

**Plan of Study for the Bioengineering Track**  
of the Engineering Sciences SB Concentration  
Effective for Students Declaring the Concentration after August 1, 2019

NAME: \_\_\_\_\_

CLASS: \_\_\_\_\_

EMAIL: \_\_\_\_\_

DATE: \_\_\_\_\_

This Plan of Study Form is for a (*Circle One*):                      DECLARATION                      REVISION

*The S.B. Program in Engineering Sciences must contain at least 20 courses: 4 courses in mathematics, 4 courses in basic sciences, and 12 courses in engineering topics. This Plan of Study is not final until this form has been signed, ensuring that the proposed plan meets the ABET distribution requirements.*

<b>REQUIRED COURSES</b> (Circle or fill-in for courses planned in each category.)	<b>Math</b>	<b>Science</b>	<b>Engr. Topics</b>	<b>Semester</b> (FA/SP Year)
<b>Mathematics</b> (2-4 courses)  <i>Begin according to placement:</i> Math 1a – Introduction to Calculus I (or Math Ma & Mb) Math 1b – Calculus, Series, and Differential Equations Math 21a – Multivariable Calculus (or Math 22a or 23b, or Applied Math 21a or 22b) Math 21b – Linear Algebra and Differential Equations (or Math 22b or 23a, or Applied Math 21b or 22a)	  1.0 1.0 1.0 1.0			  _____ _____ _____ _____
<b>Probability &amp; Statistics</b> (1 course, if starting in Math 1b or higher)  <i>Select one (ES150 preferred for Electrical Subtrack):</i> AM 101 – Statistical Inference for Scientists & Engineers ES 150 – Intro to Probability with Engineering Applications Statistics 110 – Introduction to Probability	(1.0)			_____
<b>Applied Mathematics</b> (1 course, if starting in Math 21a or equivalent)  <i>Select one:</i> AM 104 – Series Expansions & Complex Analysis AM 105 – Ordinary & Partial Differential Equations AM 106 – Applied Algebra AM 107 – Graph Theory & Combinatorics	(1.0)			_____
<b>Physics</b> (2 courses)  AP 50a – Physics as a Foundation for Sci. & Eng. Part I (or PS 12a or Physics 15a or 16) AP 50b – Physics as a Foundation for Sci. & Eng. Part II (or PS 12b or Physics 15b)		1.0 1.0		_____ _____
<b>Computer Science</b> (1 course)  <i>Select one:</i> CS 50 – Introduction to Computer Science I CS 51 – Introduction to Computer Science II CS 61 – Systems Programming & Machine Organization			1.0	_____

<b>REQUIRED COURSES</b> (Circle or fill-in for courses planned in each category.)	<b>Math</b>	<b>Science</b>	<b>Engr. Topics</b>	<b>Semester</b> (FA/SP Year)
<b>Chemistry/Life Sciences (2 courses)</b> <i>Select two (either Chemistry 17 or 20 is required for the Chemical &amp; Materials Subtrack):</i> LS 1a – Intro to the Life Sciences (or LPS A – Foundational Chemistry & Biology) LS 1b – Genetics, Genomics, and Evolution PS 10 – Chemistry: A Microscopic Perspective PS 11 – Foundations & Frontiers in Modern Chemistry (or PS 1 – Chemical Bonding, Energy, & Reactivity) CHEM 17 – Principles of Organic Chemistry (or CHEM 20 – Organic Chemistry)		1.0  1.0		_____  _____
<b>Sophomore Forum</b> <i>Required, non-credit.</i>				_____
<b>Bioengineering Core: Physiology &amp; Modeling (2 courses)</b> ES 53 – Quantitative Physiology as a Basis for Bioengineering BE 110 – Physiological Systems Analysis			1.0  1.0	_____  _____
<b>Subtrack-specific Courses (4 courses) <i>Select one Subtrack:</i></b> <ul style="list-style-type: none"> <li>• <i>Mechanical Subtrack</i> <ul style="list-style-type: none"> <li>○ ES 120 – Intro to the Mechanics of Solids</li> <li>○ ES 123 – Intro to Fluid Mechanics</li> <li>○ ES 181 – Engineering Thermodynamics</li> <li>○ BE 191 – Intro to Biomaterials (<i>preferred</i>)     (or ES 190 – Intro to Materials Science &amp; Eng.)</li> </ul> </li> <li>• <i>Electrical Subtrack</i> <ul style="list-style-type: none"> <li>○ ES 54 – Electronics for Engineers (or ES 153 (or both of ES 152 and CS 141))</li> <li>○ Signals and systems courses (<i>select two</i>): BE 128 – Biomedical Imaging and Systems, BE 129 – Intro. to Bioelectronics, BE 130 – Neural Control of Movement, ES 157 – Biological Signal Processing</li> <li>○ Another approved EE course (if ES 54/153 is taken)     (<i>see last page for list of EE electives</i>)</li> </ul> </li> <li>• <i>Chemical &amp; Materials Subtrack</i> <ul style="list-style-type: none"> <li>○ BE 121 – Cellular Engineering     (or BE 125 – Tissue Engineering)</li> <li>○ ES 123 – Intro to Fluid Mechanics</li> <li>○ ES 181 – Engineering Thermodynamics     (or ES 112 – Thermodynamics by Case Study)</li> <li>○ BE 191 – Intro to Biomaterials (<i>preferred</i>)     (or ES 190 – Intro to Materials Science &amp; Eng.)</li> </ul> </li> </ul>			1.0  1.0  1.0  1.0	_____  _____  _____  _____
<b>Approved Engineering Electives*</b> (3 courses) <i>Select three courses, at least two at the 100- or 200- level, from the list on pages 4-5.</i> 1.			1.0	_____

<b>REQUIRED COURSES</b> (Circle or fill-in for courses planned in each category.)	<b>Math</b>	<b>Science</b>	<b>Engr. Topics</b>	<b>Semester</b> (FA/SP Year)
2.			1.0	_____
3.			1.0	_____
<b>Engineering Design</b> (2 courses) ES 96 or ES 227 ( <i>one must be taken prior to senior year</i> ) ES 100hf ( <i>taken both semesters during senior year</i> )			1.0 1.0	_____ _____
<b>TOTALS</b>	<b>/4</b>	<b>/4</b>	<b>/12</b>	

\* Engineering Sciences 6, 50, 51, and 53: No more than two of these courses may count towards concentration credit. Engineering Sciences 6 and 50 can only count as an engineering elective when taken during the freshman or sophomore year.  
ES 91r may be included as an Engineering Elective in a Revised Plan of Study following the approval of a written petition and a signed certification that the project meets the ABET definition of an engineering topic.

**For courses that are co-listed in another department, students must enroll in the Engineering Sciences offering.**

**Required Signatures:**

\_\_\_\_\_

Student

\_\_\_\_\_

Date

\_\_\_\_\_

Assistant/Director of Undergraduate Studies

\_\_\_\_\_

Date

This plan *does / does not* meet the ABET distribution requirements.

\_\_\_\_\_

Associate Dean for Education

\_\_\_\_\_

Date

## Pre-approved Courses for the SB in Engineering Sciences

### Engineering Courses

*These courses fulfill the requirement for ABET engineering topics and are sorted by depth area. For courses that are co-listed in another department, students must enroll in the Engineering Sciences offering.*

#### *Biological and Biomedical*

- ES 53 – Quantitative Physiology as a Basis for Bioengineering
- BE 110 – Physiological Systems Analysis
- BE 121 – Cellular Engineering
- BE 125 – Tissue Engineering
- BE 128 – Intro. to Biomedical Imaging and Systems
- BE 129 – Intro. to Bioelectronics
- BE 130 – Neural Control of Movement
- BE 191 – Intro to Biomaterials
- ES 211 – Microphysiological Systems
- ES 221 – Drug Delivery
- ES 227 – Medical Device Design
- ES 228 – Biologically-Inspired Materials

#### *Computer*

- CS 51 – Intro to Computer Science 2
- CS 61 – System Programming & Machine Organization
- CS 124 – Data Structures and Algorithms
- CS 141 – Computing Hardware
- CS 143 – Computer Networks
- CS 146 – Computer Architecture
- CS 148 – Design of VLSI Circuits & Systems
- CS 175 – Computer Graphics
- CS 179 – Design of Useful and usable Interactive Systems
- CS 181 – Machine Learning
- CS 182 – Artificial Intelligence
- CS 187 – Computational Linguistics
- CS 189 – Autonomous Robot Systems

#### *Electrical*

- ES 50 – Intro to Electrical Engineering
- ES 54 – Electronics for Engineers
- ES 143 – *Title TBD*
- ES 151 – Applied Electromagnetism
- ES 152 – Circuits, Devices, and Transduction
- ES 153 – Laboratory Electronics
- ES 154 – Electronic Devices & Circuits
- ES 155 – Systems and Control
- ES 156 – Signals & Communications
- ES 157 – Biological Signal Processing
- ES 158 – Feedback Systems: Analysis and Design
- ES 159 – Intro to Robotics
- ES 170 – Engineering Quantum Mechanics
- ES 173 – Electronic and Photonic Devices
- ES 175 – Photovoltaic Devices
- ES 176 – Intro to MicroElectroMechanical Systems
- ES 177 – Microfabrication Laboratory

#### *Engineering Physics and Chemistry*

- E ES 170 – Engineering Quantum Mechanics
- ES 173 – Introduction to Electronic and Photonic Devices
- ES 181 – Engineering Thermodynamics
- ES 190 – Intro to Materials Science & Engineering
- ES 112 – Thermodynamics by Case Study

### *Environmental*

- ESE 6 – Intro to Environmental Science & Engineering
- ESE 109 – Earth Resources and the Environment
- ES 112 – Thermodynamics by Case Study
- ES 123 – Intro to Fluid Mechanics & Transport Processes
- ESE 130 – Biogeochemistry of Carbon Dioxide and Methane
- ESE 131 – Introduction to Physical Oceanography and Climate
- ESE 132 – Introduction to Meteorology and Climate
- ESE 133 – Atmospheric Chemistry
- ESE 136 – Climate and Climate Engineering
- ESE 160 – Space Science and Engineering: Theory and Applications
- ESE 161 – Applied Environmental Toxicology
- ESE 162 – Hydrology
- ESE 163 – Pollution Control in Aquatic Ecosystems
- ESE 166 – State-of-the-art Instrumentation in Environmental Sciences
- ESE 169 – Seminar on Global Pollution Issues

### *Mechanics and Materials*

- ES 51 – Computer Aided Machine Design
- ES 120 – Intro to the Mechanics of Solids
- ES 123 – Intro to Fluid Mechanics & Transport Processes
- ES 125 – Mechanical Systems
- ES 128 - Computational Solid & Structural Mechanics
- ES 181 – Engineering Thermodynamics
- ES 183 – Introduction to Heat Transfer
- ES 190 – Intro to Materials Science & Engineering

### *General Engineering Electives*

- ES 111 – Intro to Scientific Computing
- ES 115 – Mathematical Modeling
- ES 121 – Intro to Optimization: Models & Methods

**Prerequisite Planning Table for the ES SB - Bioengineering Track**

	Typically Offered	Math	Biology / Chemistry	Physics	Other
<i>Required Courses</i>					
ES 53	Fall				
BE 110	Fall	<i>21a,b</i>		<i>B</i>	<i>ES 53</i>
ES 96	Fall & Spring				<b>Junior Year</b>
ES 100HF	Fall-Spring				<b>ES 96 or 227</b>
<i>Selected Electives</i>					
BE 121	Fall	<b>21b</b>	<b>LS 1a,1b</b>	<b>A,B</b>	<b>ES 53, Co: BE 110</b>
BE 125	Spring		<i>LS1a, Chem 17</i>		
BE 128	Spring	<b>1b</b>		<b>B</b>	
BE 129	Spring	<b>1b</b>	<b>LS 1a, Chem 17</b>	<b>B</b>	
BE 130	Spring				
BE 191	Spring	<b>1b</b>	<b>LS1a or PS 1</b>		
CS 141	Spring				<i>CS50</i>
ES 54	Spring				
ES 112	Spring				
ES 120	Spring	<b>21a, Co: 21b</b>		<b>A</b>	
ES 123	Spring	<b>21a,b</b>		<b>A</b>	
ES 152	Fall	<b>1a,b</b>		<b>Co: B</b>	
ES 153	Fall & Spring				
ES 157	Fall	<b>21a,b</b>			<i>ES 150 or 156</i>
ES 181	Fall			<b>A</b>	
ES 190	Fall	<b>21a,b</b>		<b>A,B</b>	
ES 227	Spring				<i>ES 51</i>

<sup>1</sup>Courses listed as Recommended Preparation, and not an enforced prerequisite, are shown in italics

<sup>2</sup>Courses marked with a "Co:" may be taken as a co-requisite

<sup>3</sup>Equivalent courses are accepted for prerequisites (e.g., Phys 15a, PS 12a, or AP50a all count for Physics A)