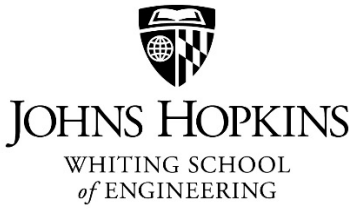

Undergraduate Advising Manual

Students Entering the Program Fall 2020

(Version: August 2020)

https://engineering.jhu.edu/chembe/

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I – INTRODUCTION

Welcome to the Department of Chemical and Biomolecular Engineering!

The ChemBE department offers courses and training culminating in a Bachelor of Science degree in Chemical and Biomolecular Engineering. Additionally, students may choose, if they wish, to pursue a Molecular and Cellular Bioengineering (MCB) Track or an Interfaces and Nanotechnology (IN) Track.

1. What is Chemical and Biomolecular Engineering?

Chemical and Biomolecular Engineering (ChemBE) is dedicated to the design and exploitation of chemical, biological, and physical processes and, to the study of phenomena for chemical and biological applications. As a result of the scope and breadth of this rigorous undergraduate program, our students commonly secure employment in industries such as Chemical and Pharmaceutical Production, Biomedicine, Biotechnology, Material Design, and Food Industry and Energy. Graduates may embark on a career to explore new products such as:

Novel polymers and materials	Biopharmaceuticals
Biofuels	Drugs and Vaccines
Gene Therapy Products	Drug Delivery Devices
Cells and Tissues	Semiconductors
Nanodevices	Food, Beverage, and Health Care Products

The demands on the modern engineer are high, and graduates must possess a wide range of skills in order to be competitive in a global market. The ChemBE program successfully satisfies these demands. Students take advanced courses in chemistry, physics, mathematics, and biology. Additionally, students are trained in transport, kinetics, separations and thermodynamics, which are essential to solving real-world engineering problems. Students also hone their professional and communication skills (report writing, oral presentations, and teamwork) in courses involving experimental projects, process design and product design.

Depending on their interests and future career goals, students can choose electives from exciting areas including green engineering, nanotechnology, and bioengineering. These courses, along with undergraduate research opportunities offered by our faculty, are designed to prepare graduates for careers in the chemical industry, biotechnology, pharmaceuticals or microelectronics. The curriculum also offers an outstanding foundation for advanced graduate studies in Chemical and Biomolecular Engineering, Biomedical Engineering, Materials Engineering, or for medical, law, or business school. Graduates receive a Bachelor of Science degree in Chemical and Biomolecular Engineering accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

2. Tracks

Students have the opportunity to develop more in-depth specialty in one or two areas within chemical and biomolecular engineering. Our two tracks are Interfaces and Nanotechnology (IN) and Molecular and Cellular Bioengineering (MCB). Students completing a track will have this fact designated on their final checklist audit form.

Interfaces and Nanotechnology (IN) Track

Interesting and new physics exist at nanometer length scales, as the surface area of an object begins to approach and exceed its volume. In this track, students are trained in the fundamental sciences used to solve problems in nanotechnology and interfacial science.

Molecular and Cellular Bioengineering (MCB) Track

Fields in Biotechnology and Biomedicine often involve processes at biological, cellular and molecular levels. Common areas utilizing skills in the MCB track include the genetic manipulation of cells for protein and vaccine production, and the study and treatment of diseases such as arteriosclerosis and cancer.

3. Graduate or Professional Schools

Graduate School

Half of our graduates pursue advanced degrees in Chemical Engineering, Environmental Engineering, Biomedical Engineering or Bioengineering. The ChemBE curriculum offers an excellent foundation for MS and PhD programs. Students can elect to take higher level electives in preparation for graduate school during their junior and senior years. The strength of JHU lies in its ability to offer numerous opportunities for undergraduate research throughout the university. Our students usually join research laboratories in the ChemBE department, in other engineering departments or in the medical school. More information on graduate school can be found on page 25.

Pre-Medical Option

The Chemical and Biomolecular Engineering degree provides excellent preparation for Medical School. Each medical school has its own admissions standards. These requirements include a few courses not required in the Chemical and Biomolecular Engineering program. As a result, students will want to take additional courses in order to fulfill requirements of a particular medical school. More information on pre-medical requirements can be found on page 26.

II – Program Mission and Objectives

Our mission is to define and educate a new archetype of innovative and fundamentally-grounded engineer at the undergraduate and graduate levels through the fusion of fundamental chemical engineering principles and emerging disciplines. We will nurture our passion for technological innovation, scientific discovery, and leadership in existing and newly created fields that cut across traditional boundaries. We will be known for developing leaders in our increasingly technological society who are unafraid to explore uncharted engineering, scientific, and medical frontiers that will benefit humanity.

The Department of Chemical and Biomolecular Engineering offers courses and training culminating in the Bachelor of Science degree in Chemical and Biomolecular Engineering. The undergraduate program emphasizes the molecular science aspects of chemical engineering and biology, in concert with engineering concepts essential to developing commercial products and processes. By selecting an appropriate track or by choice of free electives, students can prepare for a professional career path or for further study in chemical, biomolecular, or a related engineering field as well as medical, law, or business school. In the tradition of the Johns Hopkins University, many undergraduates are also involved in research, working closely with faculty and graduate students in research groups.

Program Objectives: Recent graduates of the ChemBE program will within a few years of graduation:

(1) succeed in careers in industrial, academic or government organizations in which they apply their chemical and biomolecular engineering skills to solve diverse long-standing or emerging problems

(2) excel in their graduate program, medical school or other professional education

(3) be recognized as future leaders in their chosen field

(4) perpetuate the JHU legacy of passion for learning, technical excellence, community service and research innovation to foster knowledge creation, lead discovery, and impact society.

Student Outcomes: Our students attain these objectives by following the curriculum presented in this Undergraduate Manual. At the completion of the program, our graduates demonstrate:

1. An ability to identify, formulate, and solve complex 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 judgments, 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 judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Annual Enrollment Data

Academic Year	Freshman Class	Sophomore Class	Junior Class	Senior Class	Graduates
2016-2017	89	102	82	78	76
2017-2018	85	80	88	82	82
2018-2019	107	70	71	92	87
2019-2020	90	91	71	73	71
2020-2021	98	82	81	70	

Where are our Chemical and Biomolecular Engineering graduates?

The Department of Chemical and Biomolecular Engineering graduates students who are prepared for a variety of professional career paths or for further education. Some of our recent graduates are now part of:

Accenture
PhD in Chemical Engineering at U of Pennsylvania
PhD in Chemical Eng or Biotechnology at MIT
PhD in Medical Eng & Medical Physics MIT/Harvard
Epic Systems
Genentech
Northwestern Feinberg School of Medicine
W.R. Grace
Deloitte
GlaxoSmithKline
Biogen Idec
PhD in Chem Eng at Georgia Institute of Technology
Medical School University of Pennsylvania
Capitol One
Koch-Glitsch
Sabic Innovative Plastics
Naval Surface Warfare Center
Pepsi
PhD in Chemical Engineering at U of Wisconsin
PhD Stanford University
McCormick & Co, Inc
Merck&Co
PhD in Chemical Engineering at Princeton University
GEA Systems (Columbia MD)
Johns Hopkins Medical Institutions
NIH
Apple
Procter and Gamble
Trane

Required Courses for the ChemBE Undergraduate Degree Fall 2020

Required Mathematics and Science Courses

020.305 Biochemistry (4)
030.205 Organic Chemistry I (4)

110.108 Calculus I (4)
110.109 Calculus II (4)
110.202 Calculus III (4)
110.302 Differential Equations with Applications (4)

173.111 General Physics Lab I (1)

Chemistry (8 credits)
Option 1: no AP credits, take ALL these courses:
030.101 Intro. Chemistry (3)
030.102 Intro. Chemistry II (3)
030.105 Intro. Chemistry Lab I (1)
030.106 Intro. Chemistry Lab II (1)
Option 2: 4 AP credits, take
030.103 Applied Chemical Equilibrium and Reactivity (4)
Option 3: 8 AP credits,
requirement is fulfilled (continue to Organic Chemistry)
or for those who want a refresher, take
030.103 Applied Chemical Equilibrium and Reactivity (4)

Physics (8 credits)
Option 1: no AP credits, take one of the following course series:
171.101 General Physics I (4)
171.102 General Physics II (4)
or
171.107 General Physics for Physical Science Majors I (4)
171.108 General Physics for Physical Science Majors II (4)
Option 2: 4 AP credits, take one of these courses
171.102 General Physics II (4)
or
171.108 General Physics for Physical Science Majors II (4)
Option 3: 8 AP credits,
requirement is fulfilled

Take one of the following courses (1 to 3 credits):
020.315 Biochemistry Project Laboratory (1)
030.225 Introduction to Organic Chemistry Laboratory (3)
030.305 Physical Chemistry Instrumentation Laboratory 1 (3)
250.253 Protein Engineering and Biochemistry Laboratory (3)

Required Core ChemBE Courses

500.113 Gateway Computing/Python (3)
540.101 Chemical Engineering Today (1)
540.202 Intro to Chemical and Biological Process Analysis (4)
540.203 Engineering Thermodynamics (3)
540.301 Kinetic Processes (4)
540.303 Transport Phenomena I (3)
540.304 Transport Phenomena II (4)
540.306 Chemical and Biological Separations (4)
540.315 Process Design with ASPEN (2)
540.409 Modeling Dynamics and Control for Chemical and Biological Systems (4)
540.490 Chemical and Biomolecular Lab Safety and Ethics (1)

Take one of the following courses for Senior Lab:
540.311 Projects in Chemical Engineering Unit Operations (4)
540.313 Projects in Chemical and Biomolecular Engineering Unit Operations (4)
Chemical Engineering Laboratory at DTU (Technical University of Denmark) (4)

Take one of the following course options for Product Design (3 to 6 credits)
Option 1: One-semester design (spring)
540.314 ChemBE Product Design (3)
Option 2: Two-semester design (two consecutive semesters)
540.309 Product Design Part 1 (3)
540.310 Product Design Part 2 (3)
Must take both courses to receive credit. 540.309 counts towards core credits; 540.310 counts toward engineering electives
Option 3: WSE one-semester design
500.308 Multidisciplinary Design (3)

Required HS Course

661.315 Culture of the Engineering Profession **(3)**

Take Electives to Meet Credit Requirements

128 credits total
48 credits of Engineering (E designation)
14 credits Advanced Chemistry and Biology
18 H/S credits
(must be six courses that are at least 3 credits each)

GPA Requirements

2.0 overall GPA
2.0 GPA in Engineering Core Courses ChemBE UG

IV - Departmental Advising Procedures

1. Faculty Advisors

Each student enrolled in Chemical and Biomolecular Engineering is assigned to a faculty member who will act as his or her advisor until graduation. Students plan their programs with their advisors to reflect individual interests as well as to fulfill program requirements. It is ultimately the responsibility of the student to complete all of the requirements. Students and advisors agree on courses for the semester, then both sign an updated degree planning checklist. Students return the checklist (signed and dated) to the mailbox of the Academic Coordinator in Maryland 224. Only then will the Coordinator lift the hold on SIS in order for the student to register on-line. During the semester, lifting the hold will only occur once the student has contacted the advisor and discussed the suggested changes to the course load. See the last page of this manual for faculty contact information.

Seniors MUST consult with their advisor before dropping any course at any time during their final year to avoid jeopardizing their chances of graduation. The advisor and the student will make sure that the change will not affect any key requirement in the curriculum nor postpone graduation date in any way.

2. Resources

Manuals and Guides

Students must consult the Johns Hopkins University Undergraduate and Graduate Programs Catalog (ASEN Catalog) for details regarding University requirements, grading options, independent study, etc (http://e-catalog.jhu.edu/). In addition, freshmen should refer to "Engineering 101, Program Planning Guide for First-Year Engineering Students" published by the Whiting School of Engineering (WSE). This guide contains additional information about academic policies, advanced placement credits, resources and opportunities for students, etc.

Forms

Students should regularly check the Degree Audit form available on SIS to ensure that the degree requirements are fulfilled. This document will serve as the official senior clearance for graduation.

In addition two forms are provided in this manual to aid in your course planning. The **example programs** (pages 8 to 11) show *suggested examples* of how the requirements can be fulfilled in four years of study. On this form the suggested elective sequence is arranged so that course loads are reasonably balanced, but note that they can be adjusted when appropriate. Students might find the **checklist form** (see pages 12 - 14) useful as well. It contains a simpler version of the information found in the Degree Audit. Every semester, students will fill out a checklist for their advising meetings with their advisor to monitor their progress towards graduation. This form is available as an Excel spreadsheet at: https://engineering.jhu.edu/chembe/undergraduate-studies/undergraduate-degree-program/. Students who transfer in from other programs or who enter with significant advanced credits should find this form especially useful.

Course Guides and Evaluations

The university manages an online guide in which student evaluations including numerical data and written comments are published for courses offered in the Schools of Engineering and Arts and Science (https://studentaffairs.jhu.edu/registrar/students/registration/), or Office of the Registrar>Looking for something in particular?>Undergraduate Students>Prior to Registration>Review Teacher Evaluations. Prior to selecting a course, be sure to review the past years' evaluations to see how students have rated the course and the instructor. Keep in mind that the instructor and course content can change from year to year.

V Example Programs and Degree Checklists

Examples of Programs: General Program, MCB Track, I/N Track, General with 12 AP credits

Example Program 1

Chemical and Biomolecular Engineering Degree - General Program

Students entering Fall 2020 with no Advanced Placement credits

Freshman Year / Fall

030.101	Intro to Chemistry I	3
030.105	Intro to Chemistry I Lab	1
110.108	Calculus I	4
171.101	General Physics I	4
173.111	General Physics Lab I	1
540.101	ChemBE Today	1
~~	H/S Elective	3
	Total	**17**

Freshman Year / Spring

030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Lab	1
110.109	Calculus II	4
171.102	General Physics II	4
~~	H/S Elective	3
	Total	**15**

Sophomore Year / Fall

540.202	Intro to Chemical & Biological Process Analysis	4
110.202	Calculus III	4
500.113	Gateway Computing	3
030.205	Organic Chemistry	4
	Total	**15**

Sophomore Year / Spring

540.203	Engineering Thermodynamics	3
540.303	Transport I	3
110.302	Differential Equations with Applications	4
~~	H/S Elective	3
	Undesignated Elective	3
	Total	**16**

* Students with no track can choose one of the four labs: 030.225 Introductory Organic Chemistry Lab, 030.305 Physical Chemistry Instrumentation Lab I, 020.315 Biochemistry Project Lab, or 250.253 Protein Engineering and Biochemistry Lab.

Junior Year / Fall

540.304	Transport II	4
~~	Engineering Elective	3
540.490	Introduction to Chemical Process Safety	1
	Biochem or Phys Chem or Orgo Laboratory *	1 or 3
020.305	Biochemistry	4
~~	Undesignated Elective	3
	Total	**16-18**

Junior Year / Spring

540.301	Kinetic Processes	4
540.306	Chemical and Biological Separations	4
661.315	Culture of the Engineering Profession	3
~~	Cell Biology (020.306) or Chem/Bio Elective or Cell Biology for Engineers (540.307)	4 *or* 3
~~	Undesignated Elective	3
	Total	**17-18**

Senior Year / Fall

540.311/313	Projects in ChemBE Unit Operations with Experiments	4
540.409	Dynamic Modeling and Control	4
~~	Engineering Elective	3
~~	H/S Elective	3
	Total	**14**

Senior Year / Spring

540.314	Chemical and Biomolecular Product Design **	3
540.315	ChemBE Process Design Using ASPEN	2
~~	Engineering Elective	3
~~	H/S Elective 300 level	3
~~	Undesignated Electives	5
	Total	**16**

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** Students may take the 3-credit Product Design course 540.314, the 3-credit Multidisciplinary Engineering Design 500.308 course, **or** they may take a 6-credit Product Design sequence of 540.309 and 540.310.

Example Program 2

Chemical and Biomolecular Engineering Degree - MCB Track

Students entering Fall 2020 with no Advanced Placement credits

Freshman Year / Fall

030.101	Intro to Chemistry I	3
030.105	Intro to Chemistry I Lab	1
110.108	Calculus I	4
171.101	General Physics I	4
173.111	General Physics Lab I	1
540.101	ChemBE Today	1
~~	H/S Elective	3
	Total	**17**

Freshman Year / Spring

030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Lab	1
110.109	Calculus II	4
171.102	General Physics II	4
~~	H/S Elective	3
	Total	**15**

Sophomore Year / Fall

540.202	Intro to Chemical & Biological Process Analysis	4
110.202	Calculus III	4
500.113	Gateway Computing	3
030.205	Organic Chemistry	4
	Total	**15**

Sophomore Year / Spring

540.203	Engineering Thermodynamics	3
540.303	Transport I	3
110.302	Differential Equations with Applications	4
~~	H/S Elective	3
	Undesignated Elective	3
	Total	**16**

Junior Year / Fall

540.304	Transport II	4
~~	Engineering Elective	3
540.490	Introduction to Chemical Process Safety	1
	Biochemistry Laboratory *	1 or 3
020.305	Biochemistry	4
~~	Undesignated Elective	3
	Total	**16-18**

Junior Year / Spring

540.301	Kinetic Processes	4
540.306	Chemical and Biological Separations	4
661.315	Culture of the Engineering Profession	3
020.306	Cell Biology or	4 *or*
540.307	Cell Biology for Engineers	3
~~	Undesignated Elective	3
	Total	**17-18**

Senior Year / Fall

540.313	Projects in ChemBE Unit Operations with Experiments	4
540.409	Dynamic Modeling and Control	4
~~	Bioengineering Elective	3
~~	H/S Elective	3
	Total	**14**

Senior Year / Spring

540.314	Chemical and Biomolecular Product Design **	3
540.315	ChemBE Process Design Using ASPEN	2
~~	Bioengineering Elective	3
~~	H/S Elective 300 level	3
~~	Undesignated Electives	5
	Total	**16**

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* Students with this track can choose one of the two labs: 020.315 Biochemistry Project Lab, or 250.253 Protein Engineering and Biochemistry Lab.

** Students may take the 3-credit Product Design course 540.314, the 3-credit Multidisciplinary Engineering Design 500.308 course, **or** they may take a 6-credit Product Design sequence of 540.309 and 540.310.

Example Program 3

Chemical and Biomolecular Engineering Degree - I/N Track

Students entering Fall 2020 with no Advanced Placement credits

Freshman Year / Fall

030.101	Intro to Chemistry I	3
030.105	Intro to Chemistry I Lab	1
110.108	Calculus I	4
171.101	General Physics I	4
173.111	General Physics Lab I	1
540.101	ChemBE Today	1
~~	H/S Elective	3
	Total	**17**

Freshman Year / Spring

030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Lab	1
110.109	Calculus II	4
171.102	General Physics II	4
~~	H/S Elective	3
	Total	**15**

Sophomore Year / Fall

540.202	Intro to Chemical & Biological Process Analysis	4
110.202	Calculus III	4
500.113	Gateway Computing	3
030.205	Organic Chemistry	4
	Total	**15**

Sophomore Year / Spring

540.203	Engineering Thermodynamics	3
540.303	Transport I	3
110.302	Differential Equations with Applications	4
~~	H/S Elective	3
	Undesignated Elective	3
	Total	**16**

Junior Year / Fall

540.304	Transport II	4
~~	Engineering Elective	3
540.490	Introduction to Chemical Process Safety	1
030.452	Materials and Surfaces	3
020.305	Biochemistry	4
~~	Undesignated Elective	3
	Total	**18**

Junior Year / Spring

540.301	Kinetic Processes	4
540.306	Chemical and Biological Separations	4
661.315	Culture of the Engineering Profession	3
030.305	Physical Chem Instrumentation Lab 1*	3
~~	Undesignated Elective	3
	Total	**17**

Senior Year / Fall

540.311/313	Projects in ChemBE Unit Operations with Experiments	4
540.409	Dynamic Modeling and Control	4
~~	I/N Engineering Elective	3
~~	H/S Elective	3
	Total	**14**

Senior Year / Spring

540.314	Chemical and Biomolecular Product Design **	3
540.315	ChemBE Process Design Using ASPEN	2
~~	I/N Engineering Elective	3
~~	H/S Elective 300 level	3
~~	Undesignated Electives	5
	Total	**16**

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* Students with this track must take: 030.305 Physical Chemistry Instrumentation Lab I

** Students may take the 3-credit Product Design course 540.314, the 3-credit Multidisciplinary Engineering Design 500.308 course, **or** they may take a 6-credit Product Design sequence of 540.309 and 540.310.

Example Program 4

Chemical and Biomolecular Engineering Degree - General Program

Students entering Fall 2020 or Later with Advanced Placement credits in Chemistry and Math

Freshman Year / Fall

030.103	Applied Chemical Equilibrium and Reactivity	4
110.202	Calculus III	4
171.101	General Physics I	4
173.111	General Physics Lab I	1
540.101	ChemBE Today	1
~~	H/S Elective	3
	Total	**17**

Freshman Year / Spring

540.202	Intro to Chemical & Biological Process Analysis	4
110.302	Differential Equations with Applications	4
171.102	General Physics II	4
~~	H/S Elective	3
	Total	**15**

Sophomore Year / Fall

540.203	Engineering Thermodynamics	3
500.113	Gateway Computing	3
030.205	Organic Chemistry	4
~~	H/S Elective	3
~~	Undesignated Elective	3
	Total	**16**

Sophomore Year / Spring

540.303	Transport I	3
020.305	Biochemistry	4
~~	H/S Elective	3
~~	Undesignated Elective	3
	Total	**13**

Junior Year / Fall

540.304	Transport II	4
~~	Engineering Elective	3
540.490	Introduction to Chemical Process Safety	1
	Biochem or Phys Chem or Orgo Laboratory *	1 or 3
~~	Undesignated Electives	3
	Total	**12-14**

Junior Year / Spring

540.301	Kinetic Processes	4
540.306	Chemical and Biological Separations	4
661.315	Culture of the Engineering Profession	3
~~	Cell Biology (020.306) or Chem/Bio Elective or Cell Biology for Engineers (540.307)	3 or 4
	Total	**14-15**

Senior Year / Fall

540.311/313	Projects in ChemBE Unit Operations with Experiments	4
540.409	Dynamic Modeling and Control	4
~~	Engineering Elective	3
~~	H/S Elective 300 level	3
	Total	**14**

Senior Year / Spring

540.314	Chemical and Biomolecular Product Design **	3
540.315	ChemBE Process Design Using ASPEN	2
~~	Engineering Elective	3
~~	Undesignated Electives	5
	Total	**13**
		116

AP credits

Chemistry	4
Math BC	8

* Students with no track can choose one of the four labs: 030.225 Introductory Organic Chemistry Lab, 030.305 Physical Chemistry Instrumentation Lab I, 020.315 Biochemistry Project Lab, or 250.253 Protein Engineering and Biochemistry Lab.

** Students may take the 3-credit Product Design course 540.314, the 3-credit Multidisciplinary Engineering Design 500.308 course, **or** they may take a 6-credit Product Design sequence of 540.309 and 540.310.

General Checklist

Requirements Sign-Off Sheet for B.S. in Chemical and Biomolecular Engineering
Students Entering Program Fall 2020, General Checklist (no track) **Overall GPA:** _____

Basic Science

Course		Crs	Sem
030.101	Intro Chem I (3)		
030.102	Intro Chem II (3)		
030.105	Intro Chem Lab I (1)		
030.106	Intro Chem Lab II (1)		
171.101	General Physics I (4)		
171.102	General Physics II (4)		
173.111	General Physics Lab I (1)		
	Total	*0*	*/17*

Mathematics

Course		Crs	Sem	Grade	
110.108	Calculus I (4)				>C-?
110.109	Calculus II (4)				>C-?
110.202	Calculus III (4)				
110.302	Diff Eqs With Applic. (4)				
	Total	*0*	*/16*	(min)	

Advanced Chemistry/Biology

Course		Crs	Sem
030.205	Organic Chem I (4)		
020.305	Biochemistry (4)		
020.306	[1]Cell Biology (4)		
540.307	[1]Cell Biology for Engineers (3)		
	[1]Adv. Chem Bio Elective (3)		
030.225	[2]Intro Organic Chem Lab (3)		
030.305	[2]Phys Chem Instrum Lab I (3)		
020.315	[2]Biochemistry Project Lab (1)		
250.253	[2] Protein Eng Biochem Lab (3)		
	Total	*0*	*/14* (min)

Humanities and Social Sciences (6 3-cr courses minimum)

Course		Crs	Sem	Designator (H,S,etc.)
661.315	Culture of Eng. Profession (3)			SW
	Total	*0*	*/18*	(min)

Chemical Engineering Core

Course		Crs	Sem	Grade	GPA calc
540.101	Chemical Engineering Today (1)				
500.113	Gateway Computing Python (3)				#N/A
540.202	Chem & Biol Process Anal. (4)				#N/A
540.203	Engineering Thermo (3)				#N/A
540.301	Kinetic Processes (4)				#N/A
540.303	Transport I (3)				#N/A
540.304	Transport II (4)				#N/A
540.306	Mass Transfer/Separations (4)				#N/A
540.309	[4]ChemBE Product Design Part 1 (3)				#N/A
540.311	[3]Projects in Chem Eng Unit Ops (4)				#N/A
540.313	[3]Projects in ChemBE Unit Ops (4)				#N/A
540.314	[4]ChemBE Product Design (3)				#N/A
500.308	[4]Multidisciplinary Engineering Design (3)				#N/A
540.315	Process Design with Aspen (2)				#N/A
540.409	Modeling, Dynamics & Control (4)				#N/A
540.490	Intro to Chemical Process Safety (1)				#N/A
	Total	*0*	*/ 40*		
	ChemBE core course GPA				#N/A

Engineering Elective Courses

Course		Crs	Sem	
540.310	[4]ChemBE Product Design Part 2 (3)			
				Elective 1
				Elective 2
				Elective 3
	Total	*0*	*/8*	
	Total Engineering Credits =	***0***	***/48 (min)***	

Undesignated Electives

Course		Crs	Sem	
	Total	*0*	*/15*	(can be <15)
	Total Credits	***0***	***/128***	(min)

Advanced H/S Course: _____

Writing Intensive Course: _____

Date: _____ **Student Signature**: _____

Student's Name (printed): _____

Date: _____ **Advisor Signature**: _____

Advisor's Name (printed): _____

At the conclusion of every advising meeting, return the form (signed and dated) to the mailbox of the UG Academic Coordinator in Maryland 224A.

Notes:

1. Students must complete at least one of those courses
2. Students must complete at least one of those courses
3. Students must complete only one of these courses
4. Students must complete either the a one-semester course (540.314 or 500.309) or the yearlong option (540.309-310)

Molecular & Cell Biology Track Checklist

Requirements Sign-Off Sheet for B.S. in Chemical and Biomolecular Engineering
Students Entering Program Fall 2020, Molecular and Cellular Bioengineering Track Checklist **Overall GPA:** _____

Basic Science

Course		Crs	Sem
030.101	Intro Chem I (3)		
030.102	Intro Chem II (3)		
030.105	Intro Chem Lab I (1)		
030.106	Intro Chem Lab II (1)		
171.101	General Physics I (4)		
171.102	General Physics II (4)		
173.111	General Physics Lab I (1)		
	Total	*0*	*/17*

Mathematics

Course		Crs	Sem	Grade	
110.108	Calculus I (4)				>C-?
110.109	Calculus II (4)				>C-?
110.202	Calculus III (4)				
110.302	Diff Eqs With Applic. (4)				
	Total	*0*	*/16*	(min)	

Chemical Engineering Core

Course		Crs	Sem	Grade	GPA calc
540.101	Chemical Engineering Today (1)				
500.113	Gateway Computing Python (3)				#N/A
540.202	Chem & Biol Process Anal. (4)				#N/A
540.203	Engineering Thermo (3)				#N/A
540.301	Kinetic Processes (4)				#N/A
540.303	Transport I (3)				#N/A
540.304	Transport II (4)				#N/A
540.306	Mass Transfer/Separations (4)				#N/A
540.309	[4]ChemBE Product Design Part 1 (3)				#N/A
540.313	[3]Projects in ChemBE Unit Ops (4)				#N/A
540.314	[4]ChemBE Product Design (3)				#N/A
500.308	[4]Multidisciplinary Engineering Design (3)				#N/A
540.315	Process Design with Aspen (2)				#N/A
540.409	Modeling, Dynamics & Control (4)				#N/A
540.490	Intro to Chemical Process Safety (1)				#N/A
	Total	*0*	*/ 40*		
	ChemBE core course GPA				#N/A

Advanced Chemistry/Biology

Course		Crs	Sem	
030.205	Organic Chem I (4)			
020.305	Biochemistry (4)			
020.306	[1]Cell Biology (4)			
540.307	[1]Cell Biology for Engineers (3)			
020.315	[2]Biochemistry Project Lab (1)			
250.253	[2] Protein Eng Biochem Lab (3)			
	Total	*0*	*/14*	(min)

Engineering Elective Courses

Course		Crs	Sem	
540.310	[4]ChemBE Product Design Part 2 (3)			
				Bioeng Elective 1
				Bioeng Elective 2
				Elective 3
	Total	*0*	*/8*	
	Total Engineering Credits =	***0***	***/48 (min)***	

Humanities and Social Sciences (6 3-cr courses minimum)

Course		Crs	Sem	Designator (H,S,etc.)
661.315	Culture of Eng. Profession (3)			SW
	Total	*0*	*/18*	(min)

Undesignated Electives

Course		Crs	Sem	
	Total	*0*	*/15*	(can be <15)
	Total Credits	***0***	***/128***	(min)

Advanced H/S Course: _____

Writing Intensive Course: _____

Date: _____ **Student Signature**: _____

Student's Name (printed): _____

Date: _____ **Advisor Signature**: _____

Advisor's Name (printed): _____

At the conclusion of every advising meeting, return the form (signed and dated) to the mailbox of the UG Academic Coordinator in Maryland

Notes:

1. Students must complete at least one of those courses
2. Students must complete at least one of those courses
3. Students must complete 540.313
4. Students must complete either the a one-semester course (540.314 or 500.309) or the yearlong option (540.309-310)

Interfaces & Nanotechnology Track Checklist

Requirements Sign-Off Sheet for B.S. in Chemical and Biomolecular Engineering
Students Entering Program Fall 2020 or later, Interfacial and Nanotechnology Track Checklist **Overall GPA:** _____

Basic Science

Course		Crs	Sem
030.101	Intro Chem I (3)		
030.102	Intro Chem II (3)		
030.105	Intro Chem Lab I (1)		
030.106	Intro Chem Lab II (1)		
171.101	General Physics I (4)		
171.102	General Physics II (4)		
173.111	General Physics Lab I (1)		
	Total	*0*	*/17*

Mathematics

Course		Crs	Sem	Grade	
110.108	Calculus I (4)				>C-?
110.109	Calculus II (4)				>C-?
110.202	Calculus III (4)				
110.302	Diff Eqs With Applic. (4)				
	Total	*0*	*/16* (min)		

Chemical Engineering Core

Course		Crs	Sem	Grade	GPA calc
540.101	Chemical Engineering Today (1)				
500.113	Gateway Computing Python (3)				#N/A
540.202	Chem & Biol Process Anal. (4)				#N/A
540.203	Engineering Thermo (3)				#N/A
540.301	Kinetic Processes (4)				#N/A
540.303	Transport I (3)				#N/A
540.304	Transport II (4)				#N/A
540.306	Mass Transfer/Separations (4)				#N/A
540.309	[4]ChemBE Product Design Part 1 (3)				#N/A
540.311	[3]Projects in Chem Eng Unit Ops (4)				#N/A
540.313	[3]Projects in ChemBE Unit Ops (4)				#N/A
540.314	[4]ChemBE Product Design (3)				#N/A
500.308	[4]Multidisciplinary Engineering Design (3)				#N/A
540.315	Process Design with Aspen (2)				#N/A
540.409	Modeling, Dynamics & Control (4)				#N/A
540.490	Intro to Chemical Process Safety (1)				#N/A
	Total	*0*	*/40*		
	ChemBE core course GPA				#N/A

Advanced Chemistry/Biology

Course		Crs	Sem
030.205	Organic Chem I (4)		
020.305	Biochemistry (4)		
030.305	Phys Chem Instrum Lab I (3)		
030.452	Materials and Surface (3)		
	Total	*0*	*/14* (min)

Engineering Elective Courses

Course		Crs	Sem	
540.310	[4]ChemBE Product Design Part 2 (3)			
				I/N Elective 1
				I/N Elective 2
				Elective 3
	Total	*0*	*/8*	
	Total Engineering Credits =	***0***	***/48 (min)***	

Humanities and Social Sciences (6 3-cr courses minimum)

Course		Crs	Sem	Designator (H,S,etc.)
661.315	Culture of Eng. Profession (3)			SW
	Total	*0*	*/18* (min)	

Undesignated Electives

Course		Crs	Sem
	Total	*0*	*/15* (can be <15)
	Total Credits	***0***	***/128*** (min)

Advanced H/S Course: _____

Writing Intensive Course: _____

Date: _____ **Student Signature**: _____

Student's Name (printed): _____

Date: _____ **Advisor Signature**: _____

Advisor's Name (printed): _____

At the conclusion of every advising meeting, return the form (signed and dated) to the mailbox of the UG Academic Coordinator in Maryland 224A.

Notes:

1. Students must complete at least one of those courses
2. Students must complete at least one of those courses
3. Students must complete only one of these courses
4. Students must complete either the a one-semester course (540.314 or 500.309) or the yearlong option (540.309-310)

VI – DESCRIPTION OF CURRICULUM

1. Curriculum

Chemical and Biomolecular Engineering Core Courses

The following ChemBE and General Engineering courses are required 540.101, 500.113, 540.202, 540.203, 540.301, 540.303, 540.304, 540.306, 540.311 (or 540.313), 540.314 (or 540.309/310 or 500.308), 540.315, 540.409, and 540.490 (see page 6 and page 18 for a lists of course names, numbers and pre-requisites). The total credits of core engineering courses should add up to 40. Students that switch majors into ChemBE too late to take 540.101 in their freshman year may have the requirement for 540.101 waived with permission of the student's advisor. However, since the total number of engineering credits ("Chemical Engineering Core Courses" plus "Other Engineering Courses") must be at least 48 credits, the credit requirements for Other Engineering Courses will be raised by one credit.

All students must take the capstone design courses. Process Design with Aspen, 540.315 is required for everyone. However, students interested in a more thorough design experience can substitute 540.314 or 500.308 with the yearlong 6-credit Product Design series (3 credits in 540.309 and 3 credits in 540.310). Then the first half of the course, 540.309, will count as part of the core requirements and its grade will contribute to the engineering GPA. The 3 credits from 540.310 will count as engineering electives (see below). Note that students will receive credits for 540.309 only once they have finished 540.310.

Online Safety Course.

See also information on page 25.
This course is required and is a prerequisite for EN.540.490 Introduction to Chemical Process Safety. It is required for any research course.

- Go to JHU myLearning page. Search for "Laboratory Safety Introduction Course"
- Online modules to complete, takes several hours

Other Engineering Courses

A minimum of 48 engineering credits are required for the degree; therefore, students need to take at least 8 engineering elective credits (usually equivalent to three engineering elective courses). Students that have had 540.101 waived as a requirement will have one additional "other engineering" credit requirement as discussed above.

A list of approved engineering electives is found on page 20. Most other engineering courses not on the approved list (courses with an E designation in the Whiting School of Engineering) may also be acceptable as engineering elective courses but must be approved by the advisor and the director of undergraduate studies. Courses with an E designation in the Arts and Sciences school do not count as engineering electives.

Specific rules apply to the following courses:

- Students who take the yearlong design courses will receive three credits of engineering electives from the second part of the course, 540.310.
- For students who join research groups in the ChemBE department, a three-credit course of the category titled "Current Topics" will automatically count as an engineering elective; however, only one of these courses can serve as an engineering elective.
- No more than four credits earned in Current Topics, Undergraduate Research, or Independent Study courses can be used to fulfill the engineering electives requirements. Any additional research credits will serve as undesignated credits (i.e. count towards the total 128-credit minimum). Students may take as many credits of ChemE Car competition (540.418 and 540.419) as they wish but at most 4 credits from ChemE car will count towards engineering electives. Any additional ChemE Car credits will serve as undesignated credits (i.e. count towards the total 128-credit minimum).
- Probability and Statistics courses do not count: courses on Statistics (for example 553.111), Probability and Statistics (for example 553.310) or Linear Algebra (for example 553.291) from the

Applied Mathematics and Statistics Departments will not count as engineering electives despite the fact that they carry an E designation.

Physics Courses and Laboratories

The following physics courses are required:

171.101 *and* 171.102 OR 171.07 *and* 171.108 AND 173.111

Basic Chemistry Courses and Laboratories

The following chemistry courses are required: 030.101, 030.102, 030.105, and 030.106. Students with a score of 4 on their AP credits in chemistry must sign up for 030.103 Applied Chemical Equilibrium and Reactivity with Lab (4 credits). Students with a score of 5 who wish to take one 100-level course in chemistry can take 030.103, otherwise they can skip to Organic Chemistry (see next Section). Make sure you consult the *First Year Academic Guide* and *Engineering 101* of the WSE office for more information on credit counts (https://engineering.jhu.edu/advising/new-students/first-year/).

Advanced Chemistry and Biology Courses

Students are required to take 14 credits of Advanced Chemistry and Biology courses. The following three courses (9 to 11 credits) are required, two lectures, Biochemistry 020.305 and Organic Chemistry I 030.205, and one laboratory course (030.305, 030.225, 250.253 or 020.315). The required lab course must be either Physical Chemistry Instrumentation Laboratory I, 030.305 (3 credits), Introduction to Organic Chemistry Laboratory, 030.225 (3 credits), Protein Engineering and Biochemistry Lab, 250.253 (3 credits) or Biochemistry Project Laboratory, 020.315 (1 credit). *Students following the Molecular and Cellular Bioengineering track must take one of the biochemistry labs, 020.315 or 250.253, and those following the Interfaces and Nanotechnology track must take Physical Chemistry Instrumentation Laboratory I, 030.305.*

Finally, students need to take 3 or 5 additional credits beyond these required courses to meet the 14 credits requirement. Students should discuss with their advisor which elective courses are most appropriate for their educational objectives. These courses must be chosen from the 030 or 020 codes and should be at the 200 level minimum. Some courses from the 250 code (Biophysics) may be acceptable as well. A list of approved advanced chemistry and biology electives is found on page 19. Other courses not on the approved list may also be acceptable as advanced chemistry and biology elective courses but must be approved by the advisor and the director of undergraduate studies. *Students following the Molecular and Cellular Bioengineering track must take Cell Biology for Engineers 540.307 or Cell Biology 020.306, and those following the Interfaces and Nanotechnology track must take Materials and Surfaces 030.452.*

The following course is not acceptable as Advanced Chem/Bio Electives for classes entering on or after fall 2013:
030.312 Introduction to the Human Brain

Mathematics Requirement

The following mathematics courses are required: Calculus I, II and III (110.108, 110.109 and 110.202) and Differential Equations with Applications (110.302).

Calculus is so essential to Chemical Engineering that a grade of C- or better in both Calculus I and Calculus II is required. In addition to knowledge of the material covered in Calculus I, II and III, Chemical Engineers need to be able to solve linear differential equations, some simple partial differential equations and systems of differential equations often by numerical methods. Differential Equations with Applications (110.302) provides this additional mathematical background.

Sixteen credits of math are required. Successful completion of the Advanced Placement examinations will count toward these credits (see the *First-Year Academic Guide* of the WSE office for more information). Students who do not receive advance placement credits and place out of Calculus I by their score on the math department placement exam must take an additional course in mathematics since they do not receive *credits* for Calculus I. We suggest they take a course in Linear Algebra or in Probability and Statistics to complete the required 16 credits in mathematics.

Writing Skills

The university requires that two courses designated as a W be taken to graduate and that these two courses be completed with a grade of C or better.

One of the two W courses may be any course with a W designation except for 540.311 and 540.313. The second W course must be The Culture of the Engineering Profession (661.315), a requirement for the laboratory and design courses of senior year.

Humanities and Social Sciences Courses

Students need 6 courses coded as humanities (H) or social science (S), at least 3 credits each for a minimum of 18 credits (see ASEN catalog, (http://e-catalog.jhu.edu/). One exception to this rule allows students to replace one 3-credit course with a set of courses offered in a 2-credit + 1-credit format (this exception applies to two specific sets of courses, EN.660.400 and 406, or EN.660.400 and 520.404).

ChemBE students take 5 H/S courses plus 661.315 Culture of the Engineering Profession. To encourage *breadth* and *depth* in the humanities and social sciences, at least one of the H/S courses must be an advanced level course at the 300-level or higher (in addition to EN.661.315 Culture of the Engineering Profession).

Note that most H or S courses taught during the intersession are less than 3 credits and graded pass/fail, they do not count towards the H/S requirement, they contribute to the undesignated electives.

Acceptable H/S subjects include, but are not limited to: Anthropology, Archaeology, Arts (Visual or Performing), Classics, Communications, Economics, Ethics, Geography, History, Film, Foreign Languages and Cultures, Jurisprudence (Law), Linguistics, Literature, Philosophy, Political Science, Psychology, Religion, and Sociology. Note that many Music courses are not coded as H/S, only Music courses with an H/S designation can contribute to the 6 H/S courses.

Foreign language instruction and literature courses are acceptable as Humanities credits. Note that beginning language courses often do not have an H designation because they are not allowed as an H course for Arts & Science majors. However, University rules state that beginning language courses do have an H designation for engineering students. Thus, beginning language courses count towards fulfilling the 18 credits of H/S electives even if they lack an H designator. Be aware that some language departments require that students take the entire year of an introductory language course in order to receive any credit.

Undesignated Electives

A minimum of 128 credits is required for the degree. Therefore, in addition to all the credits taken to fulfill the requirements mentioned in the various sections above (e.g. chemical engineering core courses, engineering electives, science courses, advanced chemistry/biology electives, mathematics requirement, and H & S courses) up to 15 additional credits (called undesignated credits) are required. There are no restrictions on the courses that count as undesignated electives.

2. Pre-requisites

The ChemBE curriculum allows students to learn material in a logical order, starting with fundamental concepts and culminating in the project courses of senior year. The prerequisites for the courses guide the progress of the students through the 4 years of education. The instructors will enforce the prerequisites to preserve the quality of the program and the educational experience of the students.

Prerequisites of ChemBE Core Courses

August 2020

Course	Credits	Semester	Prerequisites
540.101 Chemical Engineering Today	1	Fall	Freshmen only
540.202 Introduction to Chemical & Biological Process Analysis	4	Fall/Spring	AS.030.101 Intro Chem I
			AS.171.101 or 107 General Physics I
			and ONE of the following courses:
			AS.030.102 Intro Chem II
			AS.030.103 Applied Chemical Equilibrium and Reactivity w/ Lab
			AS.110.109 Calculus II
			AS.171.102 General Physics II
540.203 Engineering Thermodynamics	3	Fall/Spring	EN 540.202 Process Analysis
			AS.110.202 Calculus III (allowed concurrent)
540.303 Transport Phenomena 1	3	Fall/Spring	AS.110.302 Differential Equations (allowed concurrent)
540.304 Transport Phenomena 2	4	Fall	EN.540.303 Transport Phenomena 1
			EN.500 113 Gateway to Computing - Python
540.301 Kinetic Processes	4	Spring	EN.540.203 Engineering Thermodynamics
			EN.540.303 Transport Phenomena 1
540.306 Separations	4	Spring	EN.540.203 Engineering Thermodynamics
			EN.540.303 Transport Phenomena 1
540.307 Cell Biology for Engineers	3	Spring	AS.020.305 Biochemistry
540.309 Product Design Part 1	3	Fall/Spring	EN.540.301 Kinetic Processes
			EN.540.303 Transport Phenomena 1
			EN.540.306 Separations
			EN.540.490 Process Safety
540.310 Product Design Part 2	3	Fall/Spring	EN540.309 Product Design Part 1
540.311 Projects in Chemical Engineering Unit Operations with Experiments	4	Fall	EN.540.301 Kinetic Processes
			EN.540.304 Transport Phenomena 2
			EN.540.306 Separations
			EN.540.490 Process Safety
			EN.661.315 Culture of the Engineering Profession
540.313 Projects in ChemBE Unit Operations with Experiments	4	Fall	EN.540.301 Kinetic Processes
			EN.540.304 Transport Phenomena 2
			EN.540.306 Separations
			EN.540.490 Process Safety
			EN.661.315 Culture of the Engineering Profession
540.314 Product Design	3	Spring	EN.540.301 Kinetic Processes
			EN.540.303 Transport Phenomena 1
			EN.540.306 Separations
540.315 Process Design with Aspen	2		EN.540.301 Kinetic Processes
			EN.540.303 Transport Phenomena 1
			EN.540.306 Separations
			EN.540.490 Process Safety
540.409 Dynamic Modeling/Control	4	Fall	EN.540.301 Kinetic Processes
			EN.540.306 Separations
540.490 Introduction to Process Safety	1	Fall	EN.540.203 Engineering Thermodynamics
			EN.540.303 Transport Phenomena 1
			On line Lab Safety

3. Tracks

Students pursuing a degree in Chemical and Biomolecular Engineering have the option of following tracks specialized in two fields, Interfaces and Nanotechnology or Molecular and Cellular Bioengineering. Students completing a track will have this fact designated on their final checklist audit form. These tracks have additional and/or alternate requirements, as described below.

Interfaces and Nanotechnology (IN) Track

Students must fulfill the following requirements:

- The Advanced Chemistry and Biology laboratory requirement is fulfilled with AS.030.305 (Physical Chemistry Instrumentation Lab I).
- Students take Materials and Surface (AS.030.452)
- Both courses above provide six credits for the advanced chemistry electives.
- Six credits of interfaces and nanotechnology engineering electives are required. One of these courses can be research in the interfacial/nano area. See page 22 for a list of approved electives.

Molecular and Cellular Bioengineering (MCB) Track

Students must fulfill the following requirements:

- Students must take Cell Biology for Engineers EN.540.307 or Cell Biology AS.020.306.
- The Advanced Chemistry and Biology laboratory requirement is fulfilled with AS.020.315 (Biochemistry Lab) or AS.250.253 (Protein Engineering and Biochemistry Lab).
- Six credits of bioengineering electives are required. One of these courses can be research in the bio area. See page 21 for a list of approved courses.
- Students must take EN.540.313 Chemical and Biomolecular Engineering Lab instead of EN.540.311 Chemical Engineering Lab.

4. Electives

Students should be aware that some elective courses are not offered every year or may not be offered for several years.

Approved Advanced Chemistry and Biology Electives

020.304	Molecular Bioloy
020.315	Biochemistry Project Lab
020.316	Cell Biology Lab
020.330	Genetics
020.332	Photosynthesis by Land and Aquatic Organisms
020.337	Stem Cells and the Biology of Aging and Disease
020.340	Developmental Genetics Lab
020.374	Comparative Animal Physiology
030.115	Introduction to Forensic Chemistry
030.204	Chemical Structure and Bonding with Lab
030.206	Organic Chemistry II
030.225	Intro. Organic Chem Lab
030.227	Chemical Chirality
030.228	Intermediate Organic Lab
030.302	Physical Chemistry II
030.305	Physical Chemistry Instrumentation Laboratory 1
030.356	Advanced Inorganic Lab
030.371	Chemistry for Connoisseurs

030.425	Advanced Mechanistic Organic Chemistry I
030.449	Chemistry of Inorganic Compounds
030.451	Spectroscopy
030.452	Materials and Surface
171.310	Biological Physics
250.253	Protein Engineering and Biochemistry Lab
250.301	Laboratory in Molecular Evolution
250.302	Modeling the Living Cell
250.353	Molecular Biophysics Laboratory
250.351	Reproductive Physiology
360.339	Planets, Life and Universe
510.403	Materials Characterization

Other courses with significant advanced chemistry content may also be acceptable, but must be approved by your advisor and the director of undergraduate studies. Note that courses in which there is significant overlap of content with required courses are not acceptable advanced chemistry or chemistry-related electives.

The following course is not acceptable:
030.312 Introduction to the Human Brain

Approved Engineering Electives

Approved engineering electives include the courses listed directly below as well as those approved as Bioengineering or Interfaces and Nanotechnology electives that are listed further below.

Other courses with significant engineering content may also be acceptable, but must be approved by your advisor and the director of undergraduate studies. Note that courses in which there is significant overlap of content with required courses are not acceptable engineering electives.

Students should be aware that some elective courses are not offered every year or may not be offered for several years.

500.1	Bootcamp
510.107	Modern Alchemy
510.313	Mechanical Properties of Materials
510.314	Electronic Properties of Materials
510.401	Materials in Service
510.402	Soft Materials
520.142	Digital System Fundamentals
520.219-220	Fields, Matter, and Waves
530.352	Materials Selection
530.405	Mechanics of Solids and Structures
540.290/291	Chemical Engineering Modeling and Design for Sophomores
540.390/391	Chemical Engineering Modeling and Design for Juniors
540.418/419	Project in the Design of a Chemical Car
540.401	Projects in Design: Alternative Energy
540.405	Modern Data Analysis and Machine Learning for ChemBEs

540.407	Renewable Energy technologies
540.422	Intro to Polymeric Materials
540.460	Polymer Physics
540.468	Introduction to Nonlinear Dynamics and Chaos
540.601	Chemical Engineering Seminar
560.206	Solid Mechanics and Theory of Structures
570.239	Current and Emerging Environmental Issues
570.301	Environmental Engineering I: Fundamentals
570.302	Water and Wastewater Treatment
570.304	Environmental Engineering and Science
570.305	Environmental Engineering Systems Design
570.443	Aquatic Chemistry
570.491	Hazardous Waste Management

With instructor's permission, students with a good academic record can take the following courses as engineering electives:

540.630	Thermodynamics Statistical Mechanics and Kinetics
540.652	Advanced Transport Phenomena

One course is <u>not</u> acceptable:

570.334	Engineering Microeconomics (no E designation)

<u>Approved Bioengineering Electives</u>

Students should be aware that some bioengineering elective courses are not offered every year or may not be offered for several years.

Other courses with significant bioengineering content may also be acceptable, but must be approved by your advisor and the director of undergraduate studies. Note that courses in which there is significant overlap of content with required courses are not acceptable as bioengineering electives.

510.316	Biomaterials I
510.407	Biomaterials II
510.430	Biomaterials Lab
510.431	Biocompatibility of Materials
520.315	Intro. to Information Processing of Sensory Signals
530.410	Biomechanics of the Cell and Organisms
530.440	Computational Mechanics of Biological Macromolecules
530.445	Introductory Biomechanics
530.446	Experimental Biomechanics
540.400	Projects in Design: Pharmacokinetics
540.402	Metabolic Systems Biotechnology
540.414	Computational Protein Structure
540.421	Projects in Design: Pharmacodynamics
540.428	Supramolecular Materials and Nanomedicine
540.437	Application of Molecular Evolution to Biotechnology
540.462	Polymer Design and Bioconjugation
540.465	Engineering Principles of Drug Delivery

570.411	Environmental Microbiology
570.446	Biological Processes for Water and Wastewater Treatment
580.311/312	Design Team – Junior
580.411/412	Design Team – Senior
580.440	Surgery for Engineers
580.441	Cellular Engineering
580.442	Tissue Engineering
540.452	Cell and Tissue Engineering Lab

Approved Interfaces and Nanotechnology Electives

Students should be aware that some interfaces and nanotechnology elective courses are not offered every year or may not be offered for several years.

Other courses with significant content related to interfaces and nanotechnology may also be acceptable, but must be approved by your advisor and the director of undergraduate studies. Note that courses in which there is significant overlap of content with required courses are not acceptable as interfaces and nanotechnology electives.

510.311	Structures of Materials
510.422	Micro/nano Structured Materials and Devices
530.495	Microfabrication Laboratory
540.403	Colloids and Nanoparticles
540.415	Interfacial Science with Applications to Nanoscale Systems
540.428	Supramolecular Materials and Nanomedicine
540.440	Micro - Nanotechnology

5. Rules and Limitations

Grade Requirements and Department Honors

Students must have a grade point average of at least 2.00 in the Chemical and Biomolecular Engineering Core courses to graduate. These core courses are: 500.113, 540.202, 540.203, 540.301, 540.303, 540.304, 540.306, 540.311 (or 540.313), 540.314, 540.315, 540.409 and 540.490. Students with a ChemBE GPA of 3.6 will automatically receive Department Honors on their Official Transcript at graduation (no application required).

Repetition of Course Content

Courses taken to fulfill any requirement, including the requirement of 128 total credits, must not overlap in content to a substantial extent. For example, other Thermodynamics courses (for example 510.312) cannot be counted for this reason. You should discuss carefully the content of all elective courses with your advisor. His/her approval, and in questionable cases, that of the Director of Undergraduate Studies, is required to avoid problems in fulfilling course requirements.

Undergraduate Research and/or Independent Study to Fulfill "Other Engineering" Requirement

No more than four credits earned in Undergraduate Research and/or Independent Study courses can be used to fulfill the engineering electives requirements. Any additional credits in these courses will serve as undesignated credits (i.e. count towards the total 128 credit minimum).

Current Topics courses are included in research credits thus students can automatically count one Current Topics course as an engineering elective. Current Topics Courses from the bio labs count automatically towards the MCB track and those from the I/N labs towards the I/N track. Then only one or two more credits from

Undergraduate Research can count towards the engineering electives. Other research credits or credits from a second Current Topics course will count as undesignated electives.

Students who do not receive any Current Topics credits can use 4 Undergraduate Research credits to fulfill their engineering electives or track electives. If students belong to a research group in ChemBE, they sign up for 540.511 or 540.513 then their research credits will automatically count towards engineering electives and track electives. Students doing research somewhere else must complete the Research Credit Elective Request form on the ChemBE undergraduate website and submit it to the Academic Program Coordinator https://engineering.jhu.edu/chembe/wp-content/uploads/2013/09/Research_Credit_Elective_Request-2016.pdf . Once the request is evaluated, the student will be notified of the final decision.

For further information about participating in Undergraduate Research, see page 24.

Courses Taken Pass/Fail

There is no limit on the number of undesignated credits that may be taken pass/fail, but the university only authorizes one course each semester to be taken pass/fail (see catalog, Academic Policies/Grading Policies/Overview). However, all required courses and all courses fulfilling technical electives and H/S requirements cannot be taken pass/fail without special permission. To allow for situations where it may be *educationally* appropriate for the student to take a course for which he/she has significantly less than the normal preparation, the advisor, with the approval of the director of undergraduate studies, can allow up to four credits of technical electives and up to two courses of H/S courses to be taken pass/fail. The student and his/her advisor fill out the Waiver and Substitution Form on the ChemBE Undergraduate Website (http://engineering.jhu.edu/chembe/wp-content/uploads/sites/11/2014/04/ReqWaiver.pdf). The form must be delivered to the Academic Program Coordinator for approval. The Director of Undergraduate Studies will map the approved pass/fail courses into the proper categories in the Degree Audit System.

Exceptions

The procedure for obtaining an exception to any of the above requirements is a recommendation in writing by the advisor, and approval by the Director of Undergraduate Studies (and the WSE Dean of Education for exceptions to university requirements). Student and advisor fill out the Waiver and Substitution Form on the ChemBE Undergraduate Website (http://www.jhu.edu/chembe/undergraduate-programs/docs/ReqWaiver.pdf). The form must be delivered to the Academic Program Coordinator for approval. The approved waiver form will be placed in the student's departmental file, the student will receive notice of the approval. The Director of Undergraduate Studies will enter the approved exceptions into the Degree Audit System.

Course Retakes

The university allows students to retake a course to obtain a better grade if the first grade is C+ or lower. The grade from the second attempt is the only grade recorded on the transcript and included in the GPA calculation, even if the second grade is lower than the first. The grade from the first attempt disappears. See ASEN Catalog, Academic Policies/Registration Policies/Restrictions/Retaking a Course for details.

6. Ethics

Cheating and other forms of academic dishonesty are corrosive and harmful to our university. The strength of the university depends on academic and personal integrity. You must be honest and truthful in your courses. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructor. You may consult the associate dean of student affairs and/or the chairman of the Ethics Board beforehand. For undergraduate students, the procedures can be found online at http://e-catalog.jhu.edu/undergrad-students/student-life-policies/ .

VII – Options available in Chemical and Biomolecular Engineering

1. Study Abroad

ChemBE students can elect to spend a semester abroad (best during sophomore and junior year) to a variety of countries, but it requires some planning. Students should work with the Study Abroad Office first to explore various options. Then they must meet with their advisor. Finally they need to meet with the Director of UG Studies to review their plan and sign off on the Study Abroad form.

2. Projects in Chemical Engineering Unit Operations with Experiments at DTU in Copenhagen in the Summer

Students have the option to take a Laboratory Course at the Technical University of Denmark (DTU) in Copenhagen during the summer before their senior year. This course substitutes for EN.540.311 in the ChemBE curriculum. Contact the Academic Coordinator or Director of Undergraduate Studies for more information.

3. Undergraduate Research

Many undergraduate students are involved in research. They can find opportunities to work in research laboratories in the ChemBE department or in other programs at Hopkins. Students can start research as early as freshman year. The university limits the total number of research credits to 6 credits per academic year (starting in June). See ASEN Catalog Academic Policies/Registration Policies/Special Situations.

Joining a Research Group in the Engineering School

If you are interested in joining a research group in the engineering school, the first step is to meet with your faculty advisor. He/she will go over your academic record with you to determine if you are prepared for a research project. Next, you should (i) investigate the research interests of the faculty by reading their departmental webpages and publications and (ii) make appointments to talk to faculty members whose research interests you. Contact the faculty member by email in order to find out if there is an opening in their lab. Include a resume, a transcript and any useful information in your application. You may also speak to graduate students in the research group for more information.

To register for research credits, the student must fill out the (orange/yellow) Research Form from the registrar's office and sign up under a 5XX.51X *Group Research* course (540.511 or 513 in ChemBE). The student and the research professor discuss the expectations for the research project and agree on the nature of the final deliverables (see list on research registration form). They should also clarify how much work (time) is expected per credit of research. At the end of the semester, the research professor will review the accomplishments of the student (experiments, report, presentation, etc.), verify that the student invested enough time to deserve the number of credits of the course and assign a grade for the research effort. Four research credits from the 5XX.51X type will automatically count as engineering elective credits.

Joining a Research Group outside the Engineering School

If students wish to join research laboratories in another school in JHU (for example the Medical School), they must consult with their academic advisor to transfer the final research grade from the other school into the WSE. After receiving approval from their advisor, students use the (orange/yellow) Research Form from the registrar's office to sign up under the SIS section number for 540.501/503 *Independent Research* of their ChemBE advisor. They must inform their advisor of the deliverables and expectations discussed with the research professor. At the end of the semester, students must send an e-mail to their advisor explaining the nature of their project and how they met the requirements set by their research professor. It is also the students' responsibility to remind their research professor to send a final grade and number of credits to the advisor. The advisor will then enter this grade in SIS. To count credits from 540.501/503 as engineering electives, students must fill out the Research Credit Elective Request form (see page 23).

Credits received for unpaid research from another university might be eligible to transfer to Hopkins. Follow the WSE procedure for any credit transfer. If research takes place in a university outside the United States, the transfer of credits follows the procedures of the Study Abroad office. They will count as undesignated credits.

Students may not receive research credits from internships, REUs or any research work for which they receive compensation.

Safety Course for Research

Students who join a research group must take the on-line laboratory safety course through mylearning. Most students meet this requirement since they must take the online safety course before joining any lab course. It does not replace 540.490 but allows students to start research.

4. BS/MSE or MSE programs in Chemical and Biomolecular Engineering

The ChemBE department offers Masters of Science in Engineering to internal candidates as well as BS graduates from other universities. Students have two options in pursuing an M.S.E. in Chemical and Biomolecular Engineering: a coursework-only Master and an essay-based Master that entails obtaining approval to work under the guidance of a ChemBE faculty advisor to create and document original research to be submitted in an essay.

Double Counting Policy

Students pursuing both their undergraduate and master's degrees in ChemBE at JHU should be aware of the department's rules on double counting courses. Up to two courses can be counted for both degrees. For classes offered at both the 400- and 600-level, students MUST take the course at the 600-level to apply the course to their master's degree. Thus, the ChemBE graduate program's policy on double-counting courses is stricter than the WSE policy.

Application Process

The BS/MSE program in Chemical and Biomolecular Engineering allows students to obtain a Master of Science in Engineering concurrently with the Bachelor of Science. Students apply to this program during their junior year. They benefit from an undergraduate and graduate status, thus avoid the need for approval to sign up for graduate level courses.

Students can also elect to finish their BS before starting in the MSE program in ChemBE. In this case, the application process takes place in December of senior year, on the same schedule as all other graduate school applicants.

The Whiting School of Engineering offers a fifty percent tuition waiver for (a) having completed eight full-time semesters of study at Johns Hopkins, or (b) have completed a Bachelors degree at JHU *and* having not been enrolled at Johns Hopkins for at least one year (Deans Master's Fellowship - https://engineering.jhu.edu/graduate-studies/graduate-financial-aid/).

Admission decisions to the ChemBE BS/MSE and MSE programs are made on a variety of criteria including undergraduate GPA. Students are expected to have an undergraduate GPA of at least 2.8 (and preferably higher) in order to be admitted to the BS/MSE program.

Applicants for the MSE program must:

- Consult with their advisor to see if/when they should apply. If applying to the 10-course MSE they should consult their Academic Advisor. If applying to the 6-course program with essay they should consult their Research Professor or proposed MS Research Advisor.
- Inform the ChemBE Graduate Academic Program Coordinator that they will be applying for the BS/MSE program. The Program Coordinator will then supply them with detailed instructions and waive the application fee.
- Apply online through https://engineering.jhu.edu/graduate-admissions/, following all instructions from the Program Coordinator. Applications are due at the end of December or beginning of January along with all other graduate student applicants. Check Graduate School website for exact dates.

- Request only one letter of recommendation for the application file (the department waives the other two). The letter should come from the MS research advisor for the essay/6-course students and from the BS academic advisor for the 10-course students.
- There are no GRE requirements.
- The TOEFL is waived for international students

Contact the Academic Program Coordinator for Graduate Studies for more information:
Alisha Wells
Maryland Hall 224-A
awells18@jhu.edu

or the Director of Master's Studies
Dr. Sakul Ratanalert
Maryland Hall 124
sratana4@jhu.edu

5. Planning for Graduate School

Many graduates from the undergraduate ChemBE program enter graduate schools after receiving their BS. Half of our graduating class applies to and succeeds in joining a MS or PhD program right after senior year or a couple years later. Students who plan to get a graduate degree, especially a PhD, should demonstrate dedication to their course of studies and strive to work independently. They should consider the following suggestions:

- Join a research laboratory and make a contribution to the projects of the group
- Maintain a very high GPA
- Take additional courses in math or computer science (Matlab)
- Take Applied Physical Chemistry (540.204)
- Take Cell Biology (540.307 or 020.306) if you wish to join a Bio-related program
- Sign up for graduate level courses (600 level) during senior year. Note that graduate level courses do not show any credits. For undergraduate students, they will register as three-credit courses on their transcripts after completion of the course.
- Prepare for the GRE
- Attend AIChE/SBE panels on graduate school and research
- Present a poster at a technical meeting
- Become familiar with technical writing
- Publish technical papers.

Applications are due in the fall of senior year (due dates vary from university to university but most are in December and January).

6. Pre-medical Requirements

The Chemical and Biomolecular Engineering degree is an excellent curriculum for preparing students for medical school. Students who intend to apply to medical school must plan their program very carefully. In addition to the courses you must pursue to complete degree and university requirements, we advise you to take the courses necessary in preparation for the MCAT as well as the admission requirements of the majority of medical/dental schools in the U.S. However, realize that it is not possible for you to cover every pre-medical requirement for every medical school in the U.S.

An important resource for pre-medical students is the Office of Pre-Professional Programs and Advising, https://studentaffairs.jhu.edu/preprofadvising/ . All freshmen interest in the health professions are required to attend a Pre-Health 101 workshop prior to making their first individual appointment with a pre-med/pre-health advisor. For more information about Pre-Health 101 and appointments, please visit the Pre-Professional Advising

website. In addition, all freshmen who indicate an interest in pre-med/pre-health careers are automatically added to the Office's listserv to receive important program announcements, newsletters, and general information. If you are not on the listserv, you can subscribe here https://studentaffairs.jhu.edu/preprofadvising/pre-medhealth/newsletters/.

A strong application to medical school must reflect the personal qualities of the applicants as well as the academic achievements. Applicants must include the courses required by the medical school into their curriculum and maintain a good GPA. But good grades are not sufficient. It is as important to demonstrate interest in service of the community, experience in patient care, aptitude to leadership, evidence of collaboration, and dedication to other projects beneficial to society. Students are encouraged to volunteer at school, at home or even abroad, to join a research group, to get experience in the medical world, etc.
Pre-med required courses included in the ChemBE curriculum:

- General Chemistry I and II with Lab (8 credits)(030.101/102/105/106)
- Organic Chemistry I (4 credits) (030.205)
- Biochemistry with Lab and Cell Biology (8 to 11 credits) (020.305, 020.315 or 250.253, and 020.306 or 540.307)
- General Physics I with Lab and General Physics II (9 credits) (171.101/102/111)
- Calculus I and II (8 credits) (110.108/109)
- Two courses that emphasize English and/or writing intensive coursework
- H/S courses. Introductory Psychology and Introductory Sociology are recommended to assist with MCAT prep. Other humanities and social sciences coursework is recommended to demonstrate academic diversity.
- Some bioengineering electives can enhance the biology component of the pre-med requirements

Additional courses required for pre-meds:

- · Organic Chemistry II and Organic Chemistry Lab (7 credits) (030.206/225)
- A Probability and Statistics course
- · Cell Biology Lab (020.316)
- · Physics Lab II (171.112)
- · Note that there is no requirement to take General Biology (020.151 and 020.152)

Some medical schools might have different specifications on course selection and use of AP credits. Please consult with the Pre-Professional Advising office

7. Minors

Minors are available in various departments (Classics, Economics, Music, Russian, Spanish, etc.). Students are responsible for learning the requirements for their minor and receiving clearance from that department for graduation. They must bring this information to their ChemBE advisor in order to design a suitable course plan.

For example, three minors are available in the Environmental Health and Engineering department on environment and sustainability. Detailed information regarding these programs can be found at https://ehe.jhu.edu/undergraduate/degree-programs/ .

A popular minor in Entrepreneurship and Management is offered by the Center for Leadership Education (105 Whitehead Hall). http://engineering.jhu.edu/cle/
For information email : cle@jhu.edu

8. Student Organizations (AIChE/SBE)

The American Institute of Chemical Engineers (AIChE) and SBE (Society for Biological Engineering) student chapter is an organization that eases the transition from the undergraduate learning stage to the actual practice of chemical and biomolecular engineering. It promotes the professional development of the students through association with practicing engineers. Social activities include picnics, a formal dance and a holiday party. AIChE also organizes tours of local plants and arranges for speakers to discuss topics such as what to expect at graduate school, and the role of the chemical/biomolecular engineer in industry. For more information, please see the AIChE chapter webpage (https://engineering.jhu.edu/chembe/undergraduate-studies/aiche/) or email Dr. Ratanalert.

9. Cooperative Program

The Department of Chemical and Biomolecular Engineering allows students to join a cooperative program in which students spend up to one year in industry after completing their sophomore or junior year. Students do not pay tuition during the work periods and are paid a salary by their employer. The department helps to identify potential employers with internship opportunities through the Hopkins ChemBE Career Network, however, students are responsible for obtaining an offer from a suitable employer. Students successfully completing a cooperative program receive a notation on their transcript. Interested students should contact their academic advisor and Professor Betenbaugh, Director of the ChemBE Career Network.

10. How to get an internship

The AIChE student group has written the following tips, to assist students in securing an internship:

- Resume – Spend some time working on your resume. Have it critiqued, numerous times. The career center, professors, and parents are good resources. Get lots of opinions and then decide what will work best for you.
- Start Early – Start surfing the net in September/October to figure out what sort of companies and positions are out there and interest you. Don't limit yourself to any one particular company. Visit their web sites regularly, specifically their career pages, to review and apply to positions. Go to Handshake and HCCN to find out what is available.
- Interviews – The career center offers interviews with companies in the fall semester. They recruit BS and graduate students on campus and often include interviews for internships. This is your best bet for an internship because they are seeking Hopkins students specifically. Submit your resume to as many as you can even if you're not all that interested because the interview practice is always good. Don't forget to send thank you emails! Work Your Connections – Talk to professors, deans, parents, relatives, friends, etc. Hopkins has a great alumni network (check out the career center, LinkedIn and the HCCN web pages).
- Go to EVERYTHING – Go to any and every employer showcase, informational session, job fair, alumni panel, etc. that you can. You never know when you might learn something or meet someone.
- Email them, call them, do whatever you have to. Show interest. Follow up. Be annoying in a very nice, polite kind of way.
- Don't Forget REU Programs! – Almost every large college/university has some sort of REU – Research Experience for Undergrads – Apply! The deadlines are usually Feb/March/April so start writing essays over Intercession. You do get paid, and usually free housing!
- Don't panic – Most companies don't start offering summer positions until mid-March through the end of April and even into May sometimes.

VIII – OTHER RESOURCES

Resource	URL
ChemBE Department Website	http://engineering.jhu.edu/chembe/
Whiting School of Engineering – Academic Policies and Procedures	https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/
Whiting School of Engineering-- Office of Academic Affairs and Advising Office	https://engineering.jhu.edu/advising/
Office of Pre-Professional Advising	http://studentaffairs.jhu.edu/preprofadvising/
Learning Den Tutoring	https://academicsupport.jhu.edu/learning-den/
Life Design Lab (Louise Lassalle, ChemBE educator)	https://studentaffairs.jhu.edu/life-design/ https://jhu.joinhandshake.com/login
Hopkins ChemBE Career Network	http://jhuhccn.wordpress.com/
Homewood Student Affairs	https://studentaffairs.jhu.edu/
Student Health and Wellness Center	https://studentaffairs.jhu.edu/student-health
Study Abroad Office	http://web.jhu.edu/study_abroad
ASEN Catalog	http://e-catalog.jhu.edu/

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