

# Biomedical Engineering Undergraduate Student Handbook



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# Table of Contents

1	Who are we?	5
	1.1 Overview of our Undergraduate Programs	6
	1.2 ABET - engineering accreditation program	8
2	BME major and the BE degree	10
	2.1 Admission and Transfer	10
	2.1.1 Direct Admission from High School	10
	2.1.2 Transfer from within or outside SBU	10
	2.2 Academic Requirements	11
	2.2.1 Quick Overview	11
	2.2.2 Required Courses	13
	2.2.3 Specialization Tracks / Technical Electives	15
	2.2.4 Dual major BME and Physics	19
	2.3 Senior Checklist for 4-year program	22
	2.4 Engineering Design Over 4-Years	25
3	BME major Honors Program	26
	3.1 Admission	26
	3.2 Academic Requirements	26
	3.3 Honors Thesis and Defense	27
4	BME major Accelerated BE-MS Program	28
	4.1 Admission	28
	4.2 Academic Requirements	29
	4.3 Senior Checklist for 5-year program	29
5	BNG minor for BIO and BCH majors	32
	5.1 Admission	32
	5.2 Academic Requirements	32
	5.3 Senior Checklist for the BNG minor	33
6	BME Undergraduate Course Descriptions	35
	6.1 Quick Guide to the Program and Technical Electives	35
	6.2 BME Course Descriptions	36
7	Academic Advising	44
	7.1 BME Major Advising (includes BE-MS)	44
	7.1.1 Faculty as mentors	44
	7.1.2 BME online advising website for BME majors	44
	7.2 BNG Minor Advising	44

8	Career Preparation	45
8.1	Experiential Learning	45
	8.1.1 On campus research	45
	8.1.2 Industry Internships	47
	8.1.3 Summer Programs	48
8.2	SBU Career Center and Handshake	50
	8.2.1 Good Resumes	50
	8.2.2 Good Reference Letters	50
8.3	Professional Career Websites	52
	8.3.1 BMES.org	52
	8.3.2. IEEE AMBS	52
8.4	Social/Professional Media Networking	53
	8.4.1 BMES student chapter at SBU	53
	8.4.2 AEMB, the National Biomedical Honor Society	53
	8.4.3 Linked In	54
	8.4.4 Research Gate	54
8.5	Professional Preparation for medical, dental or law schools.	55

Appendices (graphic representations of course sequence and content)

A.	Generic Course Sequence for CORE Courses Flow Chart	56
B.	Biomechanics and Biomaterials Track (sequence, content, design)	57
C.	Bioelectricity and Bioimaging Track (sequence, content, design)	60
D.	Cellular and Molecular Track (sequence, content, design)	63

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*Disclaimer: Much of the text in this Handbook is verbatim from the SBU Undergraduate Bulletin and/or the BME website.*

# 1 Who are we?

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Biomedical Engineering at Stony Brook University began as a small program in December 2000. It was the first BME program in the SUNY system for both the BE (undergraduate degree) and graduate degrees MS/PhD.

Administratively, we are connected to both CEAS (the College of Engineering and Applied Sciences) and SOM (the School of Medicine). Our core faculty have their primary appointments in either CEAS or SOM.

Our new building was completed in January, 2010, where most of our core faculty have their offices and research laboratories. Our faculty are well funded by the National Institutes of Health, Department of Energy, U.S. Army & DARPA, National Science Foundation, NASA, National Space Biomedical Research Institute, American Heart Association, Coulter Foundation, NY Science, and Technology & Academic Research (NYSTAR, committed to translational research). Our faculty have a vast number of patents, some of which resulted in companies. Our faculty research areas include, but are not limited to, biomechanics, biomaterials, new bioimaging modalities, tissue engineering, bioinformatics, and nanobiotechnology.

We have stellar graduate and undergraduate programs that have the highest academic qualifications for entering students at Stony Brook University. We interact with each student through academic advising and career advising. We recruit undergraduates for *Independent Research Opportunities* (BME 499) in our own laboratories. The program requires or permits many courses required for medical school or other pre-professional preparation.

Within our undergraduate program, we have 3 focus areas (Specialization Tracks): Cellular and Molecular; Biomechanics and Biomaterials; Bioelectricity and Bioimaging (which includes an option for a dual major in Physics). Details about BME core courses and tech electives (track specific) can be found at BME website. BME majors of high standing may also receive their degree with Honors, and may apply to the Accelerated BE-MS program (5 years total).

## 1.1 Overview of our Undergraduate Programs

The Department of Biomedical Engineering offers several pathways for undergraduate students to obtain a deep knowledge of Biomedical Engineering. Biomedical Engineering involves the combination of the physical, chemical, biological and mathematical sciences with engineering principles to create solutions to a wide range of societal problems associated with medical, environmental, occupational and product development issues. Bioengineers are the people who design and develop innovative materials, processes, devices, biologics and informatics to prevent, diagnose and treat disease, to rehabilitate patients and to generally improve health. Bioengineers also provide environmentally sound solutions to industrial process problems and use their knowledge of biological systems to create biologically inspired processes and products. Section 8 provides more information on Career Preparation.

The ABET accredited (see Section 1.2) Program in Biomedical Engineering offers the major in biomedical engineering, leading to a Bachelor of Engineering (B.E.) degree. Qualified students may join the BME Honors Program that includes an in-depth research laboratory experience. High achieving students may apply for the Accelerated BE-MS 5-year program. In a rigorous, cross-disciplinary training and research environment, the BME major program provides an engineering education along with a strong background in the biological and physical sciences.

Our programs are designed to enhance the development of creativity and collaboration through studies within a specialization area (Section 2.2.3) within the field of biomedical engineering. Teamwork, communication skills, ethics and hands-on laboratory and research experience are emphasized. The curriculum provides students with the underlying engineering principles required to understand how biological organisms are formed and how they respond to their environment. Additionally, we teach how biological materials are tested for strength, how bioelectric signals are measured, how bioimaging modalities work, and factors involved in tissue engineering biocompatibility.

Core courses provide depth within the broad field of biomedical engineering. These are integrated with, and rely upon, course offerings from both the College of Engineering and Applied Sciences and the College of Arts and Sciences. In order to achieve the breadth of engineering experience expected of biomedical engineering graduates, additional elective courses from the College of Engineering and Applied Sciences may be required.

We prepare students for their Capstone experience of Senior Design (BME 440, 441) through all four years. Beginning in Year 1 they are introduced to design. In Year 2, specific topics on fabrication, computer programming, and understanding of clinical and business culture are taught through workshops and as a component in classes. In Year 3, students immerse themselves in one or more of these topics. By Year 4, students assemble into groups, each containing

at least one team member who has specialized in each topic. Together they create a clinical needs driven prototype.

Graduates are prepared for entry into professions in biomedical engineering, biotechnology, pharmaceutical industry and medical technology, as well as careers in academia, government, medicine and law. Potential employers include colleges and universities, hospitals, government, research institutes and laboratories and private industry.

More about the types of jobs available within the Biomedical Engineering field can be found on the website of the BMES – Biomedical Engineering Society (<http://jobboard.bmes.org/>) or through the IEEE-AMBE website (Section 8.3).

We have an active Student Chapter of the BMES at Stony Brook University (<https://you.stonybrook.edu/biomedicalengineeringsociety>), which can be the start of professional networking for the biomedical engineering career (Section 8.4).

Our students initiated the process to form a local chapter of AEMB, the National Biomedical Honor Society (<https://sites.google.com/site/stonybrookaemb>), which is a student group, and not the same as the academic BME Honors Program, although many students participate in both (Section 8.4).

## 1.2 ABET – Engineering Accreditation Program

The Biomedical Engineering program is accredited by the Engineering Accreditation Commission of ABET. Our first accreditation was received in 2006, and have been re-accredited every 6 years since.

Being an accredited program means that we critically assess our BME undergraduate program in regular intervals. We ask questions such as: Are students showing mastery of student (learning) outcomes that measure performance on specific content? Do our constituents in general agree with our educational objectives? Do faculty see ways for improvement based on feedback from both students and quantitative measurements? And many more. This process is then evaluated by ABET that reviews our program every 6 years.

Our goals in educating future Biomedical Engineers are outlined in our Mission Statement, Educational Objectives and Student Outcomes (<https://www.stonybrook.edu/commcms/bme/undergraduate/abet.php>).

### **Mission Statement - Department of Biomedical Engineering**

The educational goal of our biomedical engineering programs is to rigorously educate our undergraduate students in diverse fields of biomedical engineering that build on a strong foundation in engineering, physics, chemistry, mathematics and biology and then develop a core competency in a specific specialized area of biomedical engineering. Particular focus is given to in-depth education in the engineering and biological concepts underlying physiological processes. The principal means of accomplishing these goals is through a comprehensive, interdisciplinary curriculum, which begins with a critical understanding of engineering, mathematics, chemistry, physics and biology, building towards state-of-the-art biomedical engineering research and development.

Because a critical component of our educational mission is to provide a permanent foundation from which the student can succeed in a career in biomedical engineering, an integrated, core set of biomedical engineering courses have been implemented. These courses provide our students with the underlying mathematical and engineering principles required to understand how biological organisms develop and respond to their environment. The students will also attain a credible level of sophistication in their understanding of cell, tissue and organ physiology. Additionally, the student will be able to complement this background with supplementary courses within biomedical engineering, augmented by targeted electives in engineering and biology.

## **Educational Objectives**

Educational Objectives define the idealized education our students will receive. They are used in evaluation and assessment of our program, and guide curriculum reforms. Our Educational Objectives are:

- Our graduates will apply skills and insight gained from a curriculum integrating engineering and biology to biomedically related fields in sectors including academia, industry, medicine, law, and/or government.
- Our graduates will strive to become inspirational leaders who make socially and ethically responsible decisions that beneficially impact health and society from local communities to the global population.
- Our graduates will use scientific research and collaborations to develop biomedical technologies that can be translated into cost-effective clinical solutions to enhance diagnosis, prevention, and treatment of health issues.
- Our graduates will remain lifelong learners, continue to grow professionally and personally throughout their careers, and be partners to grow future generations of biomedical engineers.

## **Student Outcomes**

All courses have a designated subset of the following Student Outcomes. These are goals we have in teaching the students, which are evaluated and assessed in an ongoing annual manner. The full list of these Student Outcomes are listed below.

The students will demonstrate the following:

- 1) an ability to identify, formulate, and solve engineering problems by applying principles of engineering, science and mathematics.
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- 3) an ability to communicate effectively with a range of audiences.
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## 2 BME major and the BE degree

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### 2.1 Admission and Transfer

#### 2.1.1 Direct Admission from High School

Decisions for direct admissions to the BME major are made by the Stony Brook University Admissions Staff, and based on criteria set by the BME Undergraduate Curriculum Committee.

#### 2.1.2 Transfer from Within or Outside SBU

Freshman and transfer applicants admitted to the University but not immediately accepted into the Biomedical Engineering major must apply for acceptance to the major for either January 5<sup>th</sup> or June 5<sup>th</sup> application deadlines. This includes AOI (Area of Interest engineering students), but could also be students from any other major.

Students in good academic standing may apply in any semester, but priority for admission to the Biomedical Engineering major is given to those students who have:

- Completed AMS 161 and PHY 132/134 or equivalents;
- Earn 10 or more credits of mathematics, physics and engineering courses that are taken at Stony Brook and satisfy the major's requirements;
- Obtain a grade point average of at least 3.2 in major courses with no more than one grade below B-;
- No courses required for the major have been repeated;
- Completion of course evaluations for all transferred courses that are to be used to meet requirements of the major.

## 2.2 Academic Requirements

### 2.2.1 Quick Overview

Year 1: BME students begin with basic mathematics and natural sciences (physics and chemistry), basic computer programming skills and BME 100 Introduction to BME, which introduces engineering design concepts.

Year 2: Upper level mathematics, engineering statics and dynamics, electrical circuit analysis, genetic engineering and the BME 212 Fundamentals of Research laboratory course are mastered.

Year 3: BME students begin taking their technical elective courses (unique by specialization track) and complete the BME core courses of advanced statics (biomechanics) and dynamics (biofluids) and are introduced to the important emerging field of bioelectricity, bio-imaging, bio-sensors, and biomaterials.

Year 4: BME students complete their technical electives and take the capstone course of Senior Design. Each semester, BME students are required to meet with their faculty advisor to ensure that course pre-requisites are met, to obtain expert advice regarding technical elective courses that would best suit each student, and for career planning.

Completion of the major requires 128 credits. The summary list below outlines the course work that is required. We have prepared a sample course sequence (Table 1) for the Major in Biomedical Engineering, and the Senior Checklist (Section 2.3) that is used to verify that students have met requirements for the major.

#### ***Summary of the course work required for the BE in BME.***

<i>Math</i>	<i>6 courses</i>
<i>Natural Sciences</i>	<i>2 chemistry; 2 physics with labs; 1 biology with lab</i>
<i>Computer drafting</i>	<i>1 course</i>
<i>BME core courses</i>	<i>12 courses</i>
<i>BME technical electives</i>	<i>5 courses (minimum) (2 must have significant design)</i>
<i>Total technical electives</i>	<i>30 credits (15 credits must be engineering)</i>
<i>Total Engineering</i>	<i>51 credits</i>
<i>Additional SBC (Stony Brook Curriculum) courses not included above (ARTS, GLO, HUM, SBS, USA, WRT, DIV)</i>	

**Table 1. Sample Course Sequence for the BE in BME**

<b>Fall, Freshman Year</b>	<b>Credits</b>	<b>Spring, Freshman Year</b>	<b>Credits</b>
BME 100 Intro to BME (TECH)	3	BME 120	3
AMS 151 (QPS) or equiv	3	AMS 161 (QPS) or equiv	3
CHE 131 (SNW)	4	CHE 132 (SNW)	4
PHY 131/PHY 133 (SNW)	4	PHY 132/134 (SNW)	4
WRT 102 (WRT)	3	First Year Seminar 102	1
First Year Seminar 101	1	SBC	
<b>Total</b>	<b>18</b>	<b>Total</b>	<b>18</b>
<b>Fall, Sophomore Year</b>		<b>Spring, Sophomore Year</b>	
BME 212 or SBC requirement	3	BME 212 or BME 203	3
BIO 202 Molecular & Cellular Bio	3	BME 304 Genetic Engineering (STAS)	3
BIO 204 LAB	2	AMS 361	4
AMS 261	4	BME 260 Statics & Dynamics Bio Sys	4
BME 203 Emergent Biodesign	3	SBC	3
AMS 210 Lin Alg	3		
<b>Total</b>	<b>18</b>	<b>Total</b>	<b>17</b>
<b>Fall, Junior Year</b>		<b>Spring, Junior Year</b>	
BME 271 Intro Electric Cir & Bioelec	3	BME 301 Bioelectricity	3
AMS 310 Prob/Stat	3	BME 305 Biofluids	3
BME 300 Writing in BME	0	SBC	3
BME 303 Biomechanics (STAS)	3	BME Technical Elective 3	3
BME Technical Elective 1 (design)	3	BME Technical Elective 4	3
BME Technical Elective 2 (design)	3		
<b>Total</b>	<b>15</b>	<b>Total</b>	<b>15</b>
<b>Fall, Senior Year</b>		<b>Spring, Senior Year</b>	
BME 440 Senior Design in BME ( Gen Ed. Cat.3,4)	3	BME 441 Senior Design in BME (Gen Ed. Cat.3,4)	3
BME Technical Elective 5	3	Technical Elective 8	3
Technical Elective 6	3	Technical Elective 9	3
Technical Elective 7	3	Technical Elective 10	3
SBC	3		
<b>Total</b>	<b>15</b>	<b>Total</b>	<b>12</b>

Total tech electives                      30  
 Engineering                                      51  
 Total credits for program                      128

\* 3 BME TE required for students admitted to BME before 2017; 2 must be design  
 \* 5 BME TE required for students admitted to BME as of or after Fall 2017; 2 must be design

We acknowledge that not all students will exactly follow this course sequence. Academic advising (Section 7) is essential to ensure students finish their degree in a timely fashion.

## 2.2.2 Required Courses

The curriculum for the three Specialization Tracks are identical except for the Technical Elective courses. While some BME Technical Elective courses are appropriate for more than one track, Technical Electives from outside BME are track specific, with the exception of courses that prepare for medical school, (e.g., Organic Chemistry), which is acceptable to any track.

A complete list of BME courses with catalogue descriptions can be found within the SBU Undergraduate Bulletin, and in Section 6. Note that descriptions in the official SBU Undergraduate Bulletin supersede descriptions in this Handbook, as they are updated immediately with any changes.

No courses with a BME designation may be taken G/PNC; all are graded A-F, except as noted. The BME program strongly feels the G/PNC option should not be used. Instead it is better to take fewer courses, focus on those courses, and remain in touch with the BME Advisor so that the essential courses are taken each semester (see Section 7. Academic Advising). Below are lists of required courses, grouped by topic.

### **Required Mathematics (all courses must be passed with a C or better)**

- AMS 151, 161: Calculus I, II
- AMS 261 or MAT 203 or MAT 205: Calculus III
- AMS 361 or MAT 303 or MAT 305: Calculus IV
- AMS 210 or MAT 211: Linear Algebra
- AMS 310: Probability and Statistics
- Note: The following alternate calculus course sequences may be substituted for AMS 151, 161:
  - MAT 125, 126, 127
  - MAT 131, 132
  - MAT 141, 142

### **Required Natural Sciences (all courses must be passed with a C or better)**

- BIO 202: Fundamentals of Biology: Molecular and Cellular Biology
- BIO 204: Biology Laboratory
- CHE 131, 132: General Chemistry I, II
- PHY 131/133, 132/134: Classical Physics I, II with lab component

- Note: The following alternate science sequences may be substituted:  
PHY 125, 126, 127, or PHY 141, 142 in lieu of PHY 131, 132  
CHE 152, in lieu of CHE 131, 132

### **Required Computer and Programming Courses**

- BME 120: Programming Fundamentals in Biomedical Engineering

### **Required Engineering Courses**

- BME 203: Emergent Biodesign (required for students admitted to BME in Fall 2019) or MEC 203: Computer Aided Drafting
- BME 271: Introduction to Electric Circuits and Bioelectricity (must be passed with a C or better)

### **Required Biomedical Engineering Courses (all courses must be passed with a C or better)**

- BME 100: Introduction to Biomedical Engineering
- BME 120: Programming Fundamentals in Biomedical Engineering
- BME 203: Emergent Biodesign (required for students admitted Fall 2019)
- BME 212: BME Research Fundamentals
- BME 260: Statics and Dynamics in Biological Systems
- BME 271: Introduction to Electric Circuits and Bioelectricity
- BME 300: Writing in Biomedical Engineering (S/U Grading)
- BME 301: Bioelectricity
- BME 303: Biomechanics
- BME 304: Genetic Engineering
- BME 305: Biofluids
- BME 440: Design in Biomedical Engineering
- BME 441: Senior Design in BME

### **Upper-Division Writing Requirement (BME 300)**

All degree candidates must demonstrate skill in written English at a level acceptable for engineering majors. All BME students need to register for the writing course BME 300 concurrently with any BME 300- or 400- level BME course of their choice (not BME 440, 441 or 499). Instructor permission of that course is required; the permission form is available online

([https://docs.google.com/forms/d/e/1FAIpQLSf8yUx4CVFBoe8\\_nbrPtZbaGBa4M-xKFZOAjCjzQNKgucxJg/viewform](https://docs.google.com/forms/d/e/1FAIpQLSf8yUx4CVFBoe8_nbrPtZbaGBa4M-xKFZOAjCjzQNKgucxJg/viewform)), and through a link in Section 6. The quality of writing in technical reports submitted for the BME 300 level course will be evaluated and students whose writing does not meet the required standard are referred for remedial help. Satisfactory writing warrants an "S" grade for BME 300, thereby satisfying the requirement.

### 2.2.3 Specialization Tracks/Technical Electives

Biomedical Engineering students must complete an area of specialization in one of the three Specialization Tracks (Biomechanics and Biomaterials or Bioelectricity and Bioimaging or Cellular and Molecular). The area of specialization must be declared in writing by the end of the sophomore year and is selected in consultation with their faculty advisor to ensure a cohesive curriculum with depth at the upper level.

To fulfill the specialization, students choose from the technical elective course list for one of the three specializations. Other courses may be used towards this requirement with the permission of the track chair and Undergraduate Program Director. Permission is granted in the following way. First, the student emails the Chair of their Track, copying the Coordinator/Director of the Undergraduate Program in BME, with the course description of the course they wish to use as a technical elective; the student includes brief reasoning for their request. The Chair of the Track decides whether the course is appropriate for that track and that student, and renders a decision to the Coordinator and Director. The Coordinator or Director informs the student of their decision. Note that in some cases, an alternate technical elective may be appropriate for one student, but not another within the same track because of the student's long term professional career path.

#### ***Summary of required technical elective credits***

*30 credits in technical electives are required  
15 credits or more must be engineering designations  
15 credits must be BME (not BME 499)  
6 additional credits may be BME 499  
6 credits of BME must have a \*design designation*

Although any BME technical elective course will be accepted within any of the three tracks, below are recommended courses for each track. Non-BME technical

elective courses are entirely track specific. BME courses with significant design content are marked by (\*).

### **Biomechanics & Biomaterials Track Chair, Professor Yi-Xian Qin**

- Applies classical mechanics (statics, dynamics, fluids, solids, thermodynamics, and continuum mechanics) to biological or medical problems.
- Study of motion, material deformation, flow within the body and in devices, transport of chemical constituents across biological and synthetic media and membranes.
- Traditional biomaterials (metal alloys, ceramics, polymers, and composites) and newer biomaterials (incorporate living cells in order to provide a true biological and mechanical match for the living tissue, tissue engineering).

#### **Recommended courses** (*\* indicates significant design*):

BME 353 Introduction to Biomaterials

BME 354 Advanced Biomaterials (\*)

BME 361 Data Science with Python

BME 371 Biological Microfluidics

BME 381 Nanofabrication in Biomedical Applications (\*)

BME 404 Essentials of Tissue Engineering (\*)

BME 420 Computational Biomechanics (\*)

BME 430 Quantitative Human Physiology

ESG 302 Thermodynamics of Materials

ESG 332 Materials Science I

ESM 335 Strength of Materials

ESM 353 Biomaterials

ESM 369 Polymers

MEC 363 Mechanics of Solids

#### **Alternative courses:**

AMS 315 Data Analysis

AMS 331 Mathematical Modeling

AMS 333 Mathematical Biology

BME 311 Fundamentals of Bio-imaging (\*)

BME 312 LabVIEW Programming in Engineering (\*)

BME 313 Bioinstrumentation (\*)

BME 402 Contemporary Biotechnology

BME 481 Biosensors (\*)  
CHE 321 Organic Chemistry I  
CHE 322 Organic Chemistry II  
CHE 327 Organic Chemistry Laboratory  
CSE 326 Digital Image Processing  
CSE 332 Introduction to Scientific Visualization  
ESE 315 Control System Design  
ESG 281 Engineering Intro to Solid State  
ESG 316 Engineering Science Design II  
ESM 221 Introduction to the Chemistry of Solids  
ESM 309 Thermodynamics of Solids  
ESM 325 Diffraction Techniques and Structure of Solids  
ESM 334 Materials Engineering  
ESM 335 Strength of Materials  
ESM 355 Materials and Processes in Manufacturing Design  
ESM 369 Polymer Engineering  
ESM 450 Phase Changes and Mechanical Properties of Materials  
MEC 310 Introduction to Machine Design  
MEC 320 Engineering Design Methodology and Optimization  
MEC 402 Mechanical Vibrations  
MEC 410 Design of Machine Elements  
MEC 411 Control System Analysis and Design  
MEC 455 Applied Stress Analysis

### **Bioelectricity & Bioimaging Track Chair, Professor Congwu Du**

- Understanding the interaction of electromagnetic fields with living tissues- for medical imaging, therapeutical and physiological function purposes
- Medical Imaging combines knowledge of a unique physical phenomenon (sound, radiation, magnetism, etc.) with high speed electronic data processing, analysis and display to generate an image (MRI, PET Scan, CT Scan, etc.).
- Images can be obtained with minimal or completely noninvasive procedures, making them less painful and more readily repeatable than invasive techniques.

#### **Recommended courses** (*\* indicates significant design*):

BME 311 Fundamentals of Macro to Molecular Bioimaging (\*)  
BME 312 LabVIEW Programming in Engineering (\*)  
BME 313 Bioinstrumentation (\*)

BME 361 Data Science with Python  
BME 371 Biological Microfluidics  
BME 381 Nanofabrication in Biomedical Applications (\*)  
BME 430 Quantitative Human Physiology  
BME 481 Biosensors (\*)  
CSE 377 Introduction to Medical Imaging  
ESE 211 Electronics Laboratory A  
ESE 218 Digital System Design  
ESE 306 Random Signals and Systems  
ESE 314 Electronics Laboratory B  
ESE 315 Control System Design  
ESE 372 Electronics

**Alternative courses:**

AMS 311 Probability Theory  
BME 353 Introduction to Biomaterials  
BME 354 Advanced Biomaterials (\*)  
BME 402 Contemporary Biotechnology  
BME 404 Essentials of Tissue Engineering (\*)  
CHE 321 Organic Chemistry I  
CHE 322 Organic Chemistry II  
CHE 327 Organic Chemistry Laboratory  
ESE 305 Deterministic Signals and Systems  
ESE 324 Electronics Laboratory  
EST 421 Starting the High-Technology Venture

**Cellular & Molecular  
Track Chair, Professor David Rubenstein**

- Cellular, Tissue and Genetic Engineering that involves current approaches to attack biomedical problems at the microscopic level.
- Utilize the anatomy, biochemistry and mechanics of cellular and sub-cellular structures in order to understand disease processes and to be able to intervene at very specific sites.
- Miniature devices to deliver compounds that can stimulate or inhibit cellular processes at precise target locations to promote healing or inhibit disease formation and progression. Gene delivery and therapy.

**Recommended courses** (\* indicates significant design):

BIO 317 Principles of Cellular Signaling  
BME 311 Bioimaging (\*)  
BME 353 Introduction to Biomaterials

BME 354 Advanced Biomaterials (\*)  
BME 361 Data Science with Python  
BME 371 Biological Microfluidics  
BME 381 Nanofabrication in Biomedical Applications (\*)  
BME 402 Contemporary Biotechnology  
BME 404 Essentials of Tissue Engineering (\*)  
BME 420 Computational Biomechanics (\*)  
BME 430 Quantitative Physiology  
BME 481 Biosensors (\*)  
CHE 321 Organic Chemistry I  
CHE 322 Organic Chemistry II  
CHE 327 Organic Chemistry Laboratory

**Alternative courses:**

BIO 302 Human Genetics  
BIO 310 Cell Biology  
BIO 311 Techniques in Molecular and Cellular Biology  
BIO 320 General Genetics  
BIO 325 Animal Development  
BIO 328 Mammalian Physiology  
BIO 361 Biochemistry I  
BIO 362 Biochemistry II  
BIO 365 Biochemistry Laboratory  
BME 312 LabVIEW Programming in Engineering (\*)  
BME 313 Bioinstrumentation (\*)  
CHE 312 Physical Chemistry  
CHE 346 Biomolecular Structure and Reactivity  
CHE 353 Chemical Thermodynamics  
ESG 332 Materials Science I  
ESM 353 Biomaterials: Manufacture, Properties and Applications  
ESM 369 Polymer Engineering

## 2.2.4 Dual major BME and Physics

This dual major program is highly challenging and designed by the Departments of Biomedical Engineering and of Physics, and the Department of Radiology at Stony Brook Medicine. The goal was to create a program to give undergraduates thorough preparation for a clinical graduate level program that certifies medical physicist professionals. This program is called CAMPEP, Commission on

Accreditation of Medical Physics Education Programs. These competitive graduate programs certify their MS and PhD students to work within a clinical setting on and with sophisticated clinical imaging equipment.

This program follows the Bioelectricity and Bioimaging Track in BME, permits several Physics courses as technical electives, and requires only two BME technical electives (both must be design). All students are advised by the Director of the Undergraduate Program in BME, and the Director of the Undergraduate Program in Physics. These two Directors communicate regularly to facilitate seamless progress in the two majors.

Before embarking on this challenging program, the Director of the Undergraduate Program in BME ensures that the student is academically superior, with exemplary quantitative skills, and has a strong motivation and work ethic. Table 2 shows the sample course sequence.

**Table 2. Sample Course Sequence dual major BME+PHY**

SAMPLE COURSE SEQUENCE FOR THE DOUBLE MAJOR IN BME AND PHY FOR CEAS STUDENTS

Fall, Freshman Year	Credits	Spring, Freshman Year	Credits
BME 100 Intro to BME (TECH)	3	BME 120	3
AMS 151 (QPS) or equiv	3	AMS 161 (QPS) or equiv	3
CHE 131 (SNW)	4	CHE 132 (SNW)	4
PHY 131/PHY 133 (SNW)	4	PHY 132/134 (SNW)	4
WRT 102 (WRT)	3	First Year Seminar 102	1
First Year Seminar 101	1	SBC	
<b>Total</b>	<b>18</b>	<b>Total</b>	<b>18</b>
Fall, Sophomore Year		Spring, Sophomore Year	
BME 212	3	BME 304 Genetic Engineering (STAS)	3
BIO 202 Molecular & Cellular Bio	3	MAT 308 Calc 4/Lin Alg	4
BIO 204 LAB	2	BME 260 Statics & Dynamics Bio Sys	4
MAT 307 Calc 3/Lin Alg	4	PHY 300 Waves & Optics	4
PHY 251/252 Modern/Lab	4	BME 203 Emergent Biodesign	3
<b>Total</b>	<b>16</b>	<b>Total</b>	<b>18</b>
Fall, Junior Year		Spring, Junior Year	
BME 271 Intro Electric Cir & Bioelec	3	BME 301 Bioelectricity	3
AMS 310 Prob/Stat	3	BME 305 Biofluids	3
BME 300 Writing in BME	0 *	PHY 306 Thermodynamics	3
BME 303 Biomechanics (STAS)	3	* PHY 308 Quantum Phys	3
* PHY 303 Mechanics	3	* PHY 335 Electronic Lab	3
* PHY 301 Elec/Mag with MAT 341 optional	3	SBC	3
SBC	3		
<b>Total</b>	<b>18</b>	<b>Total</b>	<b>18</b>
Fall, Senior Year		Spring, Senior Year	
BME 440 Senior Design in BME ( Gen Ed. Cat.3,4)	3	BME 441 Senior Design in BME (Gen Ed. Cat.3,4)	3
* PHY 445 Senior Lab	3	PHY 487 or BME 488** SBC EXP+	3
* BME Technical Elective 1	3	* BME Technical Elective 3	3
* BME Technical Elective 2	3	* CSE 377***	3
SBC SBS+	3	SBC USA	3
PHY 459 SBC WRTD	0	SBC ARTS	3
SBC CER	3		
<b>Total</b>	<b>18</b>	<b>Total</b>	<b>18</b>

\*denotes tech electives BME recognizes  
 total tech electives 30  
 Engineering (51 required) 46  
 using CSE 377 also 49  
 exception allowed for phys courses 2  
 BME will exempt up to 6 credits of engineering 51  
 physics courses allowed as double dip 37  
 includes freshman classic physics  
 Total credits for program 142

\*\*BME does not require nor recognize internships, 488, to count for the degree we do recognize BME 499 Independent research  
 \*\*\*Strongly encouraged Tech Elective

## 2.3 Senior Checklist

The Senior Checklist (Table 3) can be used to make sure that all degree requirements are being met. There is a corresponding checklist for the Accelerated BE-MS Program (Section 4). These important checklists also provide pre-requisite information that is used to ensure courses are taken in sequence and graduation is not delayed. The link to the online version of the Senior Checklist can be found at:

[https://www.stonybrook.edu/commcms/bme/\\_pdf/\\_ugrad/BME\\_Grid\\_092819\\_Freshman\\_Senior.pdf](https://www.stonybrook.edu/commcms/bme/_pdf/_ugrad/BME_Grid_092819_Freshman_Senior.pdf)

**Table. 3A Senior Checklist for the 4 Year Program  
Freshman and Sophomore Years**

BME Major Senior Checklist				NAME				ID			
Graduation Month/Year				Track Specialization	Cell/Molecular	Biomaterial/Biomech	Bioelect/Bioimag				
Pre-requisites for this Course	Fall, Freshman Year	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course	Spring, Freshman Year	Credits	Sem	Grade	This course is required for:
Math placement exam (MPE) level 5	AMS 151: Calc 1 SBC QPS	3			Calc 2	Cor higher in Calc 1, or MPE level 7	AMS 161: Calc 2	3			Calc 3 or 4; BME260
MAT 125 or higher	CHE 131: Chem 1	4			Chem 2; BIO 202/204	Pre- or Co-req: Calc 1 or Calc A	CHE 132: Chem 2	4			BME 381; BME404
5 MPE; Co-req Calc 1	PHY 131/133: Physics 1/Lab SBC SNW	4			Physics 2; BME260	Cor higher in PHY 131 or PHY 141; Co-req: Calc 2	PHY 132/134: Physics 2/Lab	4			
BME major	BME 100: Intro to BME SBC TECH	3			BME212; BME260; BME 381; BME353	BME major	BME 120: Programming	3			
	WRT 102 (WRT)	3			BME 300		SBC	3			
	Freshman Seminar (101)	1					Freshman Seminar (102)	1			
	<b>Total</b>	<b>18</b>					<b>Total</b>	<b>18</b>			
Pre-requisites for this Course	Fall, Sophomore Year	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course	Spring, Sophomore Year	Credits	Sem	Grade	This course is required for:
Calc 2 or MPE level 9	AMS 261: Calc 3	4			BME305; BME430	Calc 2 or MPE level 9	AMS 361: Calc 4	4			BME 305
BME major; BME 100; Pre- or Co-req: BIO 202 or 203	BME 212: Res Lab Fund or SBC	3			BME303; BME311; BME313; BME353	BME major; BME 100; Pre- or Co-req: BIO 202 or 203	BME 212: Res Lab Fund or BME 203	3			BME303; BME 311; BME 313; BME353
Cor higher in Chem 1 or Co-requisite CHE 152	BIO 202: Mol & Cell Biology	3			Pre/Co BME212; 303; 304; 305; 381; 404;430; 481	BME 100; AMS 161; Phy 1 or Phy A	BME 260: Statics/Dynamics	4			BME303; BME305
Cor higher in Chem 1 or Co-requisite CHE 152; pre- or Co-requisite: BIO 202	BME 204: Bio Lab	2				BME 100; Bio 202 or 203	BME 304: Genetic Eng STAS	3			BME 402
AMS 151 or MAT 131 or 141 or Co-req MAT 126 or MPE	AMS 210: Lin Alg	3					SBC	3			
	BME 203: Emergent BioDesign	3									
	<b>Total</b>	<b>18</b>					<b>Total</b>	<b>17</b>			

<b>Math Sequence</b> - MAT 125/126 or MAT 131/132 or MAT 141/142 in lieu of AMS 151/161 - MAT 203 or MAT 205 in lieu of AMS 261 - MAT 303 or MAT 305 in lieu of AMS 361 - MAT 211 in lieu of AMS 210 - MAT 307/308 plus a third AMS/MAT course of your choosing (Preferably one approved as a tech elective) in lieu of AMS 210/261/361	<b>Courses requiring a C or better grade</b> - All required math courses in the calculus sequence - All required natural science courses (BIO202/204, CHE sequence and PHY sequence) - All required BME courses (BME 100/203/212/260/271/301/303/304/305/440/441) - All technical electives	<b>BME Technical Electives (pre-reqs) * design courses</b> For any track BME311* (BME212) BME402 BME312* BME404* BME313* (BME212, pre/co BME271) BME 420* BME353 (BME100, 212) BME430 BME354* (BME353) BME481* BME371 (BME305) BME489 BME381* (BME100, CHE312, pre/co BIO202 or 203)
<b>Physics Sequence</b> - PHY 125/126/127 or 141/142 in lieu of PHY 131/132	BME 300 requires an "S" grade	

**Table. 3B Senior Checklist for the 4 Year Program  
Junior and Senior Years**

BME Major Senior Checklist					NAME	ID					
Graduation Month/Year					Track Specialization						
Pre-requisites for this Course	Fall, Junior Year	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course					
						Spring, Junior Year					
						Credits					
						Sem					
						Grade					
						This course is required for:					
Calc 2; Phys 2	BME 271: Intro Electric Cir & Bioelectricity	3			BME 301; BME313; BME481	Pre- or Co-req BME212; Cor higher in BME271; BME120	BME 301: Bioelectricity	3			BME 440
AMS161 or MAT 132 or MAT 126 or MAT 142	AMS 310: Prob/Stat	3				Calc 3 & 4; Pre- or Co-req BME 212; BME260; BME303; Pre- or Co-req	BME 305: Biofluids	3			BME371; BME440
WRT 102; U3 or U4 standing; Co-req any BME300-400	BME 300: Writing in BME	0					SBC	3			
or Co-req BIO202 or 203	BME303 Biomechanics SBC: STATS	3			BME 305; BME420		BME Technical Elective 3	3			
	BME Tech Elective 1 (Design)	3					BME Technical Elective 4	3			
	BME Tech Elective 2 (Design)	3									
	<b>Total</b>	<b>15</b>					<b>Total</b>	<b>15</b>			
Pre-requisites for this Course	Fall, Senior Year	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course	Spring, Senior Year	Credits	Sem	Grade	This course is required for:
standing; BME 301 and 305	BME 440: Senior Design in BME	3			BME 441	BME 440	BME 441: Senior Design in BME	3			
	BME Technical Elective 5	3					Technical Elective 8	3			
	Technical Elective 6	3					Technical Elective 9	3			
	Technical Elective 7	3					Technical Elective 10	3			
	SBC	3									
	<b>Total</b>	<b>15</b>					<b>Total</b>	<b>12</b>			
* Check Undergraduate Bulletin for Alternative Pre-requisites and Co-requisites and the most up to date information					** BME TE required for students admitted before Fall 2017, 2 must be design						
Required Technical Electives ( 30 credits required)					30						
Required Engineering (51 credits required)					51						
Total credits for program					128						
<b>Chemistry Sequence</b> - CHE 152 in lieu of CHE 131/132 (Preferable for pre-medical students to take CHE152/331/332)					<b>SBC Requirements</b> - You need to take the following SBC courses ARTS SB5 GLO USA HUM WRT DIV (if admitted in or after fall 2019) - SBC courses can satisfy more than one SBC category - Remaining SBC requirements are satisfied within the major requirements OPS satisfied by calculus SNW satisfied by chemistry TECH satisfied by BME100 STAS satisfied by BME304 Category III and IV SBC satisfied by BME440/441 Note: This flow chart is for planning purposes only. Variations to this flow chart may meet the requirements for graduation.						
<b>Computer Programming</b> - BME 120					This student has been cleared for the BME major						
To graduate, an overall GPA of 2.5 is required					Undergraduate Program Director						
					Undergraduate Program Coordinator						
					DATE						

Note that this form also tracks grades received in courses. Many courses must be passed with a C or better (bottom of Table 3A). SBC (Stony Brook Curriculum) general education requirements are also listed (bottom of Table 3B). This form is completed and signed by the Director or Coordinator before students are cleared to graduate.

## 2.4 Engineering Design Over 4-Years

- Freshman year
  - BME 100 – introduce students to engineering design concepts
  - BME 120 – introduce students to computer programming fundamentals
- Sophomore year
  - BME 203 Emergent Biodesign - introduce students to computer aided design programs, microcontroller programming and clinical/business aspects of biodesign
  - BME 212 BME Research Fundamentals – provide an introduction to data collection and statistical analysis in the context of biophysical measurements commonly used by biomedical engineers
- Junior year
  - BME tech electives with design focus
    - BME 311 Fundamentals of Bio-imaging
    - BME 312 LabView Programming in Engineering
    - BME 313 Bioinstrumentation
    - BME 354 Advanced Biomaterials
    - BME 381 Nanofabrication in Biomedical Applications
    - BME 404 Essentials of Tissue Engineering
    - BME420 Computational Biomechanics
    - BME 481 Biosensors
  - BME 361 Data Science and Python Programming
  - BME 499 BME research
  - EXT 488 Longitudinal Biodesign Internship
    - Small design projects in collaboration with School of Medicine faculty/students
    - Clinical rotation to identify significant clinical needs
    - Summer clinical immersion program – Clinical observation, consultation, industry consultation and prototyping
- Senior year
  - BME 440/441 BME senior design
  - BME tech electives with design focus
  - BME 499 BME research
  - BME 494/495 BME Honors Thesis

Through these design related classes, students are expected to perform in-depth analyses to understand the implications of biodesign on stakeholders and market, perform well in teams, and develop working prototypes that are optimized to address unmet clinical needs.

## 3 BME major Honors Program

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### 3.1 Admission to the Honors Program in BME

The purpose of the Honors Program in Biomedical Engineering is to give high achieving students an opportunity to receive validation for a meaningful research experience and for a distinguished academic career. The Honors Program adds an in-depth research experience and a written Honors Thesis which is orally defended. For students who qualify, this honor is indicated on their diploma and on their permanent academic record. Students may also belong to the AEMB Honor Society, however, AEMB is a student group (Section 8), and this Honors Program is a SUNY recognized component of the academic program.

Any student interested in becoming a candidate for the Honors Program in Biomedical Engineering should indicate their interest at the end of the sophomore year. There is no formal application for this Honors Program; all who are qualified may add this distinction. If you would like to join the Honors Program, and feel you qualify, contact the Director or Coordinator of the Undergraduate Program (contact information at the front of this Handbook).

To be admitted to the honors program, sophomore BME majors must have:

1. Minimum cumulative grade point average of 3.50/4.0
2. B or better in all major required courses (including math and physics)

Transfer students who enter Stony Brook University in their junior year need to show within their first semester at SBU:

1. Minimum cumulative grade point average of 3.50/4.0
2. B or better in all required major courses (including math and physics)

### 3.2 Academic Requirements

The Honors Program requires two additional courses above that listed for the 4 Year BE in BME (Section 2) – BME 494 and BME 495. BME 494 (1 credit) must be taken during the fall semester of their senior year; this credit is in addition to the 128 credits towards graduation. BME 495 (3 credits) must be taken during the spring semester of their senior year; this course may substitute for 3 credits of BME 499 as a technical elective, provided there are not already 6 credits of BME 499 being used as technical elective.

Both courses are laboratory oriented, and are overseen by the same research mentor, who is a BME faculty member, or non-BME faculty approved by the Director of the Undergraduate Program in BME. The course descriptions are found

in the SBU Undergraduate Bulletin, and in Section 6. Also in Section 6 are links to the syllabi and grading rubrics for these two courses.

Graduation with departmental honors in Biomedical Engineering requires:

1. A cumulative grade point average of 3.50/4.0 or higher and a B or better in all major required courses upon graduation.
2. Completion of BME 494, a 1-credit seminar on research techniques, with a B or better.
3. Completion of BME 495, a 3-credit honors research project, with a B or better.
4. Presentation of an honors thesis (written in the format of an engineering technical paper) under the supervision of a BME faculty member (or approved non-BME faculty member). The thesis must be presented to committee and/or public audience.

### 3.3 Honors Thesis and Defense

BME 495 culminates with an Honors Thesis and Defense at the end of the semester. More detail about this is given in the syllabus found in the SBU Undergraduate Bulletin, and in Section 6. Briefly, they entail:

**Honors Thesis Report.** The written report will be at least 20 pages in length, and will include a detailed description of the project, including an abstract, background introduction to the problem, methodology or approach taken, the progress (data) the student made independently and the progress of the total project, as well as a final summary statement of the student's perceived experience; the cover page and reference list are additional pages. The written report will be due the last day of regular classes, otherwise a grade of I, incomplete, will be assigned. A copy of this report will be sent to both the Undergraduate Program Director and Undergraduate Program Coordinator. For Fall semesters, the Report is a preliminary Thesis; for Spring semesters, the Report is a final Thesis and should be a revision of the Fall version.

**Honors Thesis Defense.** The oral defense is a component of the Spring semester and involves a PowerPoint presentation to the mentor that is open to the public. The defense will target either a scientific meeting audience (for research proposals) or angel investor audience (for design prototypes). This defense must be presented during URECA or an approved committee before the last week of classes.

## 4 BME major Accelerated BE-MS Program

### 4.1 Admission

This is a prestigious five year accelerated BE/MS program enabling students to complete both the BE and MS with only 1 year beyond the normal BE (e.g. typically 5 years total). This program is highly selective with admission based on academic performance, undergraduate research as well as ability to complete a degree within the allotted time. The combined degree is designed for students who are seeking a challenge and a more diverse range of studies. The degree will provide students with advanced courses and research experience that will suitably prepare them for either Doctorate studies or a variety of advanced professional positions.

Juniors can be admitted into the accelerated degree program if they satisfy the requirements outlined in the Graduate Bulletin.

Students must apply for this program through the BME Graduate Program in their junior year (typically the application process starts in February), before they have taken Senior Design (BME440 and BME441). The requirements for admission are:

1. A cumulative GPA of at least 3.5/4.0
2. Completion of application forwarded by the BME Graduate Program Team
3. Admission to the Graduate School

Once admitted, the students are subject to additional requirements, including:

1. Admitted students are required to attend Graduate Orientation the first semester of their Graduate Career (either fall of Year 4 or fall of Year 5).
2. Students are subject to Graduate School Regulations and Policies. This will include:
  - Paying Graduate Tuition & Fees (Students are expected to be self-funded; they will not receive Tuition Scholarships)
  - No longer eligible for Undergraduate Financial Aid
  - Are required to move from Undergraduate to Graduate Housing (pertains to students who live on campus).

## 4.2 Academic Requirements

The BE (the undergraduate component) requirements for the accelerated program are the same as the requirements for the BE degree (Section 2), except that two graduate 500-level courses replace two 300- or 400-level electives, so that six graduate credits are counted toward the undergraduate degree. BME 501 and BME 502 are automatically counted to your undergraduate degree. If you need to count other classes, you need approval of both the Undergraduate and Graduate Program Directors. Undergraduates can only enroll in 6 credits of graduate coursework; please make sure to verify all graduate classes with the Graduate Program Team.

The MS requirements are overseen by the Director of the Graduate Program (contact information in the front of this Handbook). Of note, the MS may be done with a thesis or a project. Graduate students can also choose to complete a degree from one of three tracks. The exact course work and course sequence that is required depends on the choices the students make. The Graduate Program Team will provide guidance based on these choices. Please communicate and verify with the Administrator or Director of the Graduate Program.

## 4.3 Senior Checklist for 5-year program

The Senior Checklist is provided in Table 4, and includes all 5 years. The courses constituting the BE are verified by the Director of the Undergraduate Program, and courses related to the MS are verified by the Director of the Graduate Program. By the end of the 4<sup>th</sup> year, the Undergraduate degree is verified and cleared, independently of the MS degree. Thus, should students ‘change their mind’ and opt out, the BE degree is intact and still awarded. After the Undergraduate degree is cleared, then the student is considered a graduate student, as outlined above.

**Table. 4A Senior Checklist for the 5 Year Program  
Freshman and Sophomore Years**

BME Major Senior Checklist				NAME				ID			
Graduation Month/Year				Track Specialization	Cell/Molecular	Biomaterial/Biomech	Bioelect/Bioimag				
Pre-requisites for this Course	Fall, Freshman Year	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course	Spring, Freshman Year	Credits	Sem	Grade	This course is required for:
Math placement exam (MPE) level 5	AMS 151: Calc 1 SBC QPS	3			Calc 2	Cor higher in Calc 1, or MPE level 7	AMS 161: Calc 2	3			Calc 3 or 4; BME260
MAT 125 or higher	CHE 131: Chem 1	4			Chem 2; BIO 202/204	Pre- or Co-req: Calc 1 or Calc A	CHE 132: Chem 2	4			BME 381; BME404
5 MPE; Co-req Calc 1	PHY 131/133: Physics 1/Lab SBC SNW	4			Physics 2; BME260	Cor higher in PHY 131 or PHY 141; Co-req: Calc 2	PHY 132/134: Physics 2/Lab	4			
BME major	BME 100: Intro to BME SBC TECH	3			BME212; BME260; BME 381; BME353	BME major	BME 120: Programming	3			
	WRT 102 (WRT)	3			BME 300		SBC	3			
	Freshman Seminar (101)	1					Freshman Seminar (102)	1			
	<b>Total</b>	<b>18</b>					<b>Total</b>	<b>18</b>			
Pre-requisites for this Course	Fall, Sophomore Year	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course	Spring, Sophomore Year	Credits	Sem	Grade	This course is required for:
Calc 2 or MPE level 9	AMS 261: Calc 3	4			BME305; BME430	Calc 2 or MPE level 9	AMS 361: Calc 4	4			BME 305
BME major; BME 100; Pre- or Co-req: BIO 202 or 203	BME 212: Res Lab Fund or SBC	3			BME303; BME311; BME313; BME353	BME major; BME 100; Pre- or Co-req: BIO 202 or 203	BME 212: Res Lab Fund or BME 203	3			BME303; BME 311; BME 313; BME353
Cor higher in Chem 1 or Co-requisite CHE 152	BIO 202: Mol & Cell Biology	3			Pre/Co BME212; 303; 304; 305; 381; 404;430; 481	BME 100; AMS 161; Phy 1 or Phy A	BME 260: Statics/Dynamics	4			BME303; BME305
Cor higher in Chem 1 or Co-requisite CHE 152; pre- or Co-requisite: BIO 202	BME 204: Bio Lab	2				BME 100; Bio 202 or 203	BME 304: Genetic Eng STAS	3			BME 402
AMS 151 or MAT 131 or 141 or Co-req MAT 126 or MPE	AMS 210: Lin Alg	3					SBC	3			
	BME 203: Emergent BioDesign	3									
	<b>Total</b>	<b>18</b>					<b>Total</b>	<b>17</b>			
<b>Math Sequence</b> - MAT 125/126 or MAT 131/132 or MAT 141/142 in lieu of AMS 151/161 - MAT 203 or MAT 205 in lieu of AMS 261 - MAT 303 or MAT 305 in lieu of AMS 361 - MAT 211 in lieu of AMS 210 - MAT 307/308 plus a third AMS/MAT course of your choosing (Preferably one approved as a tech elective) in lieu of AMS 210/261/361				<b>Courses requiring a C or better grade</b> - All required math courses in the calculus sequence - All required natural science courses (BIO202/204, CHE sequence and PHY sequence) - All required BME courses (BME 100/203/212/260/271/301/303/304/305/440/441) - All technical electives				<b>BME Technical Electives (pre-req) * design courses</b> For any track BME311* (BME212)                      BME402 BME312*                                      BME404* BME313* (BME212, pre/co BME271      BME 420* BME353 (BME100, 212)                      BME430 BME354* (BME353)                              BME481* BME371 (BME305)                                BME499 BME381* (BME100, CHE312, pre/co BIO202 or 203)			
<b>Physics Sequence</b> - PHY 125/126/127 or 141/142 in lieu of PHY 131/132				BME 300 requires an "S" grade							

**Table. 4B Senior Checklist for the 5 Year Program  
Junior and Senior years, and 5<sup>th</sup> Graduate Year**

BME Major Senior Checklist				NAME				ID			
Graduation Month/Year					Track Specialization	Cell/Molecular	Biomaterial/Biomech	Bioelect/Bioimag			
Pre-requisites for this Course	Fall, Junior Year	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course	Spring, Junior Year	Credits	Sem	Grade	This course is required for:
Calc 2; Phys 2	BME 271: Intro Electric Cir & Bioelectricity	3			BME 301; BME313; BME481	Pre- or Co-req BME212; C or higher in BME271; BME120	BME 301: Bioelectricity	3			BME 440
AMS161 or MAT 132 or MAT 126 or MAT 142	AMS 310: Prob/Stat	3				Calc 3 & 4; Pre- or Co-req BME 212; BME260; BME303; Pre- or Co-req BIO202 or 203	BME 305: Biofluids	3			BME371; BME440
WRT 102; U3 or U4 standing; Co-req any BME300-400	BME 300: Writing in BME	0					SBC	3			
BME 260; BME212; Pre- or Co-req BIO202 or 203	BME303 Biomechanics SBC: STATS	3			BME 305; BME420		BME Technical Elective 3	3			
	BME Tech Elective 1 (Design)	3					Technical Elective 4	3			
	BME Tech Elective 2 (Design)	3					APPLICATION FOR ACCELERATED PROGRAM				
	<b>Total</b>	15					<b>Total</b>	15			
Pre-requisites for this Course	Fall, Senior Year	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course	Spring, Senior Year	Credits	Sem	Grade	This course is required for:
BME major; U4 standing; BME 301 and 305	BME 440: Senior Design in BME	3			BME 441	BME 440	BME 441: Senior Design in BME	3			
	BME Technical Elective 5 (BME 501: Engineering Principles in Cell Bio)	3					BME Technical Elective 8 (BME 502: Computational and Numerical Methods)	3			
	Technical Elective 6	3					Technical Elective 9	3			
	Technical Elective 7	3					Technical Elective 10	3			
	SBC	3					BME 521: Lab Rotation 2**	1			
	BME 520: Lab Rotation 1**	1									
	<b>Total</b>	15 or 16					<b>Total</b>	12 or 13			
Pre-requisites for this Course	Fall, 5th Year (Graduate Student)	Credits	Sem	Grade	This course is required for:	Pre-requisites for this Course	Spring, 5th Year (Graduate Student)	Credits	Sem	Grade	This course is required for:
	BME 505: Principles and Practices of BME	1					BME 509: Fundamentals of Biosciences Industry	3			
	BME Grad Tech Elective 1	3					BME Grad Tech Elective 4 ++	3			
	BME Grad Tech Elective 2	3					Grad Tech Elective 5 ++	3			
	BME Grad Tech Elective 3	3					Grad Tech Elective 6 ++	3			
	BME 520: Lab Rotation 1***	0, 1, 2					BME 581: Biomedical Nanofabrication	3			
	BME 599: BME Research**	3					BME 521: Lab Rotation 2***	0, 1, 2			
	BME 590: BME Seminar	0					BME 599: BME Research**	3			
	EMP 521: New Product Development +	3					BME 590: BME Seminar	0			
	JRN 565: Communicating Science +	3									
	<b>Total</b>	12 or more					<b>Total</b>	12 or more			

\*\* If and only if following the Biomedical Design Graduate Concentration AND completing a MS thesis  
 \*\*\* If and only if following the Biomedical Design Graduate Concentration AND completing a MS project (see the Graduate Program Director for credit amounts)  
 + If and only if following the Biomedical Entrepreneurship Concentration  
 ++ For the Biomedical Entrepreneurship Concentration these electives must have management content

Total Credits for graduate program (with project)	33
Total Credits for graduate program (with thesis)	39

## 5 BNG minor for BIO and BCH majors

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### 5.1 Admission to the minor in BNG

The Bioengineering (BNG) minor program is open to only Biology (BIO) and Biochemistry (BCH) major students in the College of Arts and Sciences (CAS). To declare the BNG minor, the student must see the Coordinator or Director of the Undergraduate Program in BME. After verification of the student's status as a BIO or BCH major, the transfer forms will be signed. All transfer forms must be brought to the University Registrar; it is currently a paper form.

For BIO majors, the BNG minor is exactly the same as the Biology Track of Bioengineering. The common goal of the Bioengineering Minor and Track Programs at Stony Brook is to expose science majors to the dominant theme in engineering, specifically, problem solving under conditions involving multiple objectives and constraints. Effective problem solving requires both identification of the assumptions underlying the problem definition and experience with a broad range of possible design solutions. We believe the biological world provides an excellent context in which to teach these concepts. Numerous examples exist in nature which can be used to critically evaluate the role of assumptions in creating "optimal" designs. Indeed, nature has provided us with a broad range of design "solutions" to apparently very similar "problems". Furthermore, as we enter the 21st century, the field of biomimetics, or applying engineering design and approaches to existing solutions found in biology, is rapidly emerging as an important new direction in engineering design.

Importantly, the BNG minor student should maintain contact with the Coordinator and Director of the BME Undergraduate Program for regular (each semester) academic advising. Students must inform the Coordinator and Director of their intention to graduate during their last semester. For the BNG minor to appear on their final transcript and diploma, the Director of the BME Undergraduate Program must confirm that the appropriate courses were taken.

### 5.2 Academic Requirements

The Bioengineering minor is the same as the Biology Bioengineering Specialization Track. It is designed for College of Arts and Sciences students who are BIO or BCH majors, who wish to obtain a more thorough understanding of how physical forces in the natural world influence biological systems. Coursework introduces these concepts and shows how an engineering approach can be useful in dealing with questions in biology and medicine. The program serves as an excellent background for students who wish to prepare for graduate

study in bioengineering or a related field or for a career in which an understanding of engineering concepts would provide an advantage.

### **Required Courses for the Minor in Bioengineering (BNG)**

All courses for the minor must be passed with a letter grade of C or higher. Completion of the minor requires 21-23 credits as outlined below.

1. Required Courses for each Track
  1. BME 100: Introduction to Biomedical Engineering
  2. BME 120: Programming for Engineers
  
2. Specialization Tracks
  1. Biomaterials/Biomechanics
    - BME 260: Engineering Statics and Dynamics
    - BME 303: Biomechanics
    - AMS 261, MAT 203 or MAT 205: Calculus III
    - Either BME 304: Genetic Engineering or BME 381 Nanofabrication in Biomedical Applications
  
  2. Bioelectricity
    - BME 271: Intro to Bioelectricity
    - BME 301: Bioelectricity
    - AMS 210 or MAT 211: Linear Algebra
    - BME 313: Bioinstrumentation
  
  3. Molecular/Cellular Bioengineering
    - BME 304: Genetic Engineering
    - BME 381: Nanofabrication in Biomedical Applications
    - PICK TWO: BME 404: Essentials of Tissue Engineering, BME 402: Contemporary Biotechnology, BME 430: Quantitative Physiology or BME 371: Biological Microfluidics
  
3. Upper Division Courses
  1. One advanced biology lecture course
  2. One advanced biology laboratory course

## **5.3 Senior Checklist for the BNG minor**

The BNG minor checklist (Table 5) can help you prepare for graduation. The checklist only shows requirements for the BNG minor and not the BIO or BCH major.

**Table. 5 Senior Checklist for the BNG minor**

**BIOENGINEERING (BNG) MINOR GRADUATION CLEARANCE** Date: \_\_\_\_\_ By: \_\_\_\_\_  
 Name: \_\_\_\_\_ SB ID #: \_\_\_\_\_  
 Email: \_\_\_\_\_ GPA: \_\_\_\_\_  
 Address \_\_\_\_\_  
 Transfer Institute: \_\_\_\_\_

**ALL COURSES FOR THE MINOR IN BIOENGINEERING (BNG) MUST BE PASSED WITH A GRADE OF C OR HIGHER**  
 Completion of the minor requires 21-23 credits:

**Required Courses for each Track**

Course	Course Title	Grade
BME 100	Introduction to Biomedical Engineering	
ESG 111, ESE 124, or CSE 130	C-Programming for Engineers	
<b>UPPER DIVISION COURSES</b>		
One Advanced Biology Lecture Course		
One Advanced Biology Laboratory Course		

**SPECIALIZATION TRACKS**

**BIOMATERIALS/BIOMECHANICS**

MEC 260	Engineering Statistics	
BME 303	Biomechanics	
AMS 261, MAT 203, OR MAT 205	CALCULUS III	
BME 304 or BME 381	H Genetic Engineering or Nanofabrication in Biomedical Operations	

**BIOELECTRICITY**

ESE 271	Electrical Circuit Analysis I	
BME 301	Bioelectricity	
AMS 210 or MAT 211	Linear Algebra	
BME 313	Bioinstrumentation	

**MOLECULAR/CELLULAR CLEARANCE:**

BME 304	H- Genetic Engineering		Cleared (All requirements completed)
BME 381	Nanofabrication in Biomedical Applications		
<b>PICK TWO:</b>			Missing or Conditions: _____
BME 404	Essentials of Tissue Engineering		
BME 402	Contemporary Biotechnology		
BME 371	Biological Microfluids		

## 6 BME Undergraduate Course Descriptions

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### 6.1 Quick Guide to the Program, Technical Electives

#### Core Courses

- o BME 100
- o BME 120
- o BME 203
- o BME 212
- o BME 260
- o BME 271
- o BME 300
- o BME 301
- o BME 303
- o BME 304
- o BME 305
- o BME 440
- o BME 441

Recommended Track: Technical Elective Courses	<u>BioE/Biol</u>	<u>BioMech/BioMat</u>	<u>Cellular/Molecular</u>
o <u>BME 311</u>	X	X	
o <u>BME 312</u>	X		
o <u>BME 313</u>	X		
o <u>BME 353</u>		X	X
o <u>BME 354</u>		X	X
o <u>BME 361</u>	X	X	X
o <u>BME 371</u>	X	X	X
o <u>BME 381</u>	X	X	X
o <u>BME 402</u>			X
o <u>BME 404</u>		X	X
o <u>BME 420</u>		X	X
o <u>BME 430</u>	X	X	X
o <u>BME 481</u>	X		X

#### Teaching Practicum

- o BME 475
- o BME 476

#### Industry Internship

- o BME 488

#### Experiential Learning (SBC EXP+)

- o BME 444

#### Independent Research

- o BME 494
- o BME 495
- o BME 499
- o BME 499 with non-BME faculty

SBC TECH/SNW Designated Courses (cannot be used for major credit)

- o [BME 200](#)
- o [BME 205](#)

## 6.2 BME Course Descriptions

Descriptions of BME courses are found in the SBU [Undergraduate Bulletin](#). Descriptions listed here are correct as of the published date of this Handbook. Always check the SBU Undergraduate Bulletin for updates. Any description in the SBU Bulletin supersedes this Handbook.

### **BME 100: Introduction to Biomedical Engineering**

A rigorous introduction to biomedical engineering that provides the historical and social context of BME through contemporary emerging areas within BME. Specific areas covered in depth include: bioelectricity and biosensors (action potentials to signal processing), bioimaging (invasive and non-invasive), genetic engineering (with ethical discussions), and biostatistics. Hands-on computational modeling introduces the physiological concept of positive and negative feedback loops in the body. Emphasis is placed on ways engineers view the living system by using design based approaches and computation.

*Prerequisites:* BME major or BNG minor or departmental consent

**SBC:** TECH

3 credits

### **BME 120: Programming Fundamentals in Biomedical Engineering**

This course will introduce the theory and fundamentals of computer programming specifically designed for the applications in biomedical engineering. Students will learn the basic computer architecture and the interaction between the computer hardware, operating system and application software. The course focus will be on the programming control logic and style critical to all programming languages including C and MATLAB. Several core and elective courses in biomedical engineering use MATLAB as a key programming language, and therefore MATLAB will be the primary language used to teach the above mentioned programming principles. This course will also serve as the foundation where the students can pursue further advanced programming skills.

*Prerequisite:* BME Major or BNG Minor

3 credits

### **BME 200: Bioengineering in Extreme Environments**

Technology at the human-engineering interface that enables human life in harsh environments, including high temperatures, high altitude, deep sea and outer space. Emphasis on the technical design requirements of the bio-engineering interface that will enable life to thrive. Physiological limits to survival will be examined within the context of when the bio-engineering technology is required. This course may not be taken for major credit.

**SBC:** SNW, TECH

3 credits

### **BME 203: Emergent Biodesign**

This course is designed to provide students with early team-based design experience. Students will learn CAD, 3D printing, microcontroller programming and have hands-on experience in prototyping to solve bite-sized real engineering problems. Students will engage in teamwork, and be exposed to clinical settings to learn how to identify clinical needs.

*Prerequisites:* BME major; U2 or higher  
3 credits

### **BME 205: Clinical Challenges of the 21st Century**

Technology used by current medical practice, focusing on weekly topics associated with a specific disease state. Technology used to diagnose and treat these disease states will be rigorously examined. Weekly topics will include: cancer, cardiovascular disease, Alzheimer's, obesity, diabetes, osteoporosis, osteoarthritis, and organ transplant. Key disease states will be presented in physiological and cellular depth. This course may not be taken for major credit.

*SBC:* SNW, TECH  
3 credits

### **BME 212: Biomedical Engineering Research Fundamentals**

Introduction to data collection and analysis in the context of biophysical measurements commonly used by bioengineers. Statistical measures, hypothesis testing, linear regression, and analysis of variance are introduced in an application-oriented manner. Data collection methods using various instruments, A/D boards, and PCs as well as LabView, a powerful data collection computer package. Not for credit in addition to the discontinued BME 309. This course has an associated fee. Please see [www.stonybrook.edu/coursefees](http://www.stonybrook.edu/coursefees) for more information.

*Prerequisites:* BME major; BME 100  
Pre- or Corequisite: BIO 202 or 203                      3 credits

### **BME 260: Statics and Dynamics in Biological Systems**

Fundamentals of engineering statics and dynamics on biological systems will be covered using vector methods. Covered topics will include free body diagrams, equilibrium of systems, rectilinear kinetics and kinematics, angular kinetics and kinematics, work, energy and momentum of biological systems. In parallel, the necessary anatomy and physiology of the organ systems including the musculoskeletal system, the nervous system and the cardiovascular system will be covered. This material will lead to a discussion on kinesiology.

*Prerequisites:* BME 100; AMS 161; PHY 125 or 131 or 141  
4 credits

### **BME 271: Introduction to Electric Circuits and Bio-electricity**

An introductory course to two key areas of the modern biomedical engineering discipline: bioelectricity and bio-photonics. The first part of the class begins with fundamental theory of circuit analysis, including lumped time-invariant models of resistors, capacitors, inductors, Ohm's Law, Kirchoff's Laws, nodal and mesh analysis for electric circuits, two-port equivalent circuits, steady-state AC circuits, phasor and transient analysis using Laplace Transform. The applications of basic circuit analysis techniques in biological circuitry will be discussed throughout the first part of the class. In the second part of the course, the principles of cell electrophysiology, bio-potentials and electrical interactions with tissue will be studied. Finally, the third part of the course will cover ray optics, including reflection, refraction, lenses and image formation, and wave optics for introduction to bio-photonics. Not for credit in addition to ESE 271.

*Prerequisites:* AMS 161 or MAT 127 or 132 or 142 or 171; PHY 127/134 or PHY 132/134 or PHY 142  
3 credits

### **BME 300: Writing in Biomedical Engineering**

See Requirements for the Major in Biomedical Engineering, Upper-Division Writing Requirement.

*Prerequisites:* WRT 102; U3 or U4 standing; BME major  
Corequisite: Any upper division BME course; perm. of instructor or Undergraduate Director  
0 credit, S/U grading

**BME 301: Bioelectricity**

In this course, we will study how electrical signals are generated and propagated in biological tissue. From the basics of Ohm's Law, as well as the laws that govern diffusion and electric field theory, we will develop mathematical models of bioelectric processes as well as perform simulations of these processes using Matlab. Understanding these signals at the cell and membrane level will provide a foundation for understanding proper nerve, cardiac and muscle function, as well as disease conditions. Using this understanding, we will examine state-of-the-art applications in current literature.

*Prerequisites:* BME 120; BME 271 or ESE 271; BIO 202

Pre or Corequisite: BME 212

3 credits

**BME 303: Biomechanics**

Illuminates the principles of mechanics and dynamics that apply to living organisms, from cells to humans to Sequoia trees. The behavior of organisms is examined to observe how they are constrained by the physical properties of biological materials. Locomotion strategies (or the lack thereof) are investigated for the forces and range of motions required and energy expenditures. Includes the relationship between form and function to illustrate how form dominates behavior. Presents the physiological effects of mechanical stresses on organs, pathologies that develop from abnormal stress, and how biological growth and adaptation arise as a natural response to the mechanics of living.

*Prerequisite:* MEC 260, BME 212

Pre- or Corequisite: BIO 202 or 203

**DEC:** H

**SBC:** STAS

3 credits

**BME 304: Genetic Engineering**

An introduction to the realm of molecular bioengineering with a focus on genetic engineering. Includes the structure and function of DNA, the flow of genetic information in a cell, genetic mechanisms, the methodology involved in recombinant DNA technology and its application in society in terms of cloning and genetic modification of plants and animals (transgenics), biotechnology (pharmaceutics, genomics), bioprocessing (production and process engineering focusing on the production of genetically engineered products.), and gene therapy. Production factors such as time, rate, cost, efficiency, safety, and desired product quality are also covered. Considers societal issues involving ethical and moral considerations, consequences of regulation, as well as risks and benefits of genetic engineering.

*Prerequisites:* BME 100; BIO 202 or 203

**DEC:** H

**SBC:** STAS

3 credits

**BME 305: Biofluids**

The fundamentals of heat transfer, mass transfer, and fluid mechanics in the context of physiological systems. Techniques for formulating and solving biofluid and mass transfer problems with emphasis on the special features and the different scales encountered in physiological systems, from the organ and the tissue level down to the molecular transport level.

*Prerequisites:* AMS 261 (or MAT 203 or MAT 205); AMS 361 (or MAT 303 or MAT 305); BME 260 (or MEC 260 and MEC 262)

Pre- or Corequisite: BIO 202; BME 212

3 credits

**BME 311: Fundamentals of Macro to Molecular Bioimaging**

This course will cover the fundamentals of modern imaging technologies, including techniques and applications within medicine and biomedical research. The course will also introduce concepts in molecular imaging with the emphasis on the relations between imaging technologies and the design of target specific probes as well as unique challenges in the design of probes of each modality: specificity, delivery, and amplification strategies. The course includes visits to clinical sites.

*Prerequisite:* BME 212

3 credits

**BME 312: LabVIEW Programming in Engineering**

LabVIEW is the leading software development platform that enables engineers and scientists to create and deploy powerful measurement and control applications and prototypes with minimal time. This course will systematically teach LabVIEW programming with the focus on the data flow model. The highlighted course topics are basic programming logics, graphic user interface design and parallel programming. It will also teach hardware integration using LabVIEW built-in functions for data acquisition, instrument control, measurement analysis and data presentation. Hands-on projects and demonstrations will be implemented throughout the course to enhance the knowledge learned in classroom. At the end of the course, students will be offered the free exam for Certified LabVIEW Associated Developer provided by National Instruments for future career development.

3 credits

**BME 313: Bioinstrumentation**

Basic concepts of biomedical instrumentation and medical devices with a focus on the virtual instrumentation in biomedical engineering using the latest computer technology. Topics include basic sensors in biomedical engineering, biological signal measurement, conditioning, digitizing, and analysis. Advanced applications of LabVIEW, a graphics programming tool for virtual instrumentation. Helps students develop skills to build virtual instrumentation for laboratory research and prototyping medical devices. This course has an associated fee. Please see [www.stonybrook.edu/coursefees](http://www.stonybrook.edu/coursefees) for more information.

*Prerequisite:* BME 212

Pre- or Corequisite: ESE 271

3 credits

**BME 353: Introduction to Biomaterials**

This course provides an introduction to materials, including metals, ceramics, polymers, composites, coatings, and adhesives that are used in the human body. It emphasizes the physiochemical properties of materials that are considered important to meet the criteria specified for the implant and device applications (e.g. strength, modulus, fatigue and corrosion resistance, conductivity), and to be compatible with the biological environment (e.g. nontoxic, noncarcinogenic, etc.). Not for credit in addition to BME 504.

*Prerequisites:* BME100 and BME 212

3 credits

**BME 354: Advanced Biomaterials**

This course is an overview of the applications of biomaterials. Here the emphasis is on the unique challenges in the design, fabrication, and evaluation of biomaterials for a particular application/field. Since biomaterials applications entail their direct or indirect contact with humans,

the various practical aspects associated with biomaterials such as sterilization, packaging, evaluating device failures as well as regulatory guidelines will be covered.

*Prerequisite:* BME 353 or ESM 353

3 Credits

### **BME 361: Data Science with Python**

This course will introduce the basics of Python programming and how to address real-world data analysis challenges by programming. It provides an overview of standard library and coding techniques with functions, loops, classes and objectives, strings, lists, tuples, and also introduces a few advanced packages to process biomedical data and images. Students will learn this object-oriented programming language to address practical problems in the class. Both lectures and laboratories are provided for this course.

*Prerequisites:* BME 120 and MAT 125/126 or AMS 151 or MAT 131

3 credits

### **BME 371: Biological Microfluidics**

This one semester course will outline theory and applications of special fluid handling conditions associated with living systems. Microfluids will be examined with respect to aquaporin channels (single file molecular water movement), intercellular fluid transport mechanisms, microvascular convective fluid movement (2 phase flow), and transvascular fluid movement (3 pore theory) with reference to the similarity of each to flow in fabricated microchannels.

*Prerequisite:* BME 305

3 credits

### **BME 381: Nanofabrication in Biomedical Applications**

Theory and applications of nanofabrication. Reviews aspects of nanomachines in nature with special attention to the role of self-lubrication, intracellular or interstitial viscosity, and protein-guided adhesion. Discusses current nanofabricated machines to perform the same tasks and considers the problems of lubrication, compliance, and adhesion. Self-assembly mechanisms of nanofabrication with emphasis on cutting-edge discovery to overcome current challenges associated with nanofabricated machines.

*Prerequisites:* CHE 132; BME 100

Pre- or Corequisite: BIO 202 or 203

3 credits

### **BME 402: Contemporary Biotechnology**

This course will provide an introduction into the realm of modern biotechnology and its applications. This course introduces the historical development of biotechnology and its contemporary applications, including, bioproducts and biofuels, microbial fermentation/bioprocessing, aerobic bioreactors, modeling and simulation, metabolism and enzyme kinetics, metabolic engineering, bioremediation and environmental sustainability and human medicine. Further, societal issues involving ethical and moral implications, perceptions and fears, intellectual property, safety, risks and regulatory issues, as well as economics of biotechnology will be discussed.

*Prerequisite:* BME 304

3 credits

### **BME 404: Essentials of Tissue Engineering**

Topics covered are: developmental biology (nature's tissue engineering), mechanisms of cell-cell and cell-matrix interactions, biomaterial formulation, characterization of biomaterial properties, evaluation of cell interactions with biomaterials, principles of designing an engineered tissue.

Considers manufacturing parameters such as time, rate, cost, efficiency, safety and desired product quality as well as regulatory issues.

*Prerequisites:* BIO 202 or 203; CHE 132

Advisory Prerequisites: CHE 321 and 322

3 credits

#### **BME 420: Computational Biomechanics**

Introduces the concepts of skeletal biology; mechanics of bone, ligament, and tendon; and linear and nonlinear properties of biological tissues. Principles of finite differences method (FDM) and finite elements method (FEM) to solve biological problems. Both FDM and FEM are applied to solve equations and problems in solid and porous media. Requires knowledge of Fortran or C programming.

*Prerequisites:* BME 303

3 credits

#### **BME 430: Quantitative Human Physiology**

This course will provide an introduction to the study of quantitative physiology. This course will introduce the physical, chemical and mathematical foundation of physiology. That knowledge will then be applied to membranes, transport, metabolisms, excitable cells and various organ systems.

*Prerequisites:* BIO 202 and AMS 261 or MAT 203 or MAT 205

3 credits

#### **BME 440: Biomedical Engineering Design**

Introduction to product development from the perspective of solving biomedical, biotechnological, environmental, and ergonomic problems incorporating appropriate engineering standards and multiple realistic constraints. Teamwork in design, establishing customer needs, writing specifications, and legal and financial issues are covered in the context of design as a decision-based process. A semester-long team design project follows and provides the opportunity to apply concepts covered in class.

*Prerequisites:* BME major; U4 standing; BME 301 and 305

3 credits

#### **BME 441: Senior Design Project in Biomedical Engineering**

Formulation of optimal design problems in biomedical and physiological settings. Introduces optimization techniques for engineering design and modeling for compact and rapid optimization of realistic biomedical engineering problems. Necessary conditions for constrained local optimum with special consideration for the multiple realistic constraints in which the product designed should function in terms of the settings (corporal, ex-corporal, biological, etc.), the engineering standards, and the safety considerations involved which are unique to biomedical engineering. Students carry out the detailed design of projects chosen early in the semester. A final design report is required. This course has an associated fee. Please see [www.stonybrook.edu/coursefees](http://www.stonybrook.edu/coursefees) for more information.

*Prerequisite:* BME 440

3 credits

#### **BME 444: Experiential Learning**

This course is designed for students who engage in a substantial, structured experiential learning activity in conjunction with another class. Experiential learning occurs when knowledge acquired through formal learning and past experience are applied to a "real-world" setting or problem to create new knowledge through a process of reflection, critical analysis, feedback

and synthesis. Beyond-the-classroom experiences that support experiential learning may include: service learning, mentored research, field work, or an internship.

*Prerequisite:* WRT 102 or equivalent; permission of the instructor and approval of the EXP+ contract

**SBC:** EXP+

0 credit, S/U grading

### **BME 461: Biosystems Analysis**

Fundamentals of the linear time series analyses framework for modeling and mining biological data. Applications range from cardiorespiratory; renal blood pressure, flow, and sequence; to gene expression data. Tools of data analysis include Laplace and Z transforms, convolution, correlation, Fourier transform, transfer function, coherence function, various filtering techniques, and time-invariant and time-varying spectral techniques.

*Prerequisites:* BME 212 and 301

3 credits

### **BME 475: Undergraduate Teaching Practicum**

Students assist the faculty in teaching by conducting recitation or laboratory sections that supplement a lecture course. The student receives regularly scheduled supervision by the faculty instructor. May be used as an open elective and repeated once.

*Prerequisites:* BME major; U4 standing; a minimum g.p.a. of 3.00 in all Stony Brook courses and a grade of B or better in the course in which the student is to assist; or permission of the department

**SBC:** EXP+

3 credits

### **BME 476: Undergrad Teaching Practicum II**

Students assist the faculty in teaching and learn independent teaching skills while observed by the instructor. May be used as an open elective.

*Prerequisites:* BME major; U4 standing; a minimum g.p.a. of 3.00 in all Stony Brook courses and a grade of B+ or better in the course in which the student is to assist; instructor and departmental approval.

**SBC:** EXP+

3 credits

### **BME 481: Biosensors**

A comprehensive introduction to the basic features of biosensors. Discusses types of most common biological agents (e.g. chromophores, fluorescence dyes) and the ways in which they can be connected to a variety of transducers to create complete biosensors for biomedical applications. Focus on optical biosensors and systems (e.g. fluorescence spectroscopy, microscopy), and fiberoptically-based biosensing techniques. New technologies such as molecular beacons, Q-dots, bioMEMs, confocal microscopy and multiphoton microscopy, and OCT will be referenced.

*Prerequisites:* BIO 202 or 203; ESE 271

3 credits

### **BME 488: Biomedical Engineering Internship**

Participation in off-campus biomedical engineering practice. Students are required to submit a proposal to the undergraduate program director at the time of registration that includes the location, immediate supervisor, nature of the project, and hours per week for the project. One

mid-semester report and one end of semester report are required. May be repeated up to a limit of 12 credits.

*Prerequisites:* BME 212 and permission of undergraduate program director

**SBC:** EXP+

3-6 credits

#### **BME 494: Honors Seminar on Research**

The course outlines components of biomedical research vs design that includes experimental design, data recording, analysis and presentation at scientific meetings, as well as engineering design schematics, patents, and presentations to angel investors. The course culminates with an Honors Thesis Proposal that follows either a research (hypothesis testing) or design (prototype construction) pathway.

*Prerequisite:* U3 standing and acceptance into the BME Honors program.

1 credit

#### **BME 495: Honors Independent Research**

The course involves research (hypothesis testing) or engineering design (prototype construction) that the student completes under the supervision of the faculty member. The course culminates with an Honors Thesis draft (Fall semester) or Honors Thesis that is orally defended (Spring semester). Both BME 494 and BME 495 must be taken to qualify to graduate with Honors in BME.

*Prerequisite:* BME 494

3 credits

#### **BME 499: Research in Biomedical Engineering**

An independent research project with faculty supervision.

*Prerequisites:* Permission of instructor

0-3 credits

## 7 Academic Advising

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### 7.1 BME Major Advising (includes BE-MS)

Academic advising is a crucial component to the undergraduate program. It ensures that all pre-requisites are met for subsequent courses. It enables faculty to identify situations or risk factors related to poor academic performance. It permits the student time for one-on-one dialogue and mentoring with their advisors to inquire about Independent Research or Internship opportunities or future professional interests.

All undergraduate BME students are required to attend academic advising sessions (or meet with their academic advisor) prior to registration each semester. In fact, a HOLD on registration for classes is placed for all BME students, until academic advising is complete. There are no exceptions; plan accordingly.

Current BME students should follow the posted course sequence for their selected track. Alternate course sequences are available from the BME academic advisors for WISE, Honors College and pre-medical or pre-dental students.

#### 7.1.1 Faculty as Mentors

It is highly recommended that each student meets with their BME advisor regarding their coursework, academic performance and career choices.

BME faculty information can be found on BME website.

#### 7.1.2 BME Online Advising Website for Majors

All BME major students will have their advising record on Navigate.

### 7.2 BNG Minor Advising

All BNG minor students are advised first by their major advisor (BIO or BCH) for courses related to their major requirements. They are advised by the Director or Coordinator of the Undergraduate Program in BME for courses related to their minor. We suggest that BNG minor students meet with the Director or Coordinator each semester, and that they inform the Coordinator of their intent to graduate during the semester preceding their graduation from Stony Brook University.

## 8 Career Preparation

### 8.1 Experiential Learning

Experiential Learning takes many forms. For engineers in training, an essential part of the training is experiential, or hands-on. Both strong academics and direct-know-how are how engineers get jobs, and in fact, a strong criteria for admission to graduate programs, including ours. There are many opportunities for experiential learning. Here we will cover three: on campus research, off campus internships and competitive summer programs.

#### 8.1.1 On campus research

On Stony Brook University campus, all BME major are encouraged to participate in BME 499 Independent Research, but generally after they have taken BME 212 Research Fundamentals. Students find a BME faculty member by browsing on the website, from their courses, or through a BMES social event. Students email the faculty in a professional manner using good business email etiquette (not like a text message), briefly introducing themselves and their interest, and providing their student ID. Students with a GPA of less than 3.0 are seldom considered for BME 499, as we feel the GPA is more important than extra time in lab. BME 499 is fun! Hands-on learning is essential! ...yet does not replace any of the core content that must be learned in our program. Instead, mastery of the core content makes one a better researcher.

BME majors may work with non-BME faculty for BME 499 and receive the same credits of technical electives. All students choosing to work with non-BME faculty sign up with the Director of the Undergraduate Program in BME, and the Director oversees that the research effort is appropriate, and the student experience is excellent.

Here are a few pointers to get you started.

#### **The email – first contact.**

In our electronic world of text messages, we often forget business etiquette. Letters of introduction are seldom used. Formal protocol is thrown by the way-side. Yet, your first email to a prospective faculty research mentor, or to a prospective employer, is their first impression of you. Let's start there. Then we will review your first impression of them, the Interview.

***Do's: Professional, short and sweet, first contact.***

Dear Dr. Frame,

My name is Sossan Shah (SBU ID: 000000001) and I am a BME major. I am currently taking BME 212, and hope to find a research lab for BME 499 for next semester. I am interested in your work on blood flow in microchannels. May I schedule an interview with you?

Best regards,  
Sossan Shah

*(sent from the @stonybrook.edu email account)*

***DO NOT's: Short and sour, texting like a BFF!***

Hi, I want to work in your lab. When can I start?

*(sent from another email account)*

Clearly the Do-email indicates a professional attitude and provides essential information to the faculty member. DO-NOT-emails are sometimes ignored as spam, or sometimes more information is requested; the initial contact is not professional.

### **The interview – follow your gut.**

Most faculty will double check your GPA using your SBU ID. We have to double check that you are a real student in our program anyway! The GPA pops up in this process. If it is less than 3.0, you may be denied based on grades.

Let's say your GPA is above 3.0 (and that is true of most BME students, by the way). Unless the lab is full of students already, you are likely to at least get an interview with the faculty member. Now, is your chance to turn your 'Spidey-Senses' on high.

You are looking for whether you find a rapport with the faculty member.

You might get to walk through the lab – notice who is there. Are they smiling? Do they frown?

You might ask which projects are available to undergraduates? Which graduate student would you be working under? What safety courses would you need to take on Blackboard (EH&S)?

Lastly, how do you dress? No need for a suit and tie, or skirt and scarf! This is not a 'job' interview. And yet it is still professional.

Labs are professional workplaces with chemicals and heavy equipment. Dress appropriately with minimal bare skin, and closed toe shoes. In summer, it is very common for lab workers to arrive to the lab with shorts and flip-flops, change into jeans and tennis shoes (or 'scrubs & crocs'), **and then** go into the lab and put on the lab coat. Dress like you know what goes on in a lab when you go for the interview.

Thus the interview is where you will evaluate your potential research mentor and environment, and where the faculty mentor will evaluate you. Do you sound like you want to learn or do you 'know it all'? Do you appear mature, professional and interested? Are you a team player?

### **The Lab – Team Work.**

You are chosen! This is an honor and privilege with responsibility. Follow the BME 499 syllabus carefully. Take the Safety Courses before you start. Dress appropriate to the job. Take good notes in the lab book. Show up on time. Communicate with your graduate student and the faculty mentor if you are sick, or have a big project due, or other factors that may keep you away from the lab during your scheduled time. Many labs can be flexible in your time if you treat this professionally. You are part of a team and your part counts towards the bigger project.

Plan that you will include a poster presentation of your BME 499 work during the spring URECA Celebration Day. This is a day when undergraduates from across campus showcase their experiential work. We all gather in the SAC with hundreds of posters, presentations, and senior design projects. Remember that this presentation, and any other publication, must be approved by the head of the lab (your faculty mentor).

## **8.1.2 Industry Internships**

Many BME majors engage in industry internships; by definition they are performed off-campus. Some are paid internships lasting the summer, or longer!

Some internships use the course, BME 488 Industry Internship. Very few are both paid and for credit.

Using BME 488, the student enrolls in BME 488 with the Director of the Undergraduate Program in BME. There are specific requirements the student must meet before approval, and during the semester, as outlined in the syllabus. Up to 3 credits of BME 488 may count as a substitute technical elective for any track, if approved by the Director. This is considered engineering, but does not always substitute for a BME technical elective course. Contact the Director as early as possible if you are considering this.

Summer internships are sometimes appropriate for the BME 488 mechanism, but there must be a clear division of the part of the project that is paid, and the part that counts for credit. See the Director to learn more.

In special cases, students receive a 6 month internship with a company. By working with the Director, students can seamlessly complete their degree in 4 Years, and complete some coursework remotely. These are special cases, and only with approval of the Director, and support from the CEAS Administrative office. See the Director to learn more.

### 8.1.3 Summer Programs

These summer programs are not internships. They are competitive summer research programs funded by the National Science Foundation (NSF) as REU's (Research Experience for Undergraduates), or by the HHMI (Howard Hughes Medical Institute), or others. The student works at another university or medical center for the summer. Travel and all living expenses are covered. Plus, most programs have additional activities built in for networking and training. Many students write up their research data into meeting abstracts for the Fall BMES meeting where they and their faculty mentor present data to hundreds of other scientists and engineers.

Typically the call for applications to the summer programs open in late December and application due dates are from late January through March. BME majors do very well in obtaining these summer research experiences. Understandably, students with some on-campus research experience (including BME 212), and with better GPA's, are more successful in landing these fun summer positions. Excellent sophomores, and more juniors, obtain these positions.

How do you find these opportunities? The BME Program Coordinator sends emails to all BME undergraduates for each and every program that contacts us. Since our

students do well in these programs, often the organizers request we encourage more of our students to apply. Students can be proactive and google search REU and tissue engineering, or REU and biomedical imaging, to find programs that meet their interest and career path.

## 8.2 SBU Career Center and Handshake

OK, hands-on experience is important. Professionalism is important. Presenting yourself with the correct degree of decorum and assertiveness is crucial. This all comes together at the SBU Career Center. We encourage all students to remain in contact with the Career Center. They offer excellent information on their website for students for education about getting jobs, preparation for job searches, professional attire, resumes, cover letters, interviews and more, plus the importance of networking and connecting with others. They offer resume writing assistance, maintain a database of potential employers and potential internships, host several job fairs on campus with hundreds of companies, give interview practices and tips, and more. They are located in the basement of Melville Library along the zebra walk.

### 8.2.1 Good Resumes

Each BME student is encouraged to create a Handshake profile. This is a professional resume that is critiqued and edited by professionals at the Career Center. It is kept on file, and can be accessed by potential employers.

There is more than one type of resume, based on the job sector or professional school of your interest. Tailoring your resume is both a skill and an art. The Career Center has professional advice for you about what to include, when to lay aside your accolades from high school, which skills are most important to list for each application.

### 8.2.2 Reference Letters

For graduate school, medical school, etc., you will need reference letters. In applying for jobs you are often asked to 'provide references' that the company will contact. Again we are faced with Do's and Do not's.

Many people do not realize it is illegal for someone to give a reference on your behalf unless you have asked them to do so. You must ask.

If they say "no", thank them for considering, and move on.

## Whom to ask for letters?

- *Professors of classes in which you excelled.*
- *Research mentors with whom you did research (go with the faculty, not graduate student, as their title will carry more weight).*
- *Intern mentors with whom you worked.*

## How to ask for letters?

- *“Can you provide a reference letter?”*
- *Briefly tell what the letter is for (do not just give a website).*
- *Ask 3-4 weeks before the due date.*

## They agree to write a letter, what next?

- *Immediately thank them! (it takes 15-20 min to write a reference letter; multiply this by 25 students per faculty...)*
- *Immediately send them a fresh resume (email)*
- *Immediately send them a full list of all places you are applying; this is especially important for graduate schools (all in one email)*
- *Immediately have all electronic-prompts sent to them*
- *For paper forms, give them the form AND a stamped, addressed envelope*

Importantly, make sure they have ALL information they need by 2 weeks before any due date. Between 1-2 weeks before the due date, if you remind them, first thank them for agreeing to write a letter, then kindly remind them of the due date. Do not send repeated e-prompts, or repeated reminders, sounding like Mom reminding you to pick up your shoes. They are doing you a favor. After the deadline is passed and the letter is sent, send another thank you email or note. Candy and presents are NOT necessary. Gratitude and appreciation are professional and appropriate. Lastly, you might send another email letting them know how your summer program, graduate training, or new job is going. We love to stay in touch with our students and alumni.

## 8.3 Professional Career Websites

There are many resources for professional development and chances for professional networking on reputable websites. Here we list the Biomedical Engineering Society and IEEE AMBS as two excellent examples of places to find career preparation information. Many of our faculty have memberships in these professional societies and regularly attend their meetings to present our own data, and to network with colleagues around the globe.

### 8.3.1 BMES.org

The Biomedical Engineering Society has an excellent section on Career Connections. The Career Resources link brings you to the AIMBE (American Institute for Medical and Biological Engineering) webpage 'Navigate the Circuit'. This is an excellent resource for both deciding what your specialization track will be, and getting ideas of specific companies that might hire a person with your skill set.

Back to the BMES website, you can browse job posting, post your own resume, and view information about job interviews that accompany the annual fall meeting of the BMES. Several employers set up booths for in person interviews of multiple candidates while the meetings are in progress. It is a chance for prospective employees to interview with several companies over just a few days.

### 8.3.2. IEEE AMBS

The IEEE website has great information about Biomedical Engineering, and career preparation on their website, 'The Institute'. The Career & Education link brings you to more information about Career Guidance, Education and information about Start-ups. More about a career in Biomedical Engineering can be found in a brochure prepared by the IEEE-Engineering in Medicine and Biology Society.

## 8.4 Social/Professional Media Networking

At some point in your professional career, you may realize that your colleagues have become very good friends. It is human nature to socialize and develop friendships. Professional friendships are the natural extension of working with your colleagues. Yet, there is a distinction between how you interact with friends in the work-place vs. a back-yard BBQ – even if with the same group of people.

Media networking is no different. On professional media outlets, only professionalism is displayed. Potential employers often check to see if you have a LinkedIn or Research Gate webpage. They may also check to see if your personal media pages are open to the public, and whether that content is also professional.

Beginning as an engineering student, it is important to foster professionalism. The BMES student chapter at Stony Brook University provides many workshops and lectures about this. The AEMB Honor Society likewise hosts events for career development. Lastly, there are two major professional media outlets that many scientists and engineers use: LinkedIn and Research Gate.

### 8.4.1 BMES Student Chapter at SBU

The student chapter of BMES at Stony Brook University is a recognized student club, with a faculty advisor. They host monthly Journal Club meetings, Workshops in Programming (Python, etc), Internship information, Business and IP (intellectual property), as well as faculty lectures on their research and fund raising events for medical research. Twice a year, they host an evening workshop focused on career preparation, with industry, business, and academic speakers.

Any BME major can join in these events, and join the BMES chapter for free. To be affiliated with the national BMES, there is a small dues payment. They have an active FaceBook page that is maintained in a professional manner.

Students who participate in these events are not only receiving excellent career preparation information, but also beginning their professional networking process.

### 8.4.2 AEMB National Biomedical Honor Society

The AEMB (alpha eta mu beta) is a National Honor Society for BME majors. It is a recognized student club, with a faculty advisor. To join, there is a GPA requirement, and an application process. They host monthly meetings on a

variety of topics. They have an outreach program to teach middle-school and high school students about BME. They maintain a non-SBU website that contains most of their activities list.

### 8.4.3 LinkedIn

LinkedIn is a professional website where you can post your current resume and skills, look for a job, network with other professionals, and follow new research areas. You must create an account to view other profiles. Creating your profile is free, and there are advanced services for a fee. This is one site that prospective employers may check if they are considering you for a position.

BME stays in touch with many alumni through LinkedIn. If you join, be sure to Connect to us!

### 8.4.4 ResearchGate

Research Gate is a professional website that targets research, both academic and industrial. This is a good site to follow for recent advances by specific investigators. You must create an account, which is free. Typically, members upload their own research interests, and published data manuscripts.

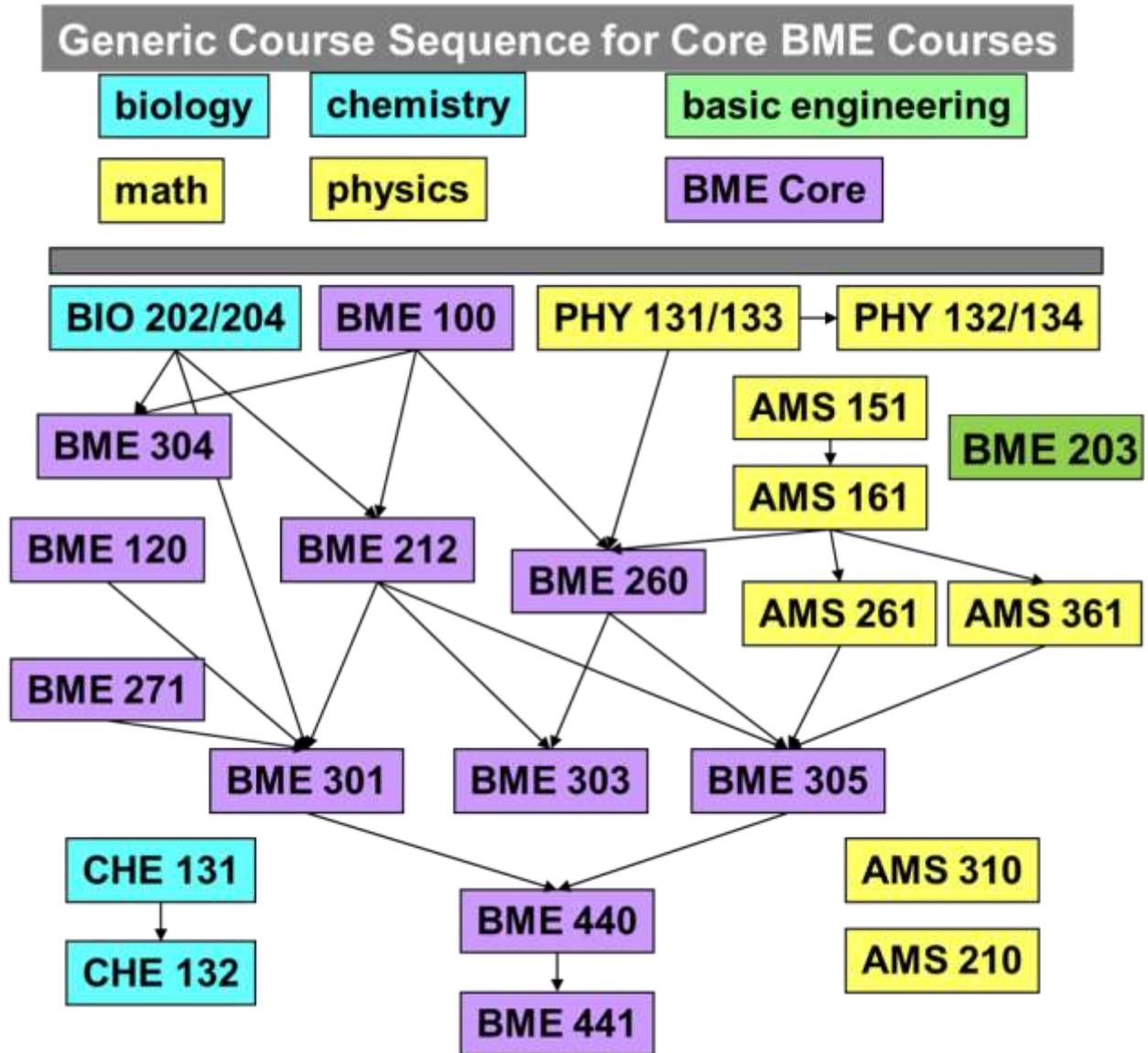
ResearchGate also has a recruiting page where jobs can be posted, and opportunities can be reviewed.

## 8.5 Pre-Professional Preparation

Approximately 25% of BME majors continue in medical, dental or law school. Their academic preparation is more rigorous than the already challenging BME major program. Academic advising is extremely important for these students. BME always directs pre-professional students to the Stony Brook University pre-health office. This office serves several important functions. First, they keep up to date information about which courses are required for medical, dental or law school. Second, they advise students on preparation for the MCAT, DCAT, and LSAT examinations. Third, they gather your application materials for medical or dental school, consolidate your letters of reference, and submit the application on your behalf. You cannot apply to these schools yourself. This office provides the free service of applying on your behalf; otherwise, you go through an outside service that is very costly! Students are encouraged to visit this office and make an appointment with a pre-health or pre-law advisor as freshmen or sophomores. BME academic Advisors can work with students to fit in the correct courses, but we rely on the student to know the specific requirements for their professional school preparation.

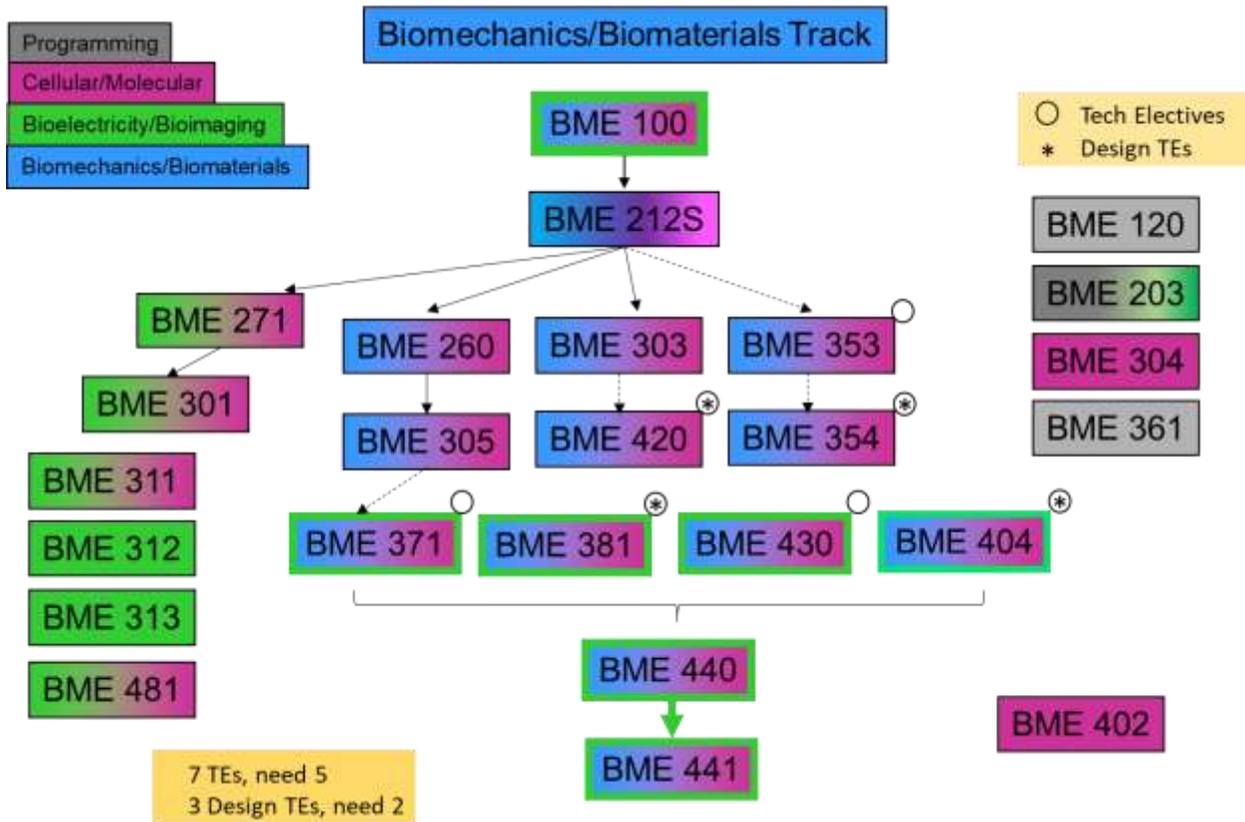
Appendix A. Generic Course Sequence for CORE Courses Flow Chart

Note this chart does NOT contain Technical Electives.

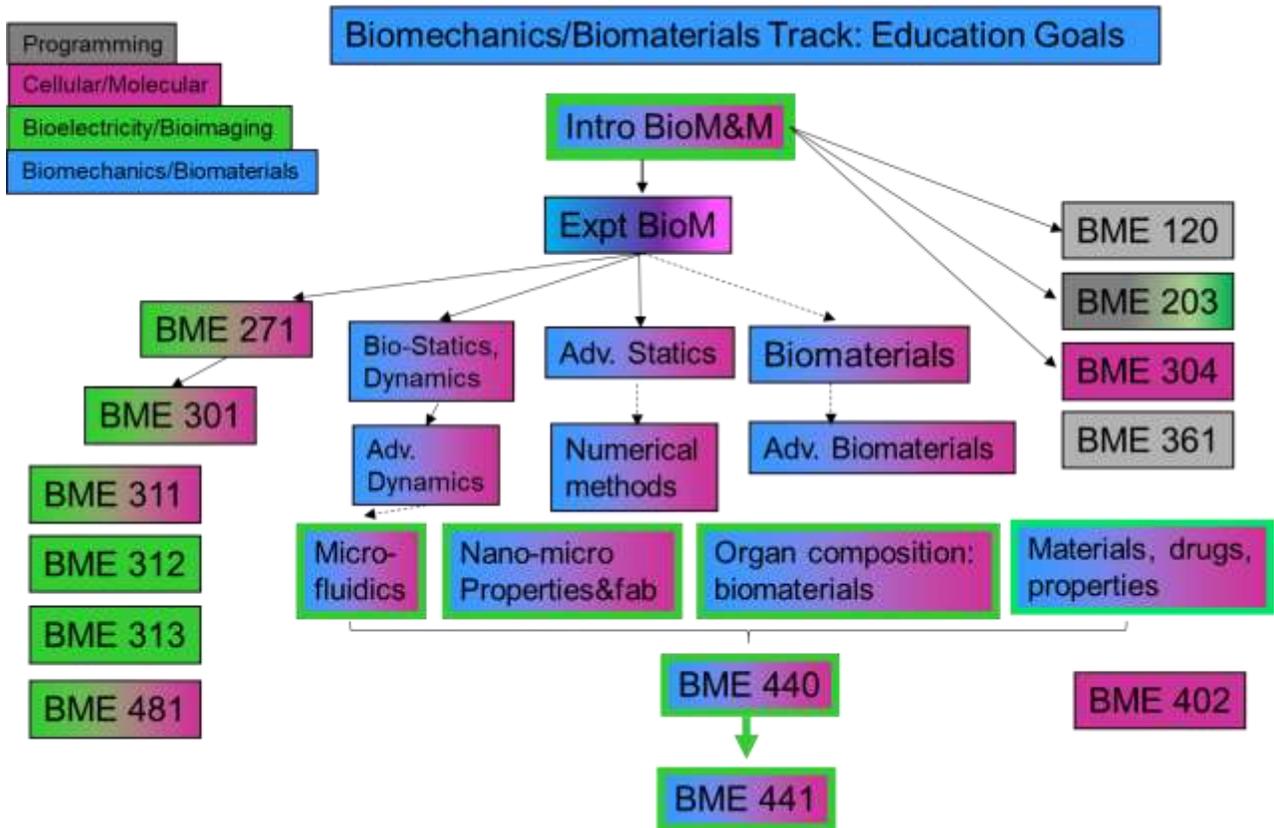


## Appendix B. Biomechanics and Biomaterials Track

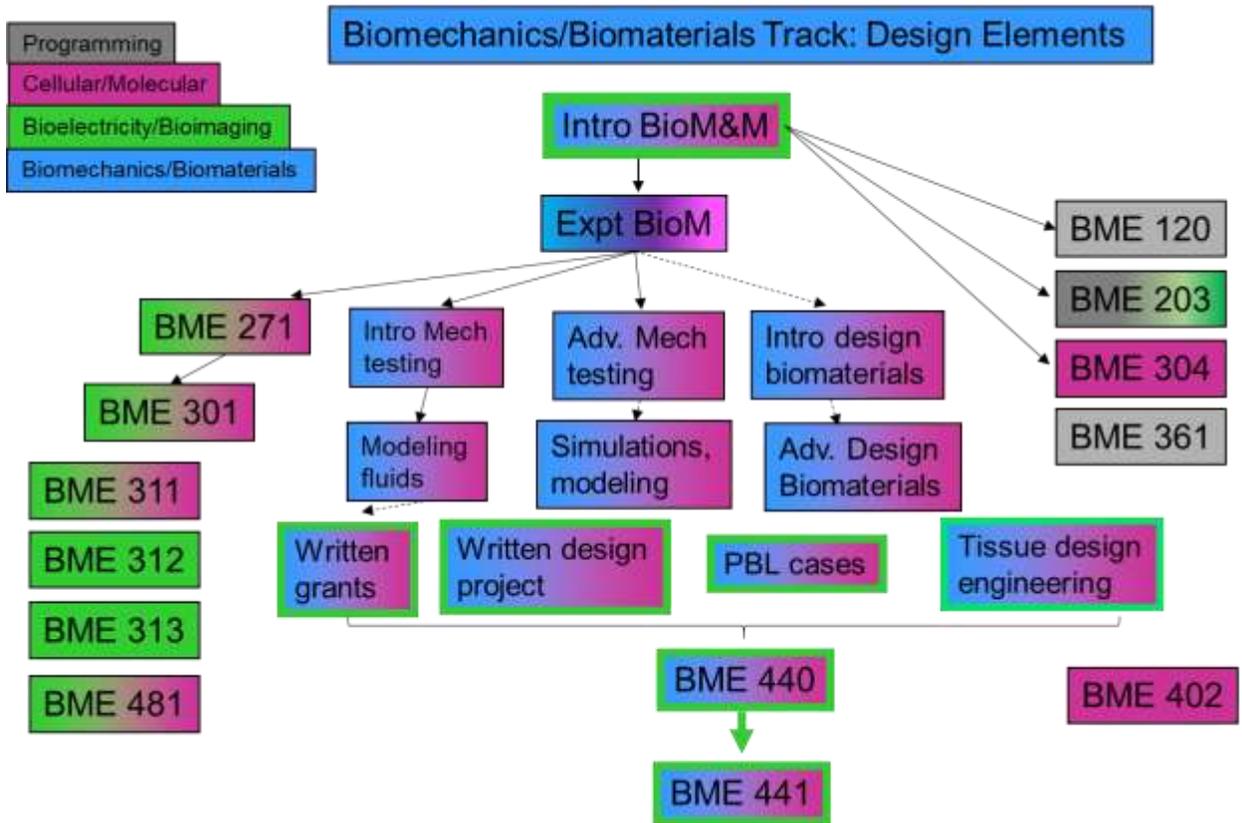
### B.1. Biomechanics and Biomaterials Track: Prerequisites Flow Chart



## B.2. Biomechanics and Biomaterials Track: Teaching Content Flow Chart

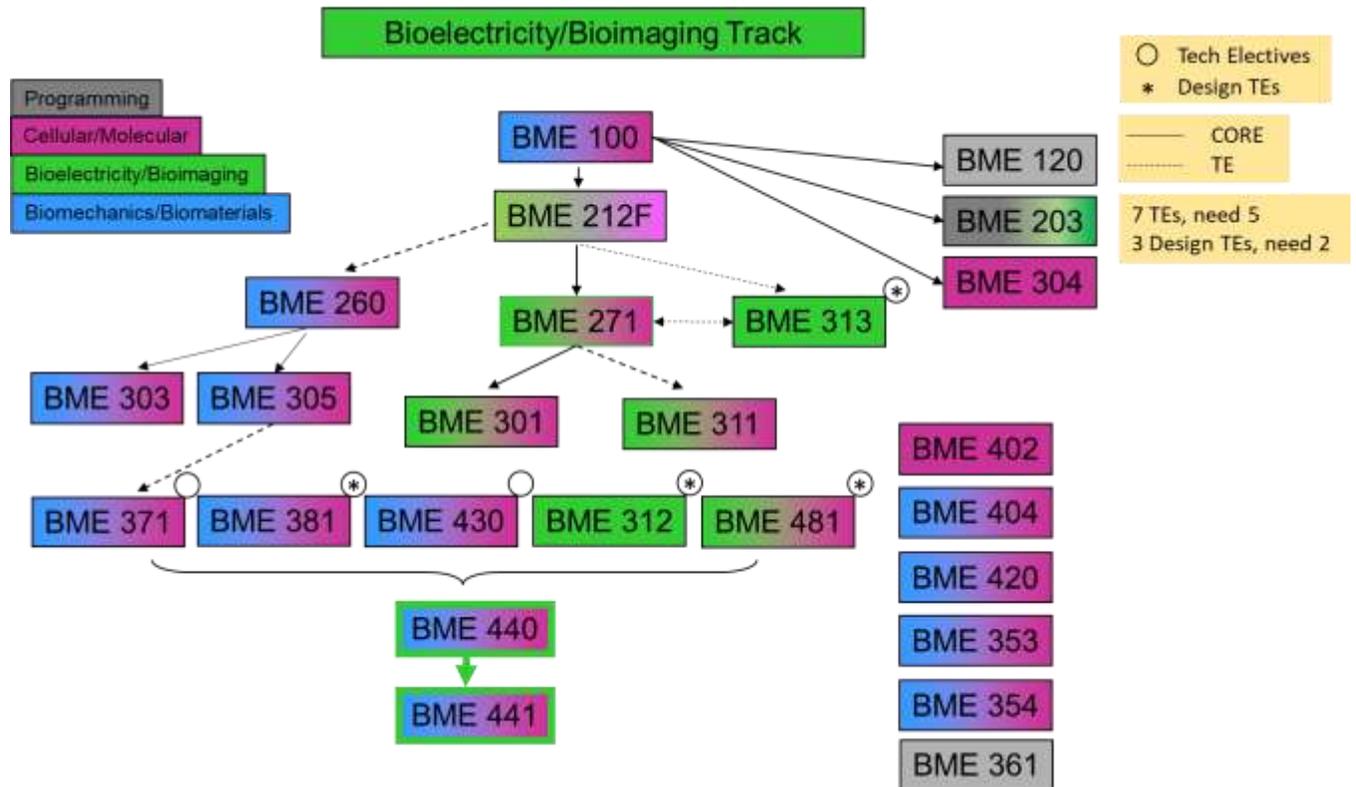


### B.3. Biomechanics and Biomaterials Track: Design Content Flow Chart

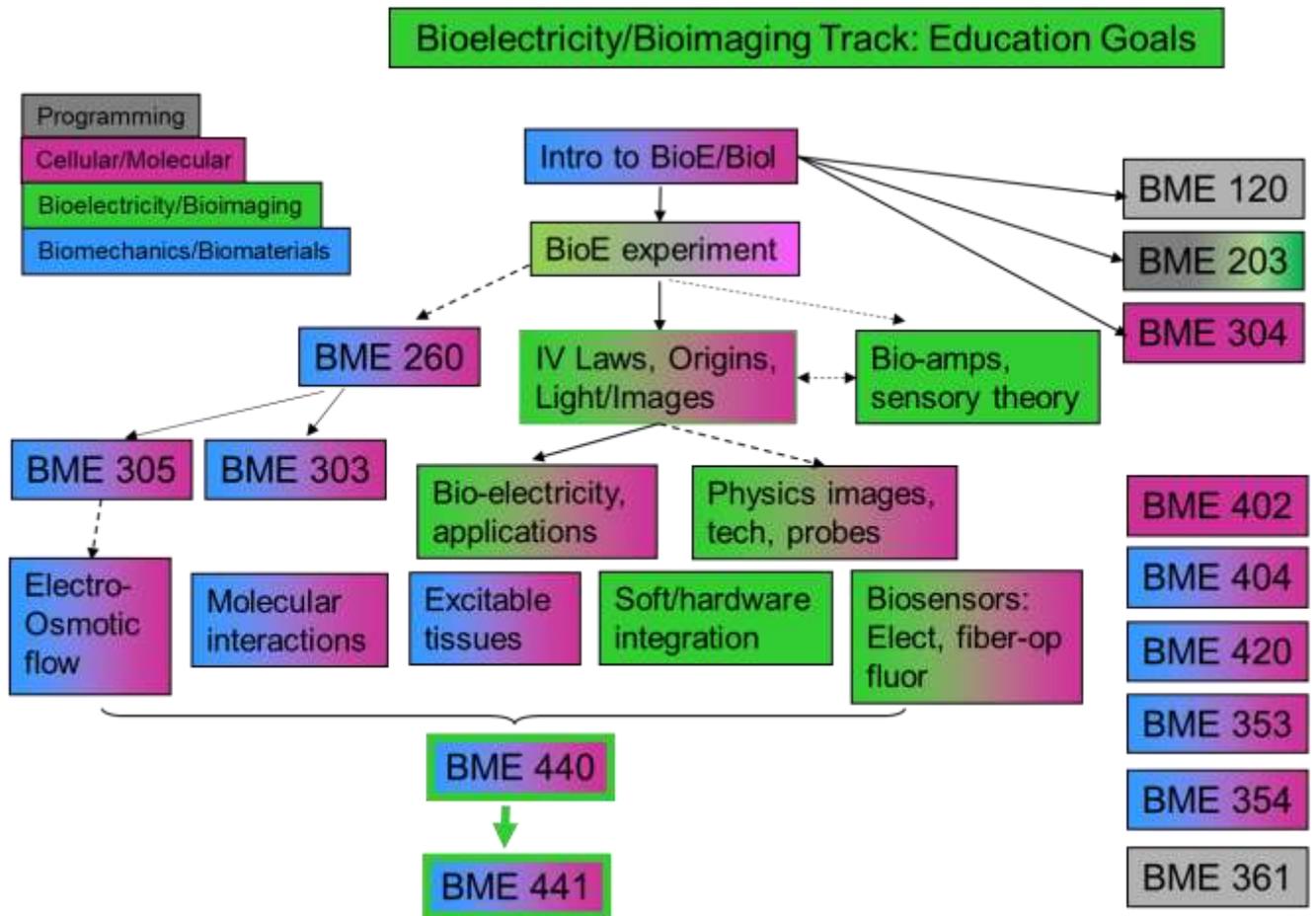


## Appendix C. Bioelectricity and Bioimaging Track

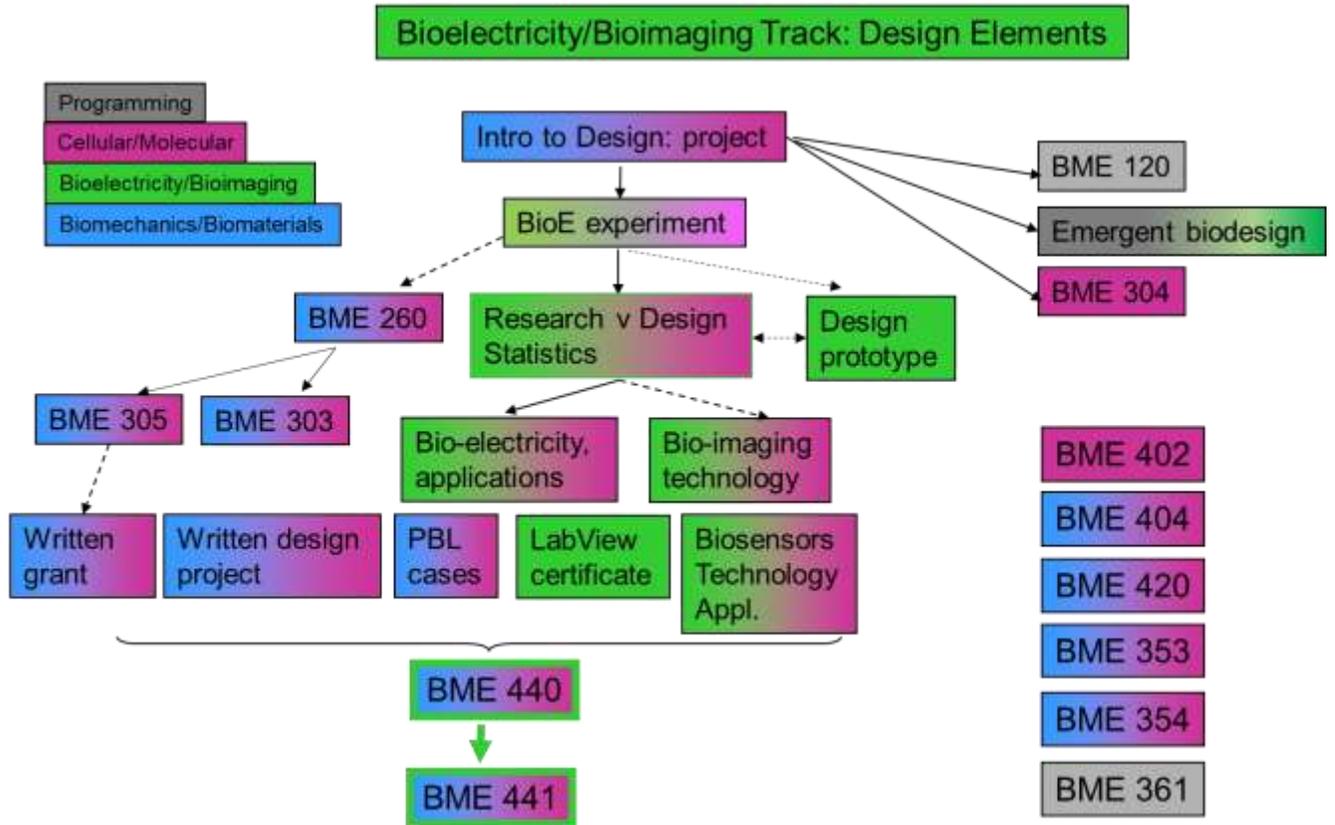
### C.1. Bioelectricity and Bioimaging Track: Prerequisites Flow Chart



## C.2. Bioelectricity and Bioimaging Track: Teaching Content Flow Chart

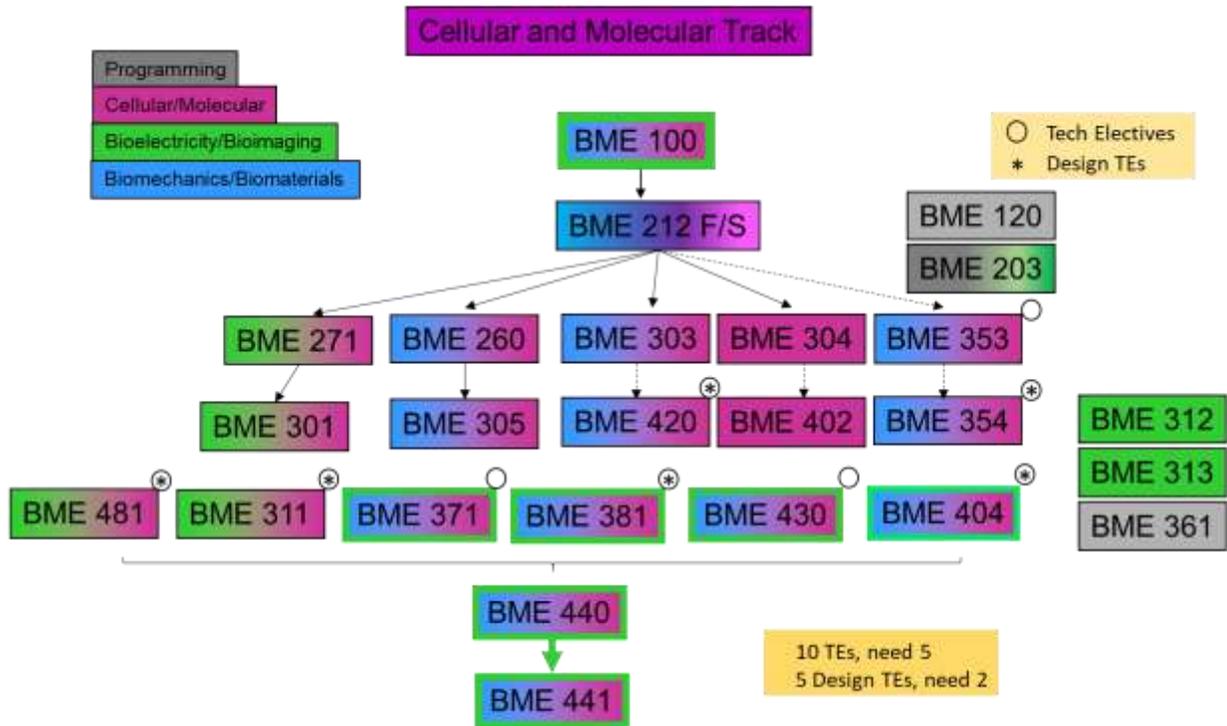


### C.3. Bioelectricity and Bioimaging Track: Design Content Flow Chart

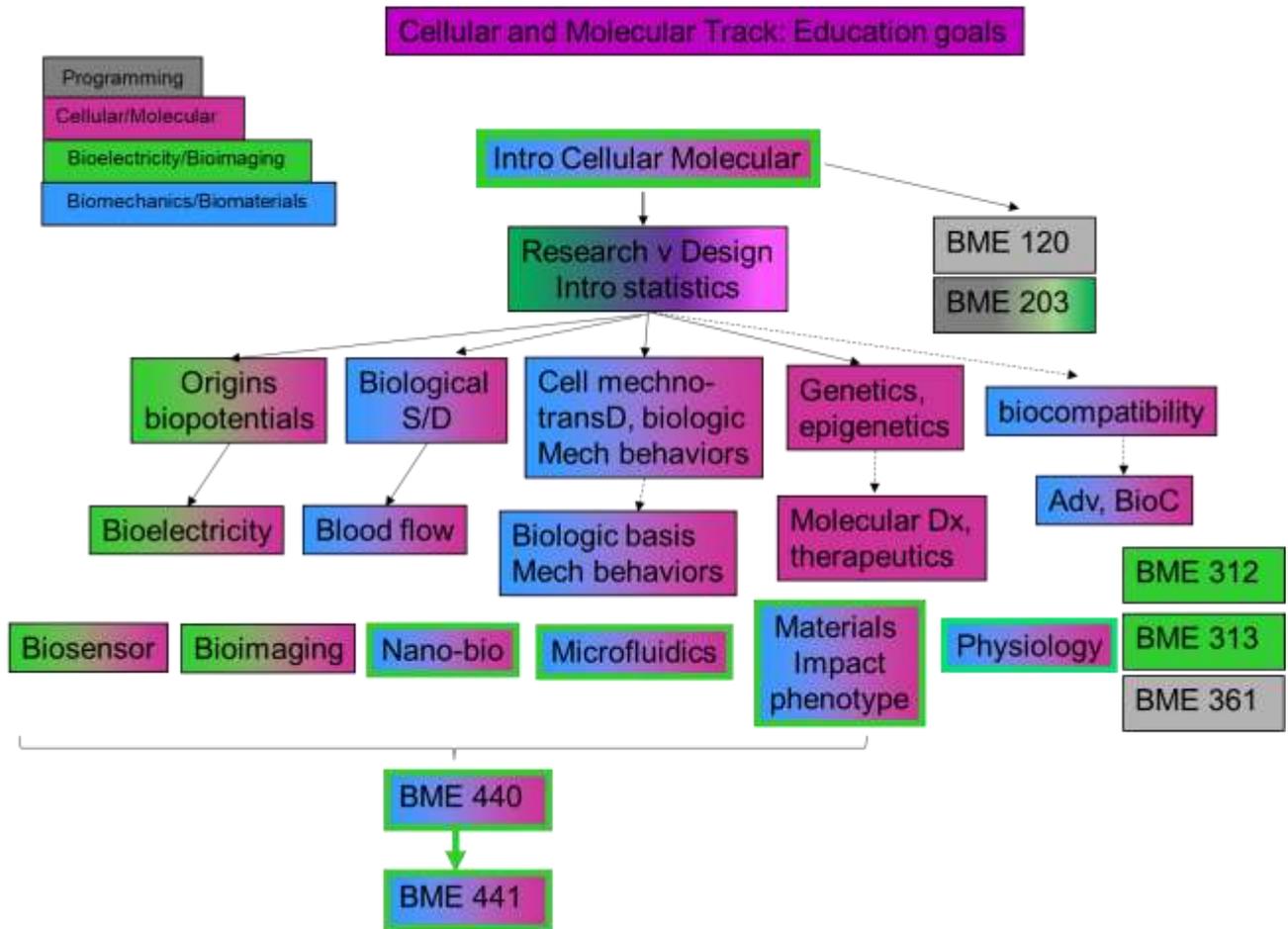


## Appendix D. Cellular Molecular Track

### D.1. Cellular Molecular Track: Prerequisites Flow Chart



## D.2. Cellular Molecular Track: Teaching Content Flow Chart



### D.3. Cellular Molecular Track: Design Content Flow Chart

