



## New Program Report

**Date Submitted:**

11/19/2021

**Institution**

University of Missouri-Kansas City

**Site Information**

**Implementation Date:**

8/1/2023 12:00:00 AM

**Added Site(s):**

**Selected Site(s):**

University of Missouri-Kansas City, 5100 Rockhill Road, Kansas City, MO, 64110

**CIP Information**

**CIP Code:**

140501

**CIP Description:**

A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of biomedical and health systems and products such as integrated biomedical systems, instrumentation, medical information systems, artificial organs and prostheses, and health management and care delivery systems.

**CIP Program Title:**

Bioengineering and Biomedical Engineering

**Institution Program Title:**

Biomedical Engineering

**Degree Level/Type**

**Degree Level:**

Bachelor's Degree

**Degree Type:**

Bachelor of Science

**Options Added:**

Collaborative Program:

N

**Mode of Delivery**

Current Mode of Delivery

Classroom

Student Preparation



## New Program Report

Special Admissions Procedure or Student Qualifications required:

High school students planning to apply to SCE are strongly encouraged to take a college preparatory program that emphasizes mathematics, science, and communication skills.

First-time college student applicants to the undergraduate program will be admitted if they obtain:

1. An ACT mathematics score of at least 25 and
2. An ACT composite score of at least 24

First-time college student applicants who do not meet the above criteria but do meet UMKC general admission requirements will have their applications reviewed by a committee for admission. Applicants who are not admitted to SCE but do meet UMKC general admission requirements may be admitted to University College.

Students without the prerequisite preparation must take the needed coursework before enrolling in courses required for the bachelor's degree. Students seeking re-admission must have been in good academic standing when last enrolled. Otherwise, re-admission requires a formal review by the undergraduate program committee.

Transfer applicants must have at least 24 credits of transferable college credit and an overall 2.0 GPA on a 4.0 scale in all coursework, which includes repeated coursework, attempted at previous institutions. Transfer applicants without a 2.0 or higher college GPA must submit a petition for admission.

Specific Population Characteristics to be served:

n/a

### Faculty Characteristics

Special Requirements for Assignment of Teaching for this Degree/Certificate:

As needed, and as enrollments grow, adjunct instructors will be used for some elective courses, but it is planned that the required courses will be taught by full-time faculty members.

There will be select courses that are team taught by medical professionals and biomedical engineering faculty.

Estimate Percentage of Credit Hours that will be assigned to full time faculty:

It is estimated that near 100% of the credit hours in the program will be assigned to full-time faculty members

Expectations for professional activities, special student contact, teaching/learning innovation:

In addition to Assistant Dean Katherine Bloemker, a degree program committee (DPC) will be formed to track activities, students, and advising for the proposed BSBME Degree.

### Student Enrollment Projections Year One-Five

<b>Year 1</b>	<b>Full Time: 25</b>	<b>Part Time: 0</b>	
<b>Year 2</b>	<b>Full Time: 54</b>	<b>Part Time: 0</b>	
<b>Year 3</b>	<b>Full Time: 85</b>	<b>Part Time: 0</b>	<b>Number of Graduates: 0</b>
<b>Year 4</b>	<b>Full Time: 119</b>	<b>Part Time: 0</b>	
<b>Year 5</b>	<b>Full Time: 146</b>	<b>Part Time: 0</b>	<b>Number of Graduates: 15</b>

Percentage Statement:

n/a

### Program Accreditation



## New Program Report

### Institutional Plans for Accreditation:

The School of Computing and Engineering (SCE) plans to have the Biomedical Engineering program accredited through the EAC of ABET. The major curriculum requirements for ABET accreditation of a Biomedical Engineering Program which have been planned into the Four-year plan are:

- (1) A minimum of 30 credit hours in math and basic sciences, including calculus, differential equations, statistics, biology, human physiology, chemistry and calculus-based physics, with experimental experience.
- (2) A minimum of 45 credit hours in engineering topics, including engineering, computer science, engineering design, and utilizing modern engineering tools.
- (3) A broad education component.
- (4) A culminating engineering design experience.
- (5) Solving biomedical engineering problems.
- (6) Analyzing, modeling, designing, and realizing biomedical engineering devices, systems, components, or processes.
- (7) Making measurements on and interpreting data from living systems.

Accreditation through the EAC of ABET cannot be sought until the first students have graduated from the program which is expected May 2025. SCE's current programs are not up for their next comprehensive review until 2025, so at that time the BSBME will be proposed for accreditation.

### Program Structure

#### Total Credits:

127

#### Residency Requirements:

n/a

#### General Education Total Credits:

34

#### Major Requirements Total Credits:

103

#### Course(s) Added

COURSE NUMBER	CREDITS	COURSE TITLE
HLSC 120	4	Anatomy and Physiology I
ECE 277	1	Circuit Theory I Lab
	3	Biomedical Technical Elective***
MEC-ENGR 299 OR ME 285	3	Thermodynamics OR Dynamics
BIOL 108L	1	General Biology I Lab
MEC-ENGR 406	3	Introduction to Biomaterials
MATH 266	4	Accelerated Calculus I (Math Pathway)
BIOL 108	3	General Biology I
ECE 381	1	Signals and Systems Lab
	3	Biomedical Technical Elective***
ECE 380	3	Signals and Systems
BME 3XX	4	Biomedical Inst. & Meas. Lab



DEPARTMENT OF  
HIGHER EDUCATION &  
WORKFORCE DEVELOPMENT

## New Program Report

BME 3XX	3	Biomedical Systems Physiology
CHEM 212R	4	General Chemistry II
CHEM 211	4	General Chemistry
BME 1XX	1	3D Modeling and 3D Printing for Biomedical Engineering
ECE 420	2	Advanced Engineering Computation
ECE 276	3	Circuit Theory I
PHYS 250	5	Physics for Science & Engineering II
BIOL 304	3	Biostatistics I
	3	Biomedical Technical Elective***
MATH 250	4	Calculus III
ME 492 or CS 304WI	3	Mechanical Design Synthesis I or Ethical Issues in Computing and Engineering (Civic Engagement)
MATH 268	3	Accelerated Calculus II
CIV-ENGR 276	3	Strength of Materials
BIOL 202	3	Cell Biology
PHYS 240	5	Physics for Science and Engineering I
MEC-ENGR 351	3	Fluid Mechanics
CHEM 211L	1	General Chemistry Lab
MATH 345	3	Differential Equations
CHEM 212LR	1	General Chemistry II Lab
ECE 216	3	Engineering Computation
BME 1XX	1	Intro to Biomedical Engineering
BME 3XX	3	Biomedical Transport
CIV-ENGR 275	3	Engineering Statics (Critical Thinking in the Natural Sciences)
BME 4XX	3	Biomedical Design Synthesis (Capstone Design)

**Free Elective Credits:**

0

**Internship or other Capstone Experience:**

All senior students are required to take a capstone design class: Biomedical Design Synthesis.

**Assurances**

I certify that the program is clearly within the institution's CBHE-approved mission. The proposed new program must be consistent with the institutional mission, as well as the principal planning priorities of the public institution, as set forth in the public institution's approved plan or plan update.



## **New Program Report**

I certify that the program will be offered within the proposing institution's main campus or CBHE-approved off-site location.

I certify that the program will not unnecessarily duplicate an existing program of another Missouri institution in accordance with 6 CSR 10-4.010, subsection (9)(C) Submission of Academic Information, Data and New Programs.

I certify that the program will build upon existing programs and faculty expertise.

I certify that the program can be launched with minimal expense and falls within the institution's current operating budget.

I certify that the institution has conducted research on the feasibility of the proposal and it is likely the program will be successful. Institutions' decision to implement a program shall be based upon demand and/or need for the program in terms of meeting present and future needs of the locale, state, and nation based upon societal needs, and/or student needs.

### Contact Information

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## BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING

### FIRST YEAR

FALL SEMESTER	HOURS	SPRING SEMESTER	HOURS
MATH 266 Accelerated Calculus I ( <i>UMKC Essentials</i> )	4	MATH 268 Accelerated Calculus II	3
CHEM 211 General Chemistry	4	PHYS 240 Physics for Science and Engineering I	5
CHEM 211L General Chemistry Lab	1	CHEM 212R General Chemistry II	4
BME 1XX Intro to Biomedical Engineering	1	CHEM 212LR General Chemistry II Lab	1
First Semester Experience ( <i>UMKC Essentials</i> )	3	Oral Communication ( <i>UMKC Essentials</i> )	3
Written Communication I ( <i>UMKC Essentials</i> )	3		
<b>Total</b>	<b>16</b>	<b>Total</b>	<b>16</b>

### SECOND YEAR

FALL SEMESTER	HOURS	SPRING SEMESTER	HOURS
MATH 250 Calculus III	4	MATH 345 Differential Equations	3
PHYS 250 Physics for Science & Engineering II	5	ECE 216 Engineering Computation	3
BIOL 108 General Biology I	3	BIOL 202 Cell Biology	3
BIOL 108L General Biology I Lab	1	CE 276 Strength of Materials	3
CE 275 Engineering Statics ( <i>UMKC Essentials</i> )	3	BME 1XX 3D Modeling and 3D Printing for Biomedical Engineering	1
		Critical Thinking in Arts & Humanities ( <i>UMKC Essentials</i> )	3
<b>Total</b>	<b>16</b>	<b>Total</b>	<b>16</b>

### THIRD YEAR

FALL SEMESTER	HOURS	SPRING SEMESTER	HOURS
BIOL 304 Biostatistics I	3	ME 299 Thermodynamics OR ME 285 Dynamics	3
ECE 380 Signals and Systems	3	BME 3XX Biomedical Inst. & Meas. Lab	4
ECE 381 Signals and Systems Lab	1	ECE 276 Circuit Theory I	3
ME 351 Fluid Mechanics	3	ECE 277 Circuit Theory I Lab	1
HLSC 120 Anatomy and Physiology I	4	ECE 420 Advanced Engineering Computation	2
Written Communication II (Technical Writing recommended) ( <i>UMKC Essentials</i> )	3	Critical Thinking in Social & Behavioral Sciences ( <i>UMKC Essentials</i> )	3
<b>Total</b>	<b>17</b>	<b>Total</b>	<b>16</b>

### FOURTH YEAR

FALL SEMESTER	HOURS	SPRING SEMESTER	HOURS
ME 492 Mechanical Design Synthesis I OR CS 304WI Ethical Issues in Computing and Engineering (Civic Engagement) ( <i>UMKC Essentials</i> )	3	BME 4XX Biomedical Design Synthesis (Capstone Design)	3
BME 3XX Biomedical Systems Physiology	3	BME 3XX Biomedical Transport	3
ME 406 Introduction to Biomaterials	3	Biomedical Technical Elective*	3
Biomedical Technical Elective*	3	Biomedical Technical Elective*	3
Culture and Diversity ( <i>UMKC Essentials</i> )	3	POL-SCI 210 OR HIST 101 OR HIST 102 - MO Const. Requirement	3
<b>Total</b>	<b>15</b>	<b>Total</b>	<b>15</b>

Total Credits to Graduate 127

***\*Biomedical Technical Elective Options – CHOOSE Courses from this list (or any 400 level advisor approved course in MEC-ENGR, CIV-ENGR, EC-ENGR, BIOL, or CHEM):***

BIOL 206 Genetics

BIOL 441 Biochemistry (pre-req: Organic Chemistry)

BIOL 452 Bioinformatics

BIOL 401 Biostatistics II

ECE 401 Nanoelectromagnetics and Plasmonics

ME 401 Introduction to Biomaterials

ME 411 Introduction to Biomechanics

ME 412 Biodynamics

ME 413 Experimental Methods in Biomechanics

ME 401 Biomedical Device Design

ME 401 Imaging to Modeling

ME 401 Introduction to Polymers and Soft Materials

ME 401 Biomaterials Surface Science

ME 401 Advanced Thermodynamics

### Math Courses (for ABET must include calculus, diff eq and statistics)

Course and Description	CR	Pre-reqs
MATH 266 Accelerated Calculus I ( <i>UMKC Essentials</i> ) An accelerated first course in calculus focusing on application of differential calculus and basic vector and matrix calculations.	4	Math 120 or both Math 110 & Math 125 or ALEKS assessment score of 76% or higher
MATH 268 Accelerated Calculus II An accelerated second course in calculus focusing on application of integral calculus, analytic geometry, and vector analysis.	3	MATH 266
MATH 250 Calculus III Vectors, solid analytic geometry, vector functions and multiple variable functions, partial derivatives, multiple integrals, line and surface integrals with applications.	4	MATH 268 or MATH 220
MATH 345 Differential Equations First order equations, linear second order differential equations, Taylor series and power series solutions, Laplace transforms, elementary systems of differential equations, numerical methods, and Fourier series and boundary value problems.	3	MATH 250
BIOL 304 Biostatistics Introduction to the concepts of probability, statistical reasoning, and experimental design in the biological sciences. The course emphasizes the application of inferential statistics to biological experiments including the use of relevant statistical computer packages.	3	MATH 110 or STAT 235

17 credit hours

### Science Courses (for ABET must include biology, human physiology, chemistry, calc-based physics)

Course and Description	CR	Pre-reqs
CHEM 211 General Chemistry Stoichiometry, gas laws, thermochemistry, atomic structure, molecular shapes and bonding theories.	4	Prerequisite: A working knowledge of college algebra. Co-requisite: CHEM 211L
CHEM 211L General Chemistry Lab Introduction to the laboratory techniques used in studying the chemical properties of substances. Some quantitative techniques are included.	1	Co-requisite: Chem 211
CHEM 212R General Chemistry II Liquids and solids, solutions, equilibrium, kinetics, electrochemistry and thermodynamics. Introductory course to all advanced work in chemistry.	4	Prerequisite: Chem 211/211L Co-requisites: CHEM 212LR
CHEM 212LR General Chemistry II Lab Introduction to analysis and synthesis. Descriptive chemistry of the more common elements.	1	Prerequisite: Chem 211/211L Co-requisites: CHEM 212R
PHYS 240 Physics for Science and Engineering I Introduction to mechanics, wave motion and sound and heat and thermodynamics.	5	Co-requisites: MATH 210 or MATH 266
PHYS 250 Physics for Science & Engineering II Introduction to electricity and magnetism, light and optics and modern physics. Four hours lecture and two hours laboratory per week.	5	Prerequisites: PHYSICS 240. Co-requisites: MATH 220 or MATH 268
BIOL 108 General Biology I Fundamental studies in biology emphasizing the unity and diversity of life. Topics include the basic chemistry of biological processes, cell types and organelles, energy harvesting and energy producing pathways, cell and life cycles, genetics, DNA structure, genes, transcription, translation, natural selection, population genetics, speciation, and phylogenetic analysis.	3	High School Biology and Chemistry background highly recommended
BIOL 108L General Biology I Lab Basic laboratory studies in Biology emphasizing the unity and diversity of life. Structure, function, heredity, development, ecology and evolution will be explored.	1	Co-requisite BIOLOGY 108
BIOL 202 Cell Biology Basic concepts of cellular and subcellular structure and function, including supramolecular and organelle structure and organization, bioenergetics, cell growth and cellular communication.	3	BIOL 108 and CHEM 212R
HLSC 120 Anatomy and Physiology I	4	None listed in Pathway



<p>This course examines the structure and function of the human body from the molecular to the organism level as they interact among all body systems across the life span. Instructors also attempt to correlate course materials with the clinical aspects of the application of physiological knowledge. Co-requisite laboratory exercises provide practical application of theoretical concepts. In this first term of two-term course, molecular biology, biochemistry, cellular biology, and histology are studied as well as the integumentary, musculoskeletal, and nervous systems.</p>		
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31 credit hours (labs in chem, physics, biology, and physiology)

**Math + Basic Science: Total Credits (for ABET must be more than 30 and include experimental experience) = 48 credit hours**

**Engineering Topics Courses (for ABET must be more than 45 and include engineering, computer science, design and utilize modern engineering tools)**

Course and Description	CR	Pre-reqs
CE 275 Engineering Statics ( <i>UMKC Essentials</i> ) Fundamentals of statics; static equilibrium; internal forces; introduction to elements of mechanics of elastic materials, and properties of areas.	3	PHYSICS 240
ECE 216 Engineering Computation Development, analysis and synthesis of structured computer programs for solving engineering problems in the Python, MATLAB, and C languages. Introduction to algorithms and data structures.	3	MATH 110 or higher or ALEKS score of 51% or higher
CE 276 Strength of Materials The course introduces and emphasizes the concepts and analysis methods for stress and strain, torsion, bending and shear stresses in beams, combined stresses, and deflection theory using a calculus based methodology. Introduction to buckling and energy methods may be included.	3	CIV-ENGR 275
ECE 276 Circuit Theory I Kirchoff's circuit laws, Ohm's Law, nodal and mesh analyses, source transformations, superposition, Thevenin and Norton equivalents, transient analysis of 1st and 2nd order systems. AC circuit analysis, phasors, impedance, sinusoidal steady-state responses, operational amplifiers and PSpice.	3	PHYSICS 250 and E&C-ENGR 241 or MATH 250 & MATH 345
ECE 277 Circuit Theory I Lab Introduction to the use and limitations of basic instruments used in electrical testing and measurement. Experimental techniques and laboratory safety. Data gathering, interpretation and presentation. Preparation of laboratory reports. Experimental work supporting theoretical concepts developed in E&C-ENGR 276.	1	Co-requisite: E&C-ENGR 276
ME 351 Fluid Mechanics Concepts of the statics and dynamics of fluids, with emphasis on principles of continuity, momentum and energy. Boundary layers, dimensional analysis and drag are covered briefly. Thorough treatment of pipe flow.	3	MEC-ENGR 272 or MATH 345
ME 299 Thermodynamics Fluid properties, work and heat, first law, second law, entropy, applications to vapor and ideal gas processes. OR ME 285 Dynamics Fundamentals of engineering dynamics, including kinematics and kinetics of particles and rigid bodies. Analysis based on forces and accelerations as well as energy and momentum methods.	3	MATH 268 and PHYSICS 250  OR  CIV-ENGR 275
ECE 380/381 Signals and Systems (with Lab) OR BME 3XX Biomedical Signals and Systems Continuous and discrete-time signals and systems, frequency response, Fourier analysis of discrete and continuous signals and systems and use of z, Fourier, Discrete Fourier, and Fast Fourier Transforms.	4	E&C-ENGR 341R or MATH 250 & MATH 345

ECE 420 Advanced Engineering Computation OR BME 4XX Biomedical Machine Learning Programming and computational analysis principles and techniques for various problems in embedded programming, applied computation, and signal processing.	2	E&C-ENGR 216
ME 401 Introduction to Biomaterials OR BME 4XX Biomaterials Current and new technical developments in mechanical engineering.	3	None listed in Pathway
ME 492 Mechanical Design Synthesis I Introduction to and application of the Engineering Design Process including: product development, needs identification, benchmarking, information gathering, concept generation, creativity methods, concept selection, professional and ethical responsibilities, and computer-aided design and rapid prototyping applications. A comprehensive design project including 3D CAD models and functioning prototypes is required.  OR  CS 304WI Ethical Issues in Computing and Engineering (Civic Engagement) ( <i>UMKC Essentials</i> ) Societal and ethical obligations of computer science, information technology, and electrical/computer engineering practice. Topics include obligations of professional practice, electronic privacy, intellectual property, ethical issues in networking, computer security, computer reliability, and whistle-blowing.	3	3D modeling experience recommended  OR  Roo Writer

31 credit hours

### New Biomedical Engineering Courses

Course and Description	CR	Pre-reqs
BME 1XX Intro to Biomedical Engineering	1	None
BME 1XX 3D Modeling and 3D Printing for Biomedical Engineering	1	None
BME 3XX Biomedical Inst. & Meas. Lab	4	TBD
BME 3XX Biomedical Transport	3	TBD
BME 3XX Biomedical Systems Physiology	3	TBD
BME 4XX Biomedical Design Synthesis (Capstone Design)	3	Senior Status

15 credit hours

**Engineering Credits: 46 credit hours (without technical electives included)**

### Technical Electives (400 level: can include Engineering, Biology, Chemistry, etc.)

Course and Description	CR	Pre-reqs
BME 4XX Technical Elective	3	Varies – Senior Status
BME 4XX Technical Elective	3	Varies – Senior Status
BME 4XX Technical Elective	3	Varies – Senior Status

9 credit hours

**Engineering Credits: 55 credit hours (with technical electives included)**

## General Education Courses

First Semester Experience ( <i>UMKC Essentials</i> )	3
Written Communication I ( <i>UMKC Essentials</i> )	3
Written Communication II (Technical Writing recommended) ( <i>UMKC Essentials</i> )	3
Oral Communication ( <i>UMKC Essentials</i> )	3
Critical Thinking in Arts & Humanities ( <i>UMKC Essentials</i> )	3
Critical Thinking in Social & Behavioral Sciences ( <i>UMKC Essentials</i> )	3
Culture and Diversity ( <i>UMKC Essentials</i> )	3
ME 492 Mechanical Design Synthesis I OR CS 304WI Ethical Issues in Computing and Engineering (Civic Engagement) ( <i>UMKC Essentials</i> )	3
MATH 266 Accelerated Calculus I (Math Requirement) ( <i>UMKC Essentials</i> )	4
CE 275 Engineering Statics (Critical Thinking in Natural & Physical Sciences) ( <i>UMKC Essentials</i> )	3
POL-SCI 210 OR HIST 101 OR HIST 102 - MO Const. Requirement	3

**General Education Credits: 34 credit hours (NOTE 10 credit hours double count for math, computer science, and engineering: MATH 266, CE 275, & ME 492 or CS 304WI)**

	Fall 21	Spring 22	Fall 22	Spring 23	Fall 23	Spring 24	Fall 24	Spring 25
<b>1st year - Fall</b>								
MATH 266 Accelerated Calculus I ( <i>UMKC Essentials</i> )	X	X	X	X	X	X	X	X
CHEM 211 General Chemistry	X	X	X	X	X	X	X	X
CHEM 211L General Chemistry Lab	X	X	X	X	X	X	X	X
BME 1XX Intro to Biomedical Engineering	X		X		X		X	
First Semester Experience ( <i>UMKC Essentials</i> )	X		X		X		X	
Written Communication I ( <i>UMKC Essentials</i> )	X	X	X	X	X	X	X	X
<b>1st year - Spring</b>								
MATH 268 Accelerated Calculus II		X		X		X		X
PHYS 240 Physics for Science and Engineering I	X	X	X	X	X	X	X	X
CHEM 212R General Chemistry II	X	X	X	X	X	X	X	X
CHEM 212LR General Chemistry II Lab	X	X	X	X	X	X	X	X
BME 1XX 3D Modeling and 3D Printing for Biomedical Engineering		X		X		X		X
Oral Communication ( <i>UMKC Essentials</i> )	X	X	X	X	X	X	X	X
<b>2nd year - Fall</b>								
MATH 250 Calculus III	X	X	X	X	X	X	X	X
PHYS 250 Physics for Science & Engineering II	X	X	X	X	X	X	X	X
BIOL 108 General Biology I	X	X	X	X	X	X	X	X
BIOL 108L General Biology I Lab	X	X	X	X	X	X	X	X
CE 275 Engineering Statics ( <i>UMKC Essentials</i> )	X	X	X	X	X	X	X	X
<b>2nd year - Spring</b>								
MATH 345 Differential Equations	X	X	X	X	X	X	X	X
ECE 216 Engineering Computation	X	X	X	X	X	X	X	X
BIOL 202 Cell Biology	X	X	X	X	X	X	X	X
CE 276 Strength of Materials		X		X		X		X
Critical Thinking in Arts & Humanities ( <i>UMKC Essentials</i> )	X	X	X	X	X	X	X	X
<b>3rd year - Fall</b>								
BIOL 304 Biostatistics I	X		X		X		X	
ECE 380/381 Signals and Systems (with Lab) OR BME 3XX Biomedical Signals and Systems	X		X		X		X	
ME 351 Fluid Mechanics	X		X		X		X	
Written Communication II (Technical Writing recommended) ( <i>UMKC Essentials</i> )	X	X	X	X	X	X	X	X
HLSC 120 Anatomy and Physiology I	X		X		X		X	
<b>3rd year - Spring</b>								
Critical Thinking in Social & Behavioral Sciences ( <i>UMKC Essentials</i> )	X	X	X	X	X	X	X	X
ECE 276 Circuit Theory I		X		X		X		X
ECE 277 Circuit Theory I Lab		X		X		X		X
ME 299 Thermodynamics OR ME 285 Dynamics		X		X		X		X
ECE 420 Advanced Engineering Computation OR BME 4XX Biomedical Machine Learning		X		X		X		X
BME 3XX Biomedical Inst. & Meas. Lab						X		X
<b>4th year - Fall</b>								
ME 492 Mechanical Design Synthesis I OR CS 304WI Ethical Issues in Computing and Engineering (Civic Engagement) ( <i>UMKC Essentials</i> )	X		X		X		X	
Culture and Diversity ( <i>UMKC Essentials</i> )	X	X	X	X	X	X	X	X
BME 3XX Biomedical Systems Physiology							X	
ME 401 Introduction to Biomaterials OR BME 4XX Biomaterials	X		X		X		X	
BME 4XX Technical Elective							X	X
BME 4XX Technical Elective							X	X
<b>4th year - Spring</b>								
BME 4XX Biomedical Design Synthesis (Capstone Design)								X
POL-SCI 210 OR HIST 101 OR HIST 102 - MO Const. Requirement***	X	X	X	X	X	X	X	X
BME 3XX Biomedical Transport								X
BME 4XX Technical Elective							X	X
BME 4XX Technical Elective							X	X

New Degree Program Proposal:

**Bachelor of Science in  
Biomedical Engineering**

University of Missouri – Kansas City  
*November 2021 Board of Curators Meeting*

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## Executive Summary

The Bachelor of Science in Biomedical Engineering (BSBME) degree is a four-year undergraduate degree consisting of 127 credit hours. Interest in BSBME degrees from high school students has seen tremendous growth in the last two decades and is a pathway to a needed career, graduate research degrees and medical school. Within the School of Computing and Engineering at UMKC (SCE), computing and engineering academic and research programming related to bio and health technologies has increased at an astounding rate with more than 20% of the research and its related coursework being within biomedical engineering. The BSBME degree also fits perfectly within Kansas City's role in the "Animal Health Corridor", the local research hospitals, St. Luke's and Children's Mercy, and the UMKC's Health Science Campus, including the schools of Medicine, Dentistry, Pharmacy and Nursing. Faculty responsible for the BSBME program will consist of professors and medical professionals from multiple schools and departments on UMKC's campus (including engineering, medicine, pharmacy, dentistry, nursing, and the bio sciences) all of whom will be included in teaching classes, providing research opportunities, participating in seminar series, and guest lecturing for the BSBME program.

According to nationally published data, the Healthcare and Social Assistance Industry has been the largest and the fastest growing employment sector in the greater Kansas City area. The healthcare sector of the greater Kansas City area comprises 11.5 percent of the region's jobs and represents the fastest-growing industry, averaging over 3000 new jobs per year over the last decade. Recent data published by the Economic Development Corporation of the City of Kansas City, Missouri shows that out of the top twenty-one (21) employers in the Kansas City area, eight (8) top employers are in the medical and healthcare service sectors. The health care sectors of the greater Kansas City (MO & KS) area have a combined workforce of more than 200,000 and contribute more than \$10 billion annually to the regional economy. The greater Kansas City area depends on biomedical engineering professionals to ensure access to the cutting-edge medical and health care technologies leading to the highest levels of medical treatments, drugs, equipment, and assessment technologies. This needed workforce and the healthcare challenges due to an aging population will drive the need for new, cost-effective innovations in medical devices, biomaterials, and data analytics. The proposed BSBME degree will bolster the technical competency of the healthcare industry in the Kansas City area and provide the workforce for jobs that will make significant contributions to the continued growth and economic development of this field and the region.

The Burning Glass reports show job growth for graduates with a Bachelor of Science in Biomedical Engineering as high in the Kansas City area, as well as across Kansas and Missouri. Problem solving is the backbone of any engineering discipline and is reinforced throughout the entire BSBME curriculum, making these students excellent potential employees for a variety of jobs outside of healthcare as well. Many will become entrepreneurs, technology assessment specialists, doctors and more.

The BSBME program will require little to no initial resources to begin matriculating students. SCE's new research facility already has the necessary labs for both the academic and research associated with such a degree. SCE already has sufficient faculty expertise and staff for this degree. The program will be revenue positive from year one and will only grow in net revenue each of the following three years, at which time SCE will make the decision whether to go steady-state in size or continue growing.

## **1. Introduction**

The Bachelor of Science in Biomedical Engineering (BSBME) degree is a four-year undergraduate degree consisting of 127 credit hours. The BSBME degree program is designed to provide a four-year undergraduate education in the broad field of biomedical engineering. Biomedical engineering is a discipline that combines biological and chemical sciences with multiple fields of engineering, including mechanical and electrical. The proposed biomedical engineering program provides an extensive curriculum that prepares graduates for careers and/or advanced study in engineering, health care, medicine, dentistry, biotechnology, bioinformatics, and pharmaceutical fields.

UMKC's long history of excellence in health science, life science and biological science-related disciplines, together with the rapidly growing disciplines of computing, engineering and other STEM fields, provides a very strong platform to start this new interdisciplinary undergraduate degree in biomedical engineering. There has been a high volume of collaborative academic and research projects among the faculty members and researchers from SCE and the academic units of the UMKC's Hospital Hill campus.

In recent years, the interest in computing and engineering academic and research collaboration related to bio and health technologies is increasing at an astounding rate. The proposed BSBME would provide a very effective platform to strengthen and institutionalize these collaborative efforts in engineering, computer science, and bio and health technology-related education, outreach, and research.

Typically, in any metropolitan city of the size and characteristics of Kansas City, more than one university offers degrees in biomedical engineering and technology to serve the needs of industry and academia. This BSBME degree will be the first and only such degree in Kansas City. An undergraduate degree in biomedical engineering will fit perfectly with UMKC's current strength in medical, health and biological science, and technology. This degree will also fit perfectly with Kansas City's role in the "Animal Health Corridor", the research hospitals, St. Luke's and Children's Mercy, and the UMKC's Health Science Campus, the schools of Medicine, Dentistry, Pharmacy and Nursing,

UMKC's School of Computing and Engineering (SCE) is Kansas City's only accredited school for engineering and computer science, and Kansas City has been the center of healthcare service and biotechnology companies in the region for many decades. Not



having degree programs in Biomedical Engineering is a serious disservice to the population of this region. There is also an urgent need to increase representation of female and minority students in STEM disciplines. Typically, BSBME programs have a much higher percentage of female and minority students than the traditional engineering degree programs. The goal of diversifying the STEM degree programs at SCE will be greatly enhanced with this new degree offering.

It should be noted that no big investments are necessary to start and maintain this program. Additional resources (including new faculty hires) will only be needed as the enrollments and revenues grow. Approximately 90% of the required and elective courses are currently offered at UMKC. Currently, SCE has more than 15 faculty that perform research in the biomedical fields and are qualified by degrees and expertise to teach BSBME courses. These faculty members in SCE are working with faculty in other participating units to develop several new courses that will fulfill the elective options within the BSBME. In the current four-year plan, a total of six new required courses would need to be created. These courses would need to be taught by faculty with expertise in the area of biomedical engineering. Initially, SCE will not need to hire any new faculty to implement the new program; the hiring of new faculty will occur as the undergraduate population grows.

The person responsible for the BSBME program is Dr. Katherine Bloemker, Assistant Dean of Academic Affairs in the School of Computing and Engineering. Dr. Bloemker is also Teaching Faculty in the Civil & Mechanical Engineering Department and will assist with the teaching in the BSBME program due to her academic experience and research in Biomechanics and Bio-Design.

Contact Information: Phone: (816) 235-5639, E-mail: [bloemkerk@umkc.edu](mailto:bloemkerk@umkc.edu).

## **2. University Mission & Program Analysis**

### **2.A. Alignment with University Mission & Goals**

The BSBME supports SCE's goal of increasing degree and discipline options in the STEM fields. The BSBME Program is highly supported by Dean Truman. See attached Letter of Support: [LOS BSBME MSBMS - Truman.pdf](#). The BSBME helps to support Chancellor Agrawal's vision of increasing the size of UMKC.

The UMKC Mission Statement reads as follows:

*"As an urban research university, our mission at the University of Missouri-Kansas City is to promote learning through the discovery, preservation and dissemination of knowledge of public value across a broad spectrum of disciplines and fields of study. UMKC celebrates the individual and embodies diversity and inclusion by intertwining these goals with innovation to enable transformational impact aimed at bringing cultural, social, health and economic prosperity to the metropolitan, regional and global communities we serve."*

The BSBME supports the University vision to promote interdisciplinary education and research. The proposed BSBME is aligned with UMKC's overall Mission particularly in the first line (underlined above). This program is, by definition, comprised of a broad spectrum of disciplines and fields of study. Students who complete the BS in Biomedical Engineering will take courses in a wide range of disciplines, including Biology, Chemistry, Computer Science, Electrical Engineering, Mathematics, Mechanical Engineering, Physiology, and Statistics.

The goals for the BSBME program are listed in the following table:

Goal 1:	Students have the fundamental technical and scientific skills that prepare them for immediate employment in or the pursuit of an advanced degree related to Biomedical Engineering
Goal 2:	Students apply the necessary problem-solving skills for contributing to and advancing in industry
Goal 3:	Students apply the necessary design skills for successfully contributing to and advancing in industry
Goal 4:	Students apply the necessary application skills in sub-specialties of Biomedical Engineering to operate in a competitive global community

These goals map onto the five pillars of the UMKC Strategic Plan as follows:

1. Provide exceptional student learning, success and experience
  - *All four of the program goals align with this pillar.*
2. Become a thriving discovery enterprise
  - *Goals 3 and 4 align with this pillar.*
3. Transform our community and region with impactful engagement
  - *Goals 2 and 3 align with this pillar.*
4. Foster an environment of invigorating multiculturalism, globalism, diversity and inclusion
  - *Goal 4 aligns with this pillar.*
5. Develop a strong and resilient people, process and physical infrastructure
  - *All four of the program goals align with this pillar.*

UMKC's Schools of Medicine and Dentistry partner with leading hospitals in Kansas City to provide students and residents with outstanding medical education. New avenues of health care, medical education, and services will be possible if UMKC and its partner hospitals can extend the collaboration to biomedical equipment and biotechnology companies and research organizations in the region and across the

nation. The School of Pharmacy has a mission of shaping the future of healthcare and improving lives. The School of Biological and Chemical Science (SBCS) faculty members are working to develop interdisciplinary and collaborative approaches to education and research to ensure that graduates are ready to immediately contribute to the demands of a 21st century workplace. Most of the Pharmacy and SBCS graduates become part of the healthcare and biotechnology workforce. The School of Nursing and Health Studies has been making continuous efforts to remain a premier academic institution by updating and upgrading its curriculum in response to the changing health care landscape, which has become a data science and biotechnology-driven sector. The proposed BSBME degree program would directly serve these missions.

## **2.B. Duplication & Collaboration within Campus, Across System**

Within the UM System, only UM-Columbia currently offers a BS degree in Biomedical Engineering. Missouri S&T only offers a minor in Biomedical Engineering. The proposed BSBME degree at UMKC is unique and comprehensive due to its interdisciplinary nature and the diverse combination of focus areas and interests. In addition, the proposed BSBME program would be the only such undergraduate program in the greater Kansas City area.

Construction was just recently completed on the new engineering lab building for SCE with an anticipated full open of all labs in Spring 2021. The Robert W. Plaster Free Enterprise and Research Center (FERC) is a 57,800 square-foot facility which will house a variety of cutting-edge research and teaching labs, including a structural high-bay, bio-nano-clean room, unmanned vehicle suite, advanced 3-D printing including bioprinting, augmented and virtual reality training, gait (motion capture) laboratory, big data, and renewable energy labs amongst many others. This new facility provides SCE with the ability to build and foster laboratory and research capabilities necessary for a world-class biomedical engineering program.

The uniqueness of the BSBME program comes from UMKC's proximity to the health care companies and hospitals located in Kansas City along with the UMKC Health Science Campus (Schools of Medicine, Dentistry, Pharmacy, and Nursing). The School of Computing and Engineering currently has significant ongoing research with all four Health Science schools accounting for 20% of SCE's \$35-40m, 3-yr research portfolio. St. Luke's and Children's Mercy Hospitals have verbally agreed to create year-long internship positions for juniors and seniors in the BSBME program. These internships will be in parallel to the coursework the students are taking, which can only be accomplished if the educational component (faculty and labs) is in close proximity to the facilities. Additionally, the School of Medicine will encourage the pre-med and medical students to take several of the courses related to biotechnology.

With the expertise of the biomedical faculty across the UM System, all of the biomedical programs can be enhanced substantially by coordinating with the other

universities. Specifically, the range of elective offerings can be augmented by using system-wide courses from UM-Columbia and Missouri S&T (and they can use UMKC courses). The biomedical faculty in SCE have already reached out to faculty at UM-Columbia and Missouri S&T to develop a course-sharing strategy. It was determined through these conversations that the biomedical program at UMKC and UM-Columbia can be mutually beneficial due to the differences in expertise on each campus.

UMKC currently excels in the area of biomechanics with a number of mechanical and civil engineering faculty already teaching elective courses and performing research in that subject area. UM-Columbia stated the need for more biomechanics-focused elective courses. UMKC would be able to share courses such as Biomechanics, Biodynamics, and Experimental Biomechanics of Human Motion. The biomechanics faculty at UMKC are already in the process of adding more elective courses which could be added to this list.

In addition to biomechanics, UMKC is in the process of building expertise in the area of biomaterials. Two senior level and graduate courses are currently offered with a number of others in the pipeline in the next year or two. This will be a great opportunity for course sharing with other UM-System biomedical programs as these additional elective offerings become available.

UM-Columbia currently excels in the areas of bioengineering and biomedical imaging and suggested the ability to share elective courses with UMKC students; these courses include Biomedical Imaging, Tissue Engineering, and Bioprocessing. This would allow UMKC students to gain valuable elective experience in an area that is not currently available on campus.

In addition, UM-Columbia currently offers undergraduate classes which are mainly online, such as Biomedical Instrumentation and Biomedical Senior Design. These are two required courses that UMKC will need to add to the curriculum by year 3 and 4 of the program. Course sharing with UM-Columbia could allow UMKC the luxury of continuing to use these online courses long-term or deciding to add regular faculty to teach these required courses as the program and revenue grows.

Finally, UM-Columbia offers a completely online certificate program which consists of four classes, including an extremely beneficial regulatory course, which would be extremely useful to UMKC biomedical students.

The proposed BSBME program at UMKC requires 127 credit hours, which on par with competitive programs in the region. The following table shows the opportunities and requirements at the regional universities. Please note that the UMKC program is equal to or less than all of the other public universities in credit hour requirements.

<b>University</b>	<b>Program</b>	<b>Credit Hours</b>
K-State	Bachelors in Biomedical Engineering	128 credit hours
KU	Certificate in Bioengineering	30 credit hours
Wichita State	Bachelors in Biomedical Engineering	128 credit hours
UM-Columbia	Bachelors in Biomedical Engineering	127 credit hours
WashU	Bachelors in Biomedical Engineering	120 credit hours
SLU	Bachelors in Biomedical Engineering	124 credit hours

### **3. Business-Related Criteria & Justification**

#### **3.A. Market Analysis**

##### **3.A.1. Rationale & Workforce Demand for the Program**

According to data published by Economic Modeling Specialist International for the period of 2004-2014, the Healthcare and Social Assistance Industry has been the largest and the fastest growing employment sector in the greater Kansas City area. There is a very important reason why the Kansas City employment data for the period of 2004-2014 is emphasized here. Due to economic slowdown, almost every sector in Kansas City and across the nation lost jobs between 2009 and 2011, but the health care industry in the Kansas City area added jobs during that very difficult economic situation. For the post-2014 period, the employment numbers and the workforce requirements of the health care and bio-technology related industries have further increased. Recent data published by the Economic Development Corporation of the City of Kansas City, Missouri shows that out of the top twenty-one (21) employers in the Kansas City area, eight (8) top employers are in the medical and healthcare service sectors<sup>1</sup>.

Overall, the health care sectors on the Kansas and Missouri sides of the greater Kansas City area have a combined workforce of more than 200,000 and contribute more than \$10 billion annually to the regional economy. Not only is the economy of this region heavily dependent on the health care industry, but the greater Kansas City area population depends on the health care service providers and professionals in the area to ensure their access to state-of-the-art medical treatment and health care technologies.

The healthcare sector is an important part of the greater Kansas City area's economy. It makes up 11.5 percent of the region's jobs, and is the fastest-growing industry, averaging over 3000 new jobs per year over the last decade. This trend is expected to continue, particularly as the Baby Boom generation ages; the proportion of the area's

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<sup>1</sup> <https://www.edckc.com/workforce-talent/major-employers/>

population aged 65 or older is expected to reach 18 percent by the year 2030<sup>2</sup>. This and other healthcare challenges will drive the need for new, cost-effective innovations in medical devices, biomaterials, and data analytics. The proposed BSBME degree will bolster the technical competency of the health care industry in the Kansas City area and provide jobs that would make significant contributions to the continued growth and economic development of this field.

The Burning Glass reports show job growth for graduates with a Bachelor of Science in Biomedical Engineering as high in both the Kansas City area, as well as across Kansas and Missouri. This is compared to an average job growth nationwide. Potential employers of graduates of a biomedical engineering degree program include biotech companies, bioanalytics firms, medical device companies, health industries, laboratories, government agencies, Veteran's Affairs, the computing industry, consulting groups, medical centers, and higher education.

The reports show top job industries for graduates in Biomedical Engineering as public administration; health care and social assistance; professional, scientific, and technical services; and manufacturing. Potential job titles include biomedical engineer, research associate, hospital management, data analyst, medical technician, scientific technician, project management, and medical coding.

Biomedical engineers in reality have very diverse career paths. They are trained to be analytical, creative problem solvers. Many have careers as bio device designers, sensor and material designers, biomedical researchers, technical business analysts, entrepreneurs, data analysts, doctors, medical management and much more. Many graduates use this technical training as a springboard into medical research, medical administration, medical technology consultancy, health administration, health-related software, and medical facilities designers.

The diversity in job titles and companies for these graduates makes it difficult for companies (databases) such as Burning Glass to capture the real number of jobs that are available for biomedical engineers. These graduates often land in companies outside of the traditional biomedical field that span the gambit of architecture (medical facility design) to Wall Street (medical startup evaluations). These jobs are nearly impossible to collect from traditional data sources.

Some key competencies of these potential employers include biomedical engineering, mechanical engineering, problem solving, research, biotechnology, medical technology, planning, communication skills, chemistry, physics, technical writing, medical imaging, data analysis, and project management.

The degree program prepares graduates in these competency areas through the curriculum. Students are required to take multiple courses in biomedical engineering, mechanical engineering, chemistry, and physics. Problem solving is the

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<sup>2</sup> [http://kcworkforce.com/Assets/reports/HealthCare\\_IndustryReport2013.pdf](http://kcworkforce.com/Assets/reports/HealthCare_IndustryReport2013.pdf)

backbone of any engineering discipline and is reinforced throughout the entire curriculum. Technical Writing is covered in the second written communication skills course as well as in upper-level engineering courses with lab and design reports. Research, communication skills, and project management are covered in numerous courses, culminating in the capstone design course taken during the last semester of the senior year.

For specific details in the Burning Glass Reports, see the market analysis in the appendix.

In the attachments, there are seven letters of support for the BSBME program. Four of these letters are from external entities including: two area hospitals (St. Luke's Hospital and Children's Mercy Hospital), one local medical technology company (RBC Medical Innovations), and one from the Kansas City Animal Health Corridor (KCAHC).

The letter from Dr. John Spertus at St. Luke's Mid-America Heart Institute indicates numerous ways in which the biomedical engineering students will be able to collaborate with professionals at the hospital "through technology transfer, internships, and research." He also notes that "biodevices, biomaterials and bioinformatics have been projected to be a trillion-dollar market in the coming years." Dr. Spertus adds that with this growth, the market will be in high need of trained biomedical engineering graduates.

The letter from Dr. Mark Hoffman at Children's Mercy Hospital points out that graduates with degrees in biomedical engineering "will be in demand as Children's Mercy, Cerner and other local employers seek to hire people who can effectively work in the space between the clinical and technical." In addition, Dr. Hoffman has expressed that he will advocate for collaborative opportunities, such as internships and student projects, to allow for biomedical engineering students to gain practical experience working at Children's Mercy.

There is also a letter from Corbin Reagan, the Director of Engineering at RBC Medical Innovations, which is a medical technology engineering company located in the Kansas City metro region (Lenexa, Kansas). Mr. Reagan specifically expresses that RBC has hired a number of UMKC engineering graduates in the past and has been very pleased with their knowledge and skillsets. With these newly proposed biomedical engineering programs, RBC would have additional motivation to hire UMKC graduates. In addition, RBC would be able to partner with the biomedical engineering students through internships, research collaborations, and senior design projects.

The Kansas City Animal Health Corridor (KCAHC) currently works in partnership with regional academic institutions to pipeline skilled talent into the animal health industry. The letter from Kimberly Young, the president of KCAHC, commits to work "with UMKC faculty and staff to share student resumes with regional animal health employers." This partnership will open up a vast array of employment opportunities to the future UMKC biomedical engineering graduates.

Although we did not provide specific letters, it should be noted that MRI Global, formerly Midwest Research Institute, and Stower’s Research Institute are both located next door to campus. Both Institutes are involved in high level biomedical research and have expressed interest in biomedical engineering graduates to help bolster their research teams.

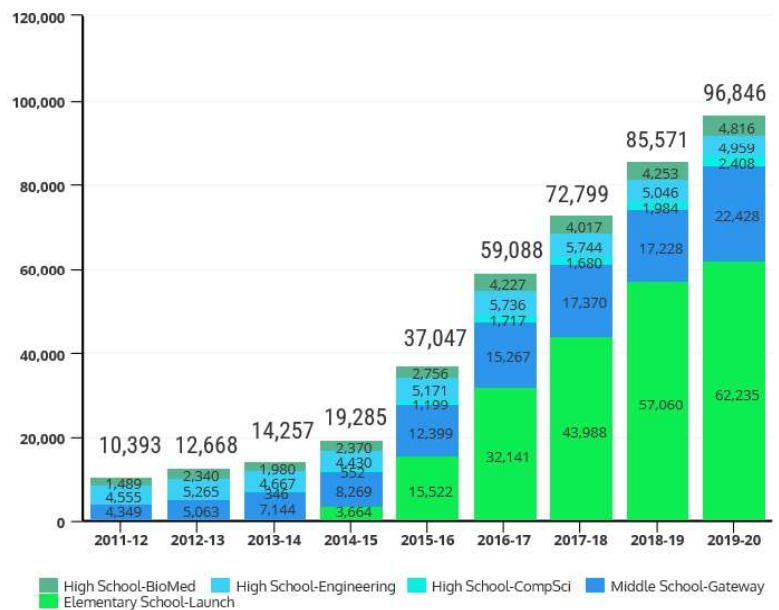
In addition to the provided external letters of support, there are three internal letters of support including letters from: Jennifer Lundgren, Provost of UMKC; Kevin Truman, Dean of SCE; and Mary Anne Jackson, Dean of the School of Medicine.

### 3.A.2. Student Demand for the Program

Biomedical engineering is an extremely popular field for graduating high school students across the US. SCE fields many questions from prospective students about the possibility of studying biomedical engineering as an undergraduate degree. Although we do not have statistics, anecdotally it has been a question that arises frequently. Currently, the best option we can recommend to those students is to pursue the BS degree in a traditional engineering field (such as mechanical or electrical) and then gain exposure to biomedical engineering topics through senior electives and graduate programs.

The KC STEM Alliance is an independent agency managed through the School of Computing and Engineering and serves as SCE’s primary K-12 outreach program. Funding to support the Alliance comes from a multi-year grant from the Ewing Marion Kauffman Foundation and from area STEM related companies, grants, and other non-profit agencies and organizations. The KC STEM Alliance is currently serving more than 90,000 students in the area with programming such as Project Lead the Way (STEM coursework and programming for area K-12 schools) and KC FIRST (competitive robotics programming), as well as several other programs aimed to engage young people in STEM learning.

KC Metro Region  
PLTW Student Enrollment Growth





The Project Lead the Way (PLTW) high school program consists of three separate curriculum tracks: Biomedical, Engineering, and Computer Science. The following table and accompanying figure show the number of Kansas City area high school students participating in PLTW in the Biomedical Track, the Engineering Track, and the Computer Science Track.<sup>3</sup> Note that Biomedical is nearly as high in participation in KC area high school students as is general engineering which encompasses all of the other engineering disciplines (mechanical, electrical, civil, etc.).

<b>Year</b>	<b>Biomedical Enrollment</b>	<b>Engineering Enrollment</b>	<b>Computer Science Enrollment</b>
2016-2017	4,227	5,736	1,717
2017-2018	4,017	5,744	1,680
2018-2019	4,253	5,046	1,984
2019-2020	4,816	4,959	2,408
<i>4 year AVG</i>	<i>4,328</i>	<i>5,371</i>	<i>1,947</i>

In the 2019-2020 academic year the undergraduate enrollments in SCE for all engineering disciplines (ME, CE, and ECE) was 588 students and for computer science was 339 students. The SCE enrollments are 11% and 17% of the average PLTW enrollments in engineering and computer science, respectively. Hypothetically, if we follow a similar trend to engineering for biomedical and assume 10% of the PLTW students would enroll in the biomedical engineering program at UMKC that puts total enrollments at 432 total students. Out of conservatism and understanding that some of these students will choose more traditional medical or biological paths we can bump that percentage down to 5% and that still puts enrollment at 216 students which is almost 50% above our five-year estimate at 146 students. To meet our projection, we would only need to get 3.4% of these PLTW students which is substantially lower than our comparable engineering and computer science program percentages. In addition, there are definitely some students in the engineering track in PLTW that we are losing due to the fact that we do not currently have degrees in biomedical engineering which would potentially add to this population even further.

If we look at only the 2019-2020 school year and break it out into specific PLTW Biomedical courses across the KC metro region, there were 2,275 in the Principles of Biomedical Science course, 1,270 in the Human Body Systems course, 518 in the Medical Interventions course, and 253 in the Biomedical Innovation course which is the senior level course in the track. Using this data, we came up with our initial estimate for incoming freshmen is 25 students which is 10% of the enrollment in this senior course in the KC metro area.

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<sup>3</sup> <https://www.kcstem.org/about/what-we-do/project-lead-the-way-2020-21/>

It is also important to note that the Biomedical Engineering discipline historically has been able to attract a very high number of female students as compared to other engineering disciplines. Recently published data presented a national average of 40.9% bachelor's degrees awarded to female students in biomedical engineering versus an average of 19.9% in all engineering disciplines.<sup>4</sup>

Currently in SCE, numerous biomedical elective courses are already offered. The demand for these courses has been consistently high and comparable to other elective courses in our traditional engineering disciplines. For example, in the biomedical courses offered over the past two years just in the mechanical engineering program (Biomaterials, Biomechanics, Biodynamics, Experimental Biomechanics of Human Motion, and Biomedical Device Design), there has been an average of 31 total undergraduate students enrolled (in both 2019 and 2020).

Undergraduate enrollment over the past three years at a few select regional universities is summarized in the following table.

University	Program	Enrollment		
		2018	2019	2020
K-State	Bachelors in Biomedical Engineering	42	79	85
KU	Certificate in Bioengineering	26	49	38
Wichita State	Bachelors in Biomedical Engineering	237	232	190
UM-Columbia	Bachelors in Biomedical Engineering	26	71	191

The enrollment projections shown in the following table have an estimated starting enrollment of 25 students with a growth of 10 students per year from there forward and a retention rate of 75% per year for the undergraduate program. See attachment: [BS Biomed Proforma.xlsx](#).

**Table 1a. Student Enrollment Projections** (anticipated total number of students enrolled in the program during the first five fall semesters following implementation.)

Year:	1	2	3	4	5
Full-time	25	54	85	119	146
Part-time	0	0	0	0	0
<b>Total</b>	25	54	85	119	146

<sup>4</sup> <https://www.asee.org/papers-and-publications/publications/college-profiles/15EngineeringbytheNumbersPart1.pdf>

**Table 1b. New Student Enrollment Projections** (anticipated number of students enrolled in the program during the first five fall semesters following implementation that are new to the University.)

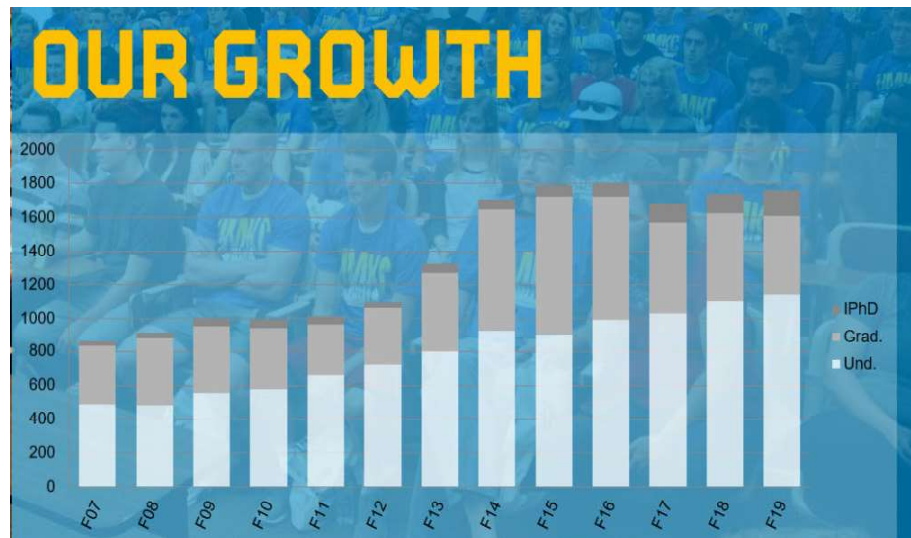
<b>Fiscal Year:</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Full-time</b>	25	54	85	119	146
<b>Part-time</b>	0	0	0	0	0
<b>Total</b>	25	54	85	119	146

**Table 1c. Projected Number of Degrees Awarded**

<b>Year:</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
<b># of Degrees Awarded</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>11</b>	<b>15</b>	<b>19</b>	<b>23</b>	<b>28</b>	<b>32</b>	<b>36</b>

In addition to specific demand indicated for a biomedical engineering degree, these enrollment projections are also in line with what we have seen from other UMKC computing and engineering programs. In 2019-2020, SCE had an undergraduate enrollment of 249 in Electrical & Computer Engineering, 121 in Civil Engineering, 339 in Computer Science, 70 in Information Technology, and 218 in Mechanical Engineering.

The undergraduate enrollments in SCE (including Electrical & Computer Engineering, Civil Engineering, Computer Science, Information Technology, and Mechanical Engineering) have grown from 490 in 2008 to 1,140 in 2019 with retention rates increasing from 60% to 82% and full-time students increasing from 47% to 79%. Growth of SCE over the past 10 year is shown in the figure.



### **3.B. Financial Projections**

A pro forma worksheet with financial projections is included, see attachment: *BS Biomed Proforma.xlsx*.

#### **3.B.1. Additional Resources Needed**

Costs include faculty and support salaries and benefits; start-up packages; course development; non-capital equipment; supplies; travel and training; and miscellaneous expenses. Hiring of an adjunct faculty member is planned for year 1 and second in year 2. Hiring of an additional full-time faculty member is planned for years 3, 4, and 5.

#### **3.B.2. Revenue**

The sources of revenue include tuition and fees for new students. No financial support is being provided by the university. No external funds are being used.

### 3.B.3. Net Revenue

Annual revenue will exceed annual expenses and the program will break even in the first year.

**Table 2. Financial Projections for Proposed Program for Years 1 Through 5.**

	Year 1	Year 2	Year 3	Year 4	Year 5
<b>1. Expenses per year</b>					
<b>A. One-time</b>					
<i>New/Renovated Space</i>	0	0	0	0	0
<i>Equipment</i>	0	0	0	0	0
<i>Library</i>	0	0	0	0	0
<i>Consultants</i>	0	0	0	0	0
<i>Others (start-up costs)</i>	0	0	60000	120000	150000
<b>Total one-time</b>	0	0	60000	120000	150000
<b>B. Recurring</b>					
<i>Faculty</i>	7650	15606	111427	211074	306382
<i>Staff</i>	5100	5202	53060	54122	55204
<i>Benefits</i>	2809	3462	58209	92765	128047
<i>Equipment</i>	0	0	12732	12989	13249
<i>Library</i>	0	0	0	0	0
<i>Other (includes payroll outside of program)</i>	41900	82247	108487	135671	163944
<b>Total recurring</b>	57459	106544	343914	506621	666827
<b>Total expenses (A+B)</b>	57459	106544	403917	626621	816827
<b>2. Revenue per year</b>					
<i>Tuition/Fees</i>	252630	554018	896930	1275957	1600568
<i>Institutional Resources</i>	0	0	0	0	0
<i>State Aid – CBHE</i>	0	0	0	0	0
<i>State Aid – Other</i>	0	0	0	0	0
<b>Total revenue</b>	252630	554018	896930	1275957	1600568
<b>3. Net revenue (loss) per year</b>					
	195172	447474	493013	649336	783741
<b>4. Cumulative revenue (loss)</b>					
	181799*	629273	1122286	1771622	2555363

NOTE: \*Takes into account \$13,373 in expenditures in year 0 for support salary and course development.

A reduced enrollment analysis was completed to validate the financial strength of the new program. A prediction of 50% enrollment from our original estimates in the proforma was completed. Even at these low enrollment numbers, the BSBME program was still financially viable, showing satisfactory positive net revenue by the second year. For specific details, see the attachment: [\*BME reduced enrollment analysis.pdf\*](#).

### **3.B.4. Academic and Financial Viability**

Although revenues are positive even with the starting enrollment of 25 students, for steady-state viability, SCE believes that the BSBME program needs a total enrollment of 100 students. This provides approximately 25 per class which keeps all courses at a single section but provides a large enough cohort for the students to receive a positive and meaningful academic experience.

**Table 3. Enrollment for Academic and Financial Viability**

<b>Viability</b>	<b>Minimum Enrollment</b>
<b>Academic</b>	<b>100</b>
<b>Financial</b>	<b>100</b>
<b>Overall</b>	<b>100</b>

### **3.C. Business Plan: Marketing, Student Success, Transition & Exit Strategies**

#### **3.C.1. Marketing Plan**

UMKC and SCE recruiting units across campus will support marketing of the BSBME program to area high school students. The BSBME also will be included in existing marketing (mass email, printed pieces, websites, social media). SCE has a dedicated MCOM staff person who works in conjunction with SCE to market our programs.

Once the program is formally launched, the Dean of SCE will appoint a Degree Program Director or Chair who will serve as the point person to work with MCOM regarding recruitment and marketing efforts. At the preliminary stage to ensure its successful start, the Dean (Kevin Truman) and the Assistant Dean (Katherine Bloemker) will coordinate with MCOM directly and serve as the point persons for the proposed BS degree in Biomedical Engineering.

There were 46 high schools in the metro KC region that taught the Project Lead the Way Biomedical track in 2019-2020. The partnership with the KC STEM Alliance will be our main focus for marketing the new biomedical undergraduate program to high school students. We would mainly market directly to the metro KC region (as we do with our current engineering programs). We would also specifically target the Kansas side since there is no biomedical engineering undergraduate program at the University of Kansas, which is the closest other major university to the West.

#### **3.C.2. Student Success Plan**

In order to ensure high retention and graduation rates for BME students, there are a number of resources that will be available to all students including advising, career

services, support services, faculty mentorship, research opportunities, and student organizations. Each of these resources is laid out in detail in the following:

- **Roo Advising, Mobility Escalators, and Career Services**
  - Biomedical Engineering students will have access to all resources offered in Roo Advising, Mobility Escalators, and Career Services.
    - **Roo Advising** provides centralized, professional advisors ensuring that the students will remain on track for a four-year graduation. They will also advise the students on the BSBME/MSBME opportunity and the professional and career advantages of pursuing an MSBME as an add-on to the BSBME.
    - **Business/Engineering Mobility Escalator** is an enhancement to Roo Advising focusing on professional and career mentoring and counseling. These mentors and counselors provide guidance on careers, ethics, and workplace dynamics. In this escalator, the BSBME and MSBME students will be entwined with the business counselors that can provide a multitude of services and career possibilities for these students. These counselors and mentors will help guide these students to the appropriate BME related career, whether it be research, biotech, professional schools, biotech firms or startups.
    - **Career Services** professionals are available to help the students explore and prepare for applying and placement in internships and jobs. The Bloch School of Management and the School of Computing and Engineering have partnered on Career Fairs for several years with over 140 companies attending the last career fair. This will only grow as we invite the biomedical related firms from the Kansas City region to join the Career Fair.
  
- **SCE and Health Sciences Support Services**
  - The BSBME/MSBME students will have access to all current SCE support services.
    - **SCE Student Affairs** team is dedicated and works in concert with the UMKC Centralized Services. The SCE Student Affairs Team has **direct, connected access to the students, faculty, companies and other UMKC schools** and can provide a personalized approach consisting of guidance, connecting, and preparing individual students, academically and professionally.
      - **Guiding** students through their 4-yr curriculum.
      - **Connecting** the students with biotech, bioengineering and biomedical companies, internships, and UG/Grad research.
        - See below for a description of SCE's Career Connections Program.

- **Preparing** each student with customized professional school preparation and career guidance.
  - Since the implementation of the SCE Student Affairs team, SCE has seen improved retention from **50% in 2008 to an average of 79%** from 2016-2021. SCE's goal has been to be a "**pump and not a filter**"; so, every action is with that goal in mind. Every student admitted and entering SCE should be a future graduate.
- **Faculty mentors**
  - Each BME student will be assigned a faculty mentor to help with career and/or research guidance.
    - Mentors will be available from multiple disciplines including, engineering, natural sciences, and health sciences. Students will have the opportunity to select their faculty mentor(s) based on their specific biomedical areas of interest.
- **Undergraduate (and Graduate) Research Opportunities**
  - Undergraduate students in the biomedical program will have access to a multitude of undergraduate and graduate research opportunities.
  - Many current mechanical, electrical, and software engineering undergraduate and graduate students participate in biomedical engineering research within the Schools of Pharmacy, Dentistry and Medicine.
    - Approximately 25% of SCE's current funded research is within the Schools of Pharmacy, Dentistry and Medicine.
  - With the addition of biomedical engineering, the number of research opportunities, courses, internships and contacts to the Schools of Biological Sciences, Medicine, Dentistry and Pharmacy will increase dramatically.
- **Student Chapter of the Biomedical Engineering Society**
  - Once the Biomedical Engineering program is approved and matriculates its first cohort of students, it is planned to add a student chapter of the Biomedical Engineering Society (BMES).
  - As with all of SCE's current societies, this engineering society will provide a place for biomedical engineering students to connect with other students and companies, attend conferences, participate in student events, and have the potential for leadership opportunities.

In order to help BME students with job placement, there are a number of resources that will be available to all students including career services, career connections,



career fairs, internship opportunities, and mobility escalators. Each of these resources is laid out in detail in the following:

- **UMKC and SCE Career Services**

- Biomedical Engineering students will have access to all services currently offered in the UMKC Career Services.
- Biomedical Engineering Students will have access to all services provided by the SCE Student Affairs Team and their faculty mentors. With the help of the SCE Student Affairs Team over the last 5 years:
  - 79% average retention of SCE students.
  - 80% of all SCE Juniors and Seniors have interned or had research opportunities.
  - 90+% of all SCE Seniors have had jobs as of graduation.
- **SCE's Career Connections Program**
  - All students in SCE (and UMKC) including those within the BME program have the ability to participate in SCE's Career Connections program. The SCE Student Affairs team brings in professionals from companies to provide insights into their day-to-day jobs (work) for BME professionals. These degree program related companies and their employees, in this case bio-related companies, are used to help students explore as many career possibilities as possible. There will be a variety of regional, bio-related companies included in the Career Connections Program.
- **Career Fairs**
  - One of the best places for students to connect with potential employers is career fairs. SCE participates in a career fair each year with the Bloch School of Management.
    - The last career fair held on campus for just business and engineering had over 140 companies and has proven to be an exceptional resource for students to connect directly with the regional and national job market.
    - Once the BME programs are in place, more biomedical focused companies will be invited to this career fair.
- **SCE's high employment placement rates**
  - It is expected that the biomedical engineering students will track with all other SCE engineering disciplines, which historically have extremely high employment placement rates, averaging 92% over the last five years, with placements locally and nationwide.
  - This placement rate is due to all the prescribed, personal UMKC and SCE support services, possible internships, career

connections, industrial capstone design projects, advisory boards and more.

- **UMKC Business and Engineering Mobility Escalator**
  - The Business and Engineering Mobility Escalator will be a good pipeline for BME students to find those connections between engineering, health sciences, and business, preparing them for biomedical related workplace(s), a research career or professional schools such as medicine, dentistry or pharmacy.

### **3.C.3. Transition Plan**

The individual primarily responsible for the BSBME program is Assistant Dean Katherine Bloemker. However, once the program is implemented a Degree Program Committee (DPC) will be formed comprised of current faculty with expertise in the biomedical fields. Having this standing committee will ensure a seamless transition in the event where any of the primary individuals can no longer fulfill the necessary duties for managing the program's day-to-day needs.

### **3.C.4. Exit Strategy**

If the situation arises that the program is underperforming expectations and financial viability is compromised, the Degree Program Committee (DPC) will be charged with providing a plan of action to improve enrollments and/or decrease expenditures. A three-year window will be allowed following the implementation of the action plan. Following the three years, if the revenues from the program are still not exceeding the expenditures, the Dean will decide whether a hiatus or discontinuation of the program is needed.

## **4. Institutional Capacity**

The BSBME program will require little to no initial resources (see the attached pro forma) to begin matriculating students. SCE's new research facility already has the necessary labs for both the academic and research associated with such a degree. SCE already has sufficient faculty expertise and staff for this degree. The addition of this degree will place a very small additional financial burden on SCE of approximately \$15k and \$25k in first two years. The program will be revenue positive from year one and will only grow in net revenue each of the following three years at which time SCE will make the decision whether to go steady-state in size or continue growing.

Initially, the Bachelor of Science in Biomedical Engineering (BSBME) will not place any new burden on the School of Computing and Engineering (SCE). The BSBME degree will be jointly administered, staff and faculty, by the SCE Departments of Civil

and Mechanical Engineering (CME) and Computer Science Electrical Engineering (CSEE). Once the program has grown, SCE leadership will decide if a separate department is optimal. SCE already has 6-7 faculty with advanced degrees or specialty research programs in the field of biomedical devices, biosensors, biomaterials, bioimaging, biomechanics and bioinformatics. These faculty coupled with other experts in other UMKC schools can cover the teaching (already teaching most of the proposed courses as electives) and research needs of the BSBME for the first several years. New faculty will only be added once the program has sufficiently increased enrollments and needs more expertise.

Being in Kansas City, SCE can also rely on community experts as adjunct faculty that have expertise in areas where SCE faculty may not. These adjuncts provide a real-world education that students cannot typically get from a non-urban located university. Additionally, these adjuncts often provide internships and career guidance that is extremely beneficial for the students and ultimately SCE's recruitment efforts.

This degree is in large demand within SCE. Many students already pursue an emphasis in biomedical engineering by taking a large number of biomedical electives taught within SCE. SCE's enrollment will increase with the offering of this new degree with very little in up-front investments.

## 5. Program Characteristics

### 5.A. Program Outcomes

Achievement of the goals listed in section 2.A is assessed by the following Student Learning Outcomes (SLOs). Note that each outcome has specific goals mapped to it.

SLO 1:	Students will be able to use mathematics and biostatistical methods to solve problems.	G1, G2
SLO 2:	Students will be able to analyze fluid flow properties of thermal-fluid systems.	G1, G2
SLO 3:	Students will be able to design and implement biomedical engineering components.	G1, G3
SLO 4:	Students will be able to analyze biomedical systems and solve systems problems.	G1, G2, G4
SLO 5:	Students will be able to investigate characteristics of biomaterials.	G1, G3, G4
SLO 6:	Students will be able to use measurements to solve biomedical engineering problems.	G1, G2, G4

The full six-year assessment plan can be found in the attachment: [\*BSBME Assessment Plan.pdf\*](#)

## 5.B. Program Design & Content

The mapping of courses to the SLOs can be found in the attachment: [BSBME Curriculum Map.xlsx](#).

The four-year program plan with suggested sequence of courses can be found in the attachment: [BSBME 4 Year Prgm Plan.pdf](#).

The full list of courses with pre-requisites included can be found in the attachment: [BSME Proposed Classes.pdf](#).

The four-year course rotation for each course in the program can be found in the attachment: [BSBME 4 Year Course Rotation.xlsx](#).

## 5.C. Program Structure

### 5.C.1. Program Structure Form

1. **Total Credits Required for Graduation:** 127
2. **Residence requirements, if any:** None
3. **General education**
  - a. Total general education credits: 34\*
    - i. \*Calculus course is 4 credit hours, Additional 3 credit hours for the MO Constitution requirement. See attachment: [BSBME Proposed Classes.pdf](#).

Courses (specific course or distribution area and credit hours):

Course	Hrs	Course	Hrs	Course	Hrs
MATH 266 Accelerated Calculus I ( <i>Math</i> )	4*	Critical Thinking in Arts & Humanities	3	First Semester Experience	3
CIV-ENGR 275 Engineering Statics ( <i>Critical Thinking in the Natural Sciences</i> )	3	Critical Thinking in Social & Behavioral Sciences	3	Written Communication I	3
MEC-ENGR 492 Mechanical Design Synthesis I <i>OR</i>	3	Culture and Diversity	3	Oral Communication	3
COMP-SCI 304WI Ethical Issues in Computing and Engineering ( <i>Civic Engagement</i> )		POL-SCI 210 OR HIST 101 OR HIST 102 - MO Const. Requirement	3*	Written Communication II	3

#### 4. Major Requirements

a. Total credits specific to degree: 103\*\*

- i. \*\*10 credit hours fulfill both general education and math/engineering requirements. See attachment: [BSBME Proposed Classes.pdf](#).

Courses (specific course or distribution area and credit hours):

Course	Hrs	Course	Hrs	Course	Hrs
MATH 266 Accelerated Calculus I ( <i>Math Pathway</i> )	4**	CIV-ENGR 275 Engineering Statics ( <i>Critical Thinking in the Natural Sciences</i> )	3**	BME 1XX Intro to Biomedical Engineering	1
MATH 268 Accelerated Calculus II	3	CIV-ENGR 276 Strength of Materials	3	BME 1XX 3D Modeling and 3D Printing for Biomedical Engineering	1
MATH 250 Calculus III	4	ECE 216 Engineering Computation	3	BME 3XX Biomedical Inst. & Meas. Lab	4
MATH 345 Differential Equations	3	ECE 276 Circuit Theory I	3	BME 3XX Biomedical Systems Physiology	3
CHEM 211 General Chemistry	4	ECE 277 Circuit Theory I Lab	1	BME 3XX Biomedical Transport	3
CHEM 211L General Chemistry Lab	1	ECE 380 Signals and Systems	3	BME 4XX Biomedical Design Synthesis (Capstone Design)	3
CHEM 212R General Chemistry II	4	ECE 381 Signals and Systems Lab	1	Biomedical Technical Elective***	3
CHEM 212LR General Chemistry II Lab	1	ECE 420 Advanced Engineering Computation	2	Biomedical Technical Elective***	3
PHYS 240 Physics for Science and Engineering I	5	MEC-ENGR 299 Thermodynamics OR ME 285 Dynamics	3	Biomedical Technical Elective***	3
PHYS 250 Physics for Science & Engineering II	5	MEC-ENGR 351 Fluid Mechanics	3		
BIOL 108 General Biology I	3	MEC-ENGR 406 Introduction to Biomaterials	3		
BIOL 108L General Biology I Lab	1	MEC-ENGR 492 Mechanical Design Synthesis I OR	3**		
BIOL 202 Cell Biology	3	COMP-SCI 304WI Ethical Issues in Computing and Engineering ( <i>Civic Engagement</i> )			
BIOL 304 Biostatistics I	3				
HLSC 120 Anatomy and Physiology I	4				

**5. Free elective credits**

a. Total free elective credits: 0\*\*\*

- i. \*\*\*There are no free electives, however there are 9 credit hours of technical electives that the students can select from a number of options in multiple disciplines. See page 2 of attachment: [BSBME 4 Year Prgm Plan.pdf](#).

**6. Requirement for thesis, internship or other capstone experience:**

All senior students are required to take a capstone design class: Biomedical Design Synthesis.

**7. Any unique features such as interdepartmental cooperation:**

Required courses in the BSBME program will be taught by faculty members from both the Civil & Mechanical Engineering Department as well as the Computer Science Electrical Engineering Department. Technical Elective courses can come from a variety of degree programs including: Engineering, Biology, and Chemistry.

## **5.D. Program Goals and Assessment**

The student learning outcomes are assessed in the courses listed on the curriculum map with the letter A (see attachment: [BSBME Curriculum Map.xlsx](#)). Data is collected from the instructor of each course. Depending on the course, this data could be performance on a project, an exam question, a presentation, or a homework assignment. This performance data is provided to the program coordinator and the assessment coordinator for SCE (Assistant Dean Katherine Bloemker). Each student activity performance is broken into 3 categories (unacceptable, acceptable, and excellent). The target for achievement in all courses is that 80% of the students meet the acceptable or excellent level for the student activity relating to the particular outcome. The Degree Program Committee (DPC) will be responsible for program oversight.

In addition to regular campus assessment from HLC, the BSBME program will undergo routine accreditation through the EAC of ABET alongside SCE's five other currently accredited programs. ABET is a standing agenda item at all faculty meetings and all undergraduate faculty are well versed in the requirements needed to sustain ABET accreditation requirements and maintaining programmatic continuous improvement. The faculty in SCE are all individually involved in ABET accreditation measures, including course assessment, student work collection, PEO reviews, student survey reviews, and frequent interaction with advisory boards. It is planned that once implemented, the BSBME program will follow an assessment plan and structure very similar to those of the other five programs.

As mentioned previously, average undergraduate retention rates in SCE are about 82%. The goal for the BSBME program would be for both retention and graduation rates to be at or above the SCE average, definitely above 80%.

Placement rates for undergraduate engineering students in SCE is extremely high, nearing 90%. This is mainly due to the fact that over 90% of SCE's undergraduate students work at an internship while attending school. Many of those internships turn directly into full-time employment upon graduation. The goal for BSBME would be to stay at or above the current placement rates in SCE. However, it is assumed that a majority of the BSBME students will go on to the expedited MS program so placement out of the BSBME program will not focus on immediate employment, but either employment or graduate school.

## **5.E. Student Preparation**

High school students planning to apply to SCE are strongly encouraged to take a college preparatory program that emphasizes mathematics, science, and communication skills.

First-time college student applicants to the undergraduate program will be admitted if they obtain:

1. An ACT mathematics score of at least 25 and
2. An ACT composite score of at least 24

First-time college student applicants who do not meet the above criteria but do meet UMKC general admission requirements will have their applications reviewed by a committee for admission. Applicants who are not admitted to SCE but do meet UMKC general admission requirements may be admitted to University College.

Students without the prerequisite preparation must take the needed coursework before enrolling in courses required for the bachelor's degree. Students seeking re-admission must have been in good academic standing when last enrolled. Otherwise, re-admission requires a formal review by the undergraduate program committee.

Transfer applicants must have at least 24 credits of transferable college credit and an overall 2.0 GPA on a 4.0 scale in all coursework, which includes repeated coursework, attempted at previous institutions. Transfer applicants without a 2.0 or higher college GPA must submit a petition for admission.

## **5.F. Faculty and Administration**

More than thirty existing faculty members from the Schools of Biological and Chemical Sciences, Computing and Engineering, Dentistry, Medicine, Nursing and Health Sciences, and Pharmacy are identified to offer courses and research projects

related to biomedical engineering. See attachment for specific names and expertise areas: *Faculty Members for Biomedical Engineering v2.pdf*. It is estimated that near 100% of the credit hours in the program will be assigned to full-time faculty members. As needed, and as enrollments grow, adjunct instructors can be used for some elective courses, but it is planned that the required courses will be taught by full-time faculty members.

There will be select courses **that are team taught by medical professionals and biomedical engineering faculty**, but those specific courses are to be developed as the program progresses. There has been tremendous interest from the Health Science faculties to be involved and to be co-teachers in these courses; Pharmacy, Medicine, Dentistry, Nursing and Bio Sciences. The planned curriculum is infused with collaboration between engineering faculty and medical professionals. In each year, it is planned that students will have direct access to medical professionals through specific courses, experiences, field trips, projects, and seminars. The 5-year progression of these activities is as follows:

**Year 1: “Intro to Biomedical Engineering”**

- physician and medical professional guest lectures and speakers in addition to the technical bioengineering topics needed

**Year 2: “3D Modeling and Printing for Biomedical Engineering”**

- physician and medical professional guest lectures and speakers in addition to the technical bioengineering topics needed

**Year 3: Field trips within required courses**

- to the Health Science Campus and the research labs (Vision Center, Orthopedic Surgery, Center for Mineralized Tissue, School of Pharmacy, CMH, Truman, St. Luke’s) in order to discuss current and future biomedically engineered needs such as devices, software, imaging, drug delivery, informatics, personalized medicine, telemedicine, augmented reality and more.
- to develop potential ideas for projects, independent studies and directed reading courses.

**Year 4: Capstone Design course**

- industry, medical, and research sponsored projects (SCE has 15-20 industry projects a year for its current capstone design courses.)

**Year 5 (5-year BSMS): Graduate Biomedical Engineering Seminar**

- will include presentations from physicians and medical professionals in addition to bioengineers and biomedical researchers. Each week will bring a different topic or research area that pertains to the many facets of the biomedical engineering profession.



Assistant Dean Katherine Bloemker will be the primary point person for the program. In addition to Dr. Bloemker, a degree program committee (DPC) will be formed to help keep tracks of activities, students, and advising for the proposed BSBME Degree.

To start the degree program in Fall 2021, no new faculty is needed. New faculty hires will not be needed until students reach the 3<sup>rd</sup> year of the program – planned for Fall 2023. At that point, the department plans to hire an adjunct professor as well as a tenure-track professor to teach a portion of the required courses. Although the pro forma indicates hiring of an additional faculty member by year 4 and another by year 5, future hiring of tenure-track faculty will be based solely on growth in headcount and revenue generated.

## **5.G. Alumni and Employer Survey**

SCE plans to complete senior exit and alumni surveys for the BSBME program, just as is done in all other accredited programs in the school. Currently, all graduating seniors in the SCE programs are required to fill out a senior exit survey through Qualtrics. The survey asks about student outcomes, student experience, whether they have an engineering job or are planning to go to graduate school, whether they plan to or have taken the FE (Fundamentals of Engineering Exam – the first step towards licensure), and whether they plan to become licensed after their four years of experience is achieved.

In addition to the survey, all graduating seniors have a face-to-face senior exit interview with either their faculty advisor or the department chair before graduating. This interview allows the students to elaborate on their responses to the survey questions as well as give other feedback from their experience in the program. Once per accreditation cycle an alumni survey is sent out to all alumni from the SCE programs. The survey asks about student outcomes, whether they have an engineering job, whether they have a graduate degree, and whether they plan to or have become licensed. In addition to these surveys, the Dean of SCE routinely hosts lunches for alumni engagement for the school. At these lunches the Dean gives a state of the school. In addition, the alumni are informed about continuing education opportunities and upcoming alumni events.

SCE also plans to create an advisory board for the BSBME program, exactly like is currently done in all other accredited programs in the school. The advisory board members will represent employers of the program. The advisory board members are involved in maintaining a strong program. Since the advisory board members have a personal interest in SCE, their participation in developing objectives assures them that SCE is an association with which they can be proud. Following the procedures currently used in SCE, the advisory board will meet twice per semester to discuss the state of the program. These meetings generally include a school update from the dean or chairperson, an ABET update, board committee reports, board focus points for the year, and other announcements. Once per year the advisory board meets with

undergraduate students in each of their respective engineering programs. In addition, the faculty in the engineering programs also meet with their respective advisory boards once per year.

## **5.H. Program Accreditation**

SCE currently had three undergraduate programs accredited through the EAC of ABET (Civil Engineering, Electrical & Computer Engineering, and Mechanical Engineering) and two accredited programs through the CAC of ABET (Computer Science and Information Technology). SCE plans to have the Biomedical Engineering program accredited through the EAC of ABET. The major curriculum requirements for ABET accreditation of a Biomedical Engineering Program which have been planned into the Four-year plan are: (1) A minimum of 30 credit hours in math and basic sciences, including calculus, differential equations, statistics, biology, human physiology, chemistry and calculus-based physics, with experimental experience. (2) A minimum of 45 credit hours in engineering topics, including engineering, computer science, engineering design, and utilizing modern engineering tools. (3) A broad education component. (4) A culminating engineering design experience. (5) Solving biomedical engineering problems. (6) Analyzing, modeling, designing, and realizing biomedical engineering devices, systems, components, or processes. (7) Making measurements on and interpreting data from living systems.

Accreditation through the EAC of ABET cannot be sought until the first students have graduated from the program which is expected May 2025. SCE's current programs are not up for their next comprehensive review until 2025, so at that time the BSBME will be proposed for accreditation.

## **6. Appendices**

- A. Curriculum Documents
- B. Faculty Documents
- C. Assessment Documents
- D. Financial Documents
- E. Burning Glass Reports
- F. Letters of Support