Plan of Study for the Bioengineering Track

of the Engineering Sciences SB Concentration

Effective for Students Declaring the Concentration after August 1, 2024

NAME: _____ CLASS YEAR: _____

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.

Please list your selected concentration courses in the schedule below:

Fall 1	Spring 1	Fall 2	Spring 2	Fall 3	Spring 3	Fall 4	Spring 4

REQUIRED COURSES	Selected Courses
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 22b or 25a) Math 21b – Linear Algebra and Differential Equations (or Math 22a or 25b)	
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	
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	
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)	

REQUIRED COURSES	Selected Courses
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	
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 PS 11 – Foundations & Frontiers in Modern Chemistry CHEM 17 – Principles of Organic Chemistry (or CHEM 20 – Organic Chemistry)	
Bioengineering Core: Physiology & Modeling (2 courses) ES 53 – Quantitative Physiology as a Basis for Bioengineering BE 110 – Physiological Systems Analysis	
Subtrack-specific Courses (4 courses) *Select one Subtrack:* *Mechanical Subtrack* • ES 120 – Intro to the Mechanics of Solids • ES 123 – Intro to Fluid Mechanics • ES 181 – Engineering Thermodynamics • BE 191 – Intro to Biomaterials (*preferred*) (or ES 190 – Intro to Materials Science & Eng.) *Electrical Subtrack* • ES 50 – Intro to Electrical Engineering (or ES 153 (or both of ES 152 and CS 141)) • 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 • Another approved EE course (if ES 50 is taken) *(see last page for list of EE electives)* *Chemical & Materials Subtrack* • BE 121 – Cellular Engineering (or BE 125 – Tissue Engineering) • ES 123 – Intro to Fluid Mechanics • ES 181 – Engineering Thermodynamics (or ES 112 – Thermodynamics by Case Study) • BE 191 – Intro to Biomaterials (*preferred*) (or ES 190 – Intro to Materials Science & Eng.)	
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. 2. 3.	

REQUIRED COURSES	Selected Courses
Engineering Design (2 courses) ES 96 or ES 227 (*one must be taken prior to senior year*) ES 100hf (*taken both semesters during senior year*)	

* 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 first 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 124 – Biomechanics of Movement and Assistive Robotics
- 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 109a – Data Science 1: Introduction to Data Science
- CS 120 – Introduction to Algorithms and their limitations
- 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 151 – Applied Electromagnetism
- ES 152 – Circuits, Devices, and Transduction
- ES 155 – Systems and Control
- ES 156 – Signals & Communications
- ES 157 – Biological Signal Processing
- ES 158 – Introduction to Optimal Control and Estimation
- ES 159 – Intro to Robotics
- ES 170 – Engineering Quantum Mechanics
- ES 173 – Electronic and Photonic Devices
- ES 175 – Photovoltaic Devices
- 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
- ESE 131 – Introduction to Physical Oceanography 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 164 – Environmental Chemistry
- ESE 166 – State-of-the-art Instrumentation in Environmental Sciences
- ESE 168 – Human Environmental Data Science: Agriculture, Conflict and Health
- ESE 169 – Field and Lab-based Seminar on Local 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
- ES 192 – Material Selection and Design

General Engineering Electives

- ES 105hfr – Humanitarian Design Projects (4 credits)
- 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 124	Spring	*21b*		**A**	**CS 50 or equiv.**
BE 125	Spring		*LS1a, Chem 17*		
BE 128	Spring	**1b**		**B**	
BE 129	Spring	**1b**		**B**	*ES 50*
BE 130	Spring				
BE 131	Fall	**1b**	*LS1a/ES53*	**B**	*ES 50*
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 155	Fall	*21a, 21b*			
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)