4.08 years, and students in materials science majors had a 56% four-year graduation rate, which is significantly above the university's current average four-year graduation rate of 40.3%.

Program Review

Academic programs are currently reviewed at UW-Eau Claire every seven years, with the materials science program last being reviewed in 2014-2015, which was prior to the development of the materials science engineering curriculum. The review process includes a three-faculty internal review committee and an external evaluator who also participates in a site visit. The perspectives and recommendations for improvement from these reviewers are forwarded to the Academic Policies Committee of the University Senate and to the Provost for consideration. To meet UW System expectations that new academic programs be reviewed within five years, the BME program would undergo its first review in the 2025-26 academic year; this timeline is separate from the regularly scheduled review of other majors within the MS&E program (2021-22). The MS&E program is scheduled for its initial ABET accreditation review in 2019-20. Thereafter, ABET on-site reviews are conducted every five years. As with UW-Eau Claire's on-going assessment process, ABET's program of continuous improvement requires yearly updates and assessment of the academic program. Once the BME program is accredited by ABET (see below), the on-campus review process will use the same reports and data as the ABET review document.

Accreditation

The proposed BME curriculum is designed to meet the strict ABET accreditation standards. As mentioned previously, the MS&E program is expected to undergo ABET review in 2019-20. Thus, the BME program would be the second program at UW-Eau Claire seeking accreditation by ABET's Engineering Accreditation Commission (EAC). Most of the components required by the EAC are already in place or will be in place before accreditation is sought. ABET Readiness Review and full accreditation will be requested for the BME major after the first student cohort graduates in the 2022-23 academic year. It is anticipated the site visit will require at least 18 months of preparation before the team arrives.

The Higher Learning Commission (HLC) will be notified of the new major after approval by UW System Board of Regents. No separate approval from HLC is required.

JUSTIFICATION

Rationale and Relation to Mission

The BME program is fully consistent with UW-Eau Claire's mission and strategic plan goals. The university's 2016-2020 Strategic Plan (<https://www.uwec.edu/files/60/2016-Strategic-Plan-WEB-FINAL.pdf>) vows to ensure that all students will connect and succeed, and that all students will live what they study. The 2016-2020 Academic Master Plan (<https://www.uwec.edu/acadaff/academic-master-plan/>) strives to create a program array that enhances the image and reputation of UW-Eau Claire; is aligned with the mission, values, and strengths of the University; and is attractive and relevant to current and future students. UW-Eau Claire's mission statement commits to providing a rigorous, intentional, and experiential

undergraduate education experience; exemplary student-faculty research; and educational opportunities responsive to the needs of our communities, state, region and beyond. Thus, the BME major is consistent with UW-Eau Claire's mission and strategic goals: it will provide experiential learning opportunities for students to live what they study; it aligns with UW-Eau Claire's strong reputation in mathematics, science, and health science programs and its commitment to undergraduate research; its curriculum and employment opportunities are attractive to students and will help supply engineering talent to create an economic environment attractive to engineering-related industries in the region.

In 1988, UW-Eau Claire was identified by the UW System Board of Regents as the Center of Excellence for Faculty and Undergraduate Student Research Collaboration. In 2016, UW-Eau Claire was recognized by the Council on Undergraduate Research as the top master's level university in the nation in providing excellent undergraduate research programming. These recognitions are aligned with our institutional mission and our commitment (Blugold Commitment) to provide all UW-Eau Claire students with opportunities to participate in at least one of three high impact practices (internship, intercultural immersion experience, or undergraduate research) during their UW-Eau Claire career. Undergraduate research and experiential learning experiences will be key parts of the BME program. These research opportunities will be enhanced by UW-Eau Claire's collaborative research agreement with Mayo Clinic Health Systems (MCHS). The agreement is only the second of its kind in the world between MCHS and an institution of higher education, and the only such agreement involving a comprehensive, primarily undergraduate institution. The MCHS agreement will provide UW-Eau Claire students with unparalleled opportunities for hands-on clinical research experiences, working in collaboration with UW-Eau Claire faculty and Mayo Clinic physicians and scientists. Biomedical research, including the design and use of medical devices in clinical settings, is an obvious area for collaborative work between the two institutions.

We seek approval of the BME proposal from shared governance. We have support from academic leadership groups at UW-Eau Claire, from the consortium partners in the NWEAC, from regional biomedical industries, as well as from regional leadership within the MCHS.

Institutional Program Array

The BME program will build upon UW-Eau Claire's strong program array in the sciences and mathematics, primarily by drawing upon curriculum and faculty expertise in chemistry, biology, physics, and mathematics. The program also dovetails with our existing MS&E curriculum and infrastructure, including its faculty expertise and its array of instrumentation and processing equipment. Many of the foundational engineering courses will be shared between the BME and MS&E programs. The sharing of curriculum and faculty resources across disciplines provides a cost-effective and efficient strategy to deliver the BME program. For BME, those shared courses will be complemented by a selection of required and elective courses that are specific to biomedical engineering.

Other Programs in the University of Wisconsin System

The proposed BME program will represent only the third biomedical engineering degree (joining those offered at UW-Madison and UW-Milwaukee) within the UW System, the only such program at a comprehensive campus, and the only such program north and west of Madison. The missions of UW-Madison and UW-Milwaukee are distinct from that of UW-Eau Claire and these schools attract different student populations to their academic programs. Thus,

the proposed BME will fill a significant geographic and programming gap for students who wish to pursue a biomedical engineering degree in the northwest region of the state and wish to do so within the more intimate structure of a comprehensive university focused on undergraduate education. It should also be noted that UW-Eau Claire's proximity to the Minneapolis/St. Paul metropolitan area aligns several of the university's primary student catchment areas within the economic umbrella of the Twin Cities and its robust biomedical industries. Thus, UW-Eau Claire students who have an interest in biomedical fields and academic programs will be able to pursue a BME degree and have access to internship and employment opportunities within close proximity to their home region.

UW-Eau Claire's BME program will provide students with a foundation in engineering principles as they are applied to a broad range of biomedical problems and situations. The program will also provide a curriculum that places particular emphasis on the engineering, design, use, and manufacture of biocompatible materials and devices (e.g., stents, sutures, drug delivery systems, prosthetics, and implants). For this reason, the BME program's connection to UW-Eau Claire's existing MS&E major is especially relevant.

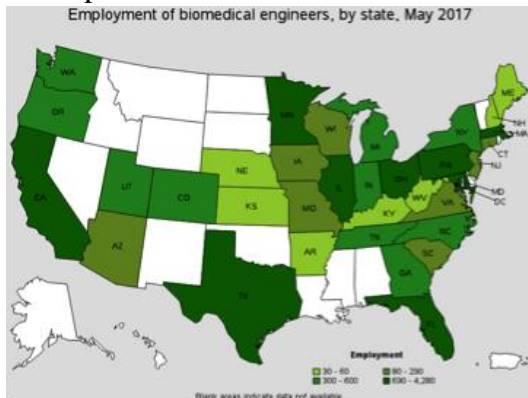
Need as Suggested by Current Student Demand

In fall of 2018, UW-Eau Claire purchased a list of students that had taken science/math AP exams from the College Board for recruiting purposes. The students on the list were from Wisconsin, Minnesota and northern Illinois. Of the 587 students that listed Engineering as a possible major, 62 specifically identified Biomedical Engineering as a possible major to pursue.

There is a strong student interest in biomedical engineering at UW-Eau Claire. At the beginning of the spring 2019 semester, an email survey was sent to current students enrolled in STEM and healthcare-related programs. Of the 355 responses, 120 students indicated that they would have likely chosen the BME degree if it were offered.

Need as Suggested by Market Demand

According to the Wisconsin Department of Workforce Development, the number of Biomedical Engineering jobs is expected to grow by 12.12% from 2016-2026 [<https://www.jobcenterofwisconsin.com/wisconomy/query>]. Nationally, the U.S. Bureau of Labor Statistics expects a 7.2% growth in Biomedical Engineering positions during the same time frame [<https://www.bls.gov/oes/current/oes172031.htm#st>]. According the U.S Bureau of Labor Statistics the metro area with the second largest number of Biomedical Engineers is the Minneapolis-St. Paul metro area that includes part of northwestern Wisconsin.



Employment of biomedical engineers by area, May 2016



A search on the Job Center of Wisconsin website on January 31st, 2019 for biomedical engineer results in 168 openings listed. An Indeed.com search the same day resulted in 53 open biomedical engineering positions in Wisconsin. Demand for Biomedical engineers is expected to continue to be strong due to longer life expectancy and higher rates of healthcare spending that increase the demand for medical and assistive devices. According to BCC Research, the medical device industry is expected to grow at a compound annual growth rate of 5.3% from 2017-2022 [<https://globenewswire.com/news-release/2018/03/19/1441876/0/en/Healthy-Growth-Forecast-for-Medical-Devices-Global-Market.html>]. According to Coherent Market Insights the global elderly and disabled assistive device market valued at \$14B in 2015 is expected to surpass \$26B by 2024 [<https://www.coherentmarketinsights.com/market-insight/elderly-and-disabled-assistive-devices-market-82>)].