Plan of Study for the Bioengineering Track

of the Engineering Sciences SB Concentration

Effective for Students Declaring the Concentration after August 1, 2023

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.

REQUIRED COURSES (Circle or fill-in for courses planned in each category.)	**Math**	**Science**	**Engr. Topics**	**Semester** (FA/SP Year)
Mathematics (2-4 courses) *Begin according to placement:* 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) Math 21b – Linear Algebra and Differential Equations (or Math 22b or 23a)	 1.0 1.0 1.0 1.0			 _____ _____ _____ _____
Probability & Statistics (1 course, if starting in Math 1b or higher) *Select one (ES150 preferred for Electrical Subtrack*): AM 101 – Statistical Inference for Scientists & Engineers ES 150 – Intro to Probability with Engineering Applications Statistics 110 – Introduction to Probability	 (1.0)			 _____
Applied Mathematics (1course, if starting in Math 21a or equivalent) *Select one:* AM 104 – Series Expansions & Complex Analysis AM 105 – Ordinary & Partial Differential Equations AM 106 – Applied Algebra AM 107 – Graph Theory & Combinatorics	 (1.0)			 _____
Physics (2 courses) PS 12a - Mechanics and Statistical Physics (or AP 50a or Physics 15a or 16) PS 12b - Electromagnetism and Quantum Physics (or AP50b or Physics 15b)		 1.0 1.0		 _____ _____
Computer Science (1 course) *Select one:* CS 50 – Introduction to Computer Science I CS 51 – Introduction to Computer Science II CS 61 – Systems Programming & Machine Organization AM 10 – Computing w/ Python for Scientists and Engineers CS 32 – Computational Thinking and Problem Solving SCI 5 – An Intro to Computation for Contemporary Science			 1.0	 _____

REQUIRED COURSES (Circle or fill-in for courses planned in each category.)	**Math**	**Science**	**Engr. Topics**	**Semester** (FA/SP Year)
Chemistry/Life Sciences (2 courses) *Select two (either Chemistry 17 or 20 is required for the Chemical & Materials Subtrack):* LS 1a – Intro to the Life Sciences (or LPS A – Foundational Chemistry & Biology) LS 1b – Genetics, Genomics, and Evolution CHEM 10 - Quantum, Statistical, and Computational Foundations of Chemistry (or PS 10 – Chemistry: A Microscopic Perspective) PS 11 – Foundations & Frontiers in Modern Chemistry CHEM 17 – Principles of Organic Chemistry (or CHEM 20 – Organic Chemistry)		1.0 1.0		_____ _____
Sophomore Forum *Required, non-credit.*				_____
Bioengineering Core: Physiology & Modeling (2 courses) ES 53 – Quantitative Physiology as a Basis for Bioengineering BE 110 – Physiological Systems Analysis			1.0 1.0	_____ _____
Subtrack-specific Courses (4 courses) *Select one Subtrack:* • *Mechanical Subtrack* o ES 120 – Intro to the Mechanics of Solids o ES 123 – Intro to Fluid Mechanics o ES 181 – Engineering Thermodynamics o BE 191 – Intro to Biomaterials (*preferred*) (or ES 190 – Intro to Materials Science & Eng.) • *Electrical Subtrack* o ES 50 – Intro to Electrical Engineering (or ES 153 (or both of ES 152 and CS 141)) o Signals and systems courses (*select two)*: BE 128 – Biomedical Imaging and Systems, BE 129 – Intro. to Bioelectronics, BE 130 – Neural Control of Movement, BE 131 – Intro to Neuroengineering, ES 157 – Biological Signal Processing o Another approved EE course (if ES 50 is taken) *(see last page for list of EE electives)* • *Chemical & Materials Subtrack* o BE 121 – Cellular Engineering (or BE 125 – Tissue Engineering) o ES 123 – Intro to Fluid Mechanics o ES 181 – Engineering Thermodynamics (or ES 112 – Thermodynamics by Case Study) o BE 191 – Intro to Biomaterials (*preferred*) (or ES 190 – Intro to Materials Science & Eng.)			1.0 1.0 1.0 1.0	_____ _____ _____ _____

REQUIRED COURSES (Circle or fill-in for courses planned in each category.)	**Math**	**Science**	**Engr. Topics**	**Semester** (FA/SP Year)
Approved Engineering Electives* (3 courses) *Select three courses, at least two at the 100- or 200- level, from the list on pages 4-5.*				
1.			1.0	_____
2.			1.0	_____
3.			1.0	_____
Engineering Design (2 courses)				
ES 96 or ES 227 (*one must be taken prior to senior year*)			1.0	_____
ES 100hf (*taken both semesters during senior year*)			1.0	_____
TOTALS	**/4**	**/4**	**/12**	

* Engineering Sciences 6, 50, 51, and 53: No more than three 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. *See handbook.

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 _____

Associate/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 131 – Intro to Neuroengineering
- BE 191 – Intro to Biomaterials
- ES 221 – Drug Delivery
- ES 227 – Medical Device Design

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

- 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
- ESE 115 - Ecosystem Patterns and Processes: Parallels in Natural and Built Environments
- ES 123 – Intro to Fluid Mechanics & Transport Processes
- ESE 130 – Biogeochemistry of Carbone 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
Required Courses					
ES 53	Fall			**Co: A or B**	
BE 110	Fall	*21a,b*		*B*	*ES 53*
ES 96	Fall & Spring				**Junior Year**
ES 100HF	Fall-Spring				**ES 96 or 227**
Selected Electives					
BE 121	Fall	**21b**	**LS 1a,1b**	**A,B**	**ES 53, Co: BE 110**
BE 125	Spring		*LS1a, Chem 17*		
BE 128	Spring	**1b**		**B**	
BE 129	Spring	**1b**	**LS 1a**, *Chem 17*	**B**	
BE 130	Spring				
BE 131	Fall	**1b**		**B**	
BE 191	Fall	**1b**	**LS1a or LPSa**		
CS 141	Spring				*CS50*
ES 50	Spring				
ES 112	Spring				
ES 120	Spring	**21a, Co: 21b**		**A**	
ES 123	Spring	**21a,b**		**A**	
ES 152	Fall	**1a,b**		**Co: B**	
ES 153	Fall & Spring				
ES 157	Fall	**21a,b**			*ES 150 or 156*
ES 181	Fall			**A**	
ES 190	Fall	**21a,b**		**A,B**	
ES 227	Spring				*ES 51 or ES 50*

[1]Courses listed as Recommended Preparation, and not an enforced prerequisite, are shown in italics

[2]Courses marked with a "Co:" may be taken as a co-requisite

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