

Chemical Engineering Advising Handbook

This Handbook summarizes the academic requirements of the Chemical Engineering Curriculum following the removal of the “Options” and applies to students who **entered the CHE major in Summer 2018 or later (typically, students who started at PSU in Fall 2016 or later)**. Students who entered the major before Summer 2018 still have the “Options” available to them. This handbook also applies to students following the “General Option.” Students following options other than General should consult the previous handbook for details. Students who started in Summer 2015 or later follow the curriculum detailed in this handbook, while a minority of CHE students remain who started before summer 2015 and should follow the “Old” curriculum.



Designed to meet the needs of our students and faculty for decades to come, the new Chemical Engineering and Biomedical Engineering Building opened in spring 2019. (photo from Ribbon Cutting Ceremony, 4/4/19)

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Introduction to the Department

The Chemical Engineering Department is a vibrant academic unit with activities spanning undergraduate and graduate education, research, and service to the field. We have approximately 40 faculty members, 110 graduate students, and 350 undergraduate students in their 3rd year or beyond. We are mainly located in the Chemical and Biomolecular Engineering Building on Shortlidge Road.

Undergraduate Office: Angela Dixon, Jennie Gibson, 121 CBE, 814-865-2574
CH E 480W Lab: 1st floor CBE **CH E Computer Labs:** 1st floor CBE
IT Support: JoElle DeVinney, 124 CBE, 814-863-9634

ChE Faculty

KONSTANTINOS ALEXOPOULOS, 226 CBE Building, kxa5325@psu.edu, 814-865-2713
MONTY ALGER, 305 CBE Building, mxa50@psu.edu, 814-867-6044
CHRIS ARGES, 215 CBE Building, cga5126@psu.edu, 814-863-2153
ANTONIOS ARMAOU, 230 CBE Building, armaou@psu.edu, 814-865-5316
GARY AURAND, 209 CBE Building, gza140@psu.edu, 814-863-3845
ALI BORHAN, 308 CBE Building, borhan@psu.edu, 814-865-7847
BERT CHANDLER, 414 CBE Building, bkc5474@psu.edu, 814-863-6629
WAYNE CURTIS, 409 CBE Building, wrc2@psu.edu, 814-863-4805
RONALD DANNER, 309 CBE Building, rpdp@psu.edu, 814-863-4814
KRISTEN FICHTHORN, 403 CBE Building, fichthorn@psu.edu, 814-863-4807
ENRIQUE GOMEZ, 404 Steidle Building, edg12@psu.edu, 814-867-3428
ESTHER GOMEZ, 410 CBE Building, ewg10@psu.edu, 814-867-4732
MECHTELD HILLSLEY, 415 CBE Building, mmv100@psu.edu, 814-863-9356
MICHAEL JANIK, 205 CBE Building, mjj13@psu.edu, 14-863-9366
SEONG KIM, N323 Millenium Science Complex, shkim@psu.edu, 814-863-4809
COSTAS MARANAS, 306 CBE Building, costas@psu.edu, 814-863-9958
JANNA MARANAS, 208 CBE Building, jmaranas@psu.edu, 814-863-6228
PATRICK MATHER, 10 Schreyer Honors College, Atherton Hall, ptm101@psu.edu, 814-863-2631
THEMIS MATSOUKAS, 313 CBE Building, matsoukas@psu.edu, 814-863-2002
SCOTT MILNER, 204 CBE Building, stm9@psu.edu, 814-863-9355
HEE-JEUNG OH, 213 CBE Building, hfo5022@psu.edu, 814-863-9085
TONYA PEEPLES, 101M Hammond Building, tzp225@psu.edu, 814-865-4287
CHRISTIAN PESTER, 314 CBE Building, pester@psu.edu, 814-865-6846
ROBERT RIOUX, 22A CBE Building, rnr189@psu.edu, 814-867-2503
HOWARD SALIS, 244 Agricultural Engineering Building, hms17@psu.edu, 814-865-1931
PHIL SAVAGE, DEPARTMENT HEAD, 121D CBE Building, pes15@psu.edu, 814-867-5876
AMIR SHEIKHI, 413 CBE Building, sheikhi@psu.edu, 814-863-7564
RUI SHI, 229 CBE Building, rms6987@psu.edu, 814-863-6590
EZGI TORAMAN, 154 Hosler, hzt5148@psu.edu, 814-863-9261
DARRELL VELEGOL, 225 CBE Building, velegol@psu.edu, 814-865-8739
STEPHANIE VELEGOL, 224 CBE Building, sbv1@psu.edu, 814-865-4907
BRYAN VOGT, 315 CBE Building, bdv5051@psu.edu, 814-863-5459
THOMAS WOOD, 304 CBE Building, tuw14@psu.edu, 814-863-5459

XUEYI ZHANG, 214 CBE Building, xuz32@psu.edu, 814-865-9746

ANDREW ZYDNEY, 404 CBE Building, alz3@psu.edu, 814-863-7113

Academic Requirements

The CHE major requires 133 credits for graduation. These are listed below.

GENERAL EDUCATION & OTHER GENERAL REQUIREMENTS (34 credits)

EDSGN 100 Introduction to Engineering Design (3)

ENGL 015 Rhetoric and Composition (3)

ENGL 202C Effective Writing: Technical Writing (3)

CAS 100A or B Effective Speech (3)

First-Year Seminar (1)

General Education “Knowledge Domains” (21 credits) that typically include:

 GHW elective (3)

 GA/GH/GS electives (18 credits, must include ECON 102 or 104, must include 3 credits of US and 3 credits of IL, if following “Summer 2018 Gen Eds”, must include 6 credits of “Integrative Studies”)

MATH (14 credits)

MATH 140 Calculus With Analytic Geometry I (4)

MATH 141 Calculus with Analytic Geometry II (4)

MATH 231 Calculus of Several Variables (2)

MATH 251 Ordinary and Partial Differential Equations (4)

PHYSICS (8 credits)

PHYS 211 General Physics: Mechanics (4)

PHYS 212 General Physics: Electricity and Magnetism (4)

CHEMISTRY AND LIFE SCIENCES (24 credits)

CHEM 110 Chemical Principles I (3)

CHEM 111 Experimental Chemistry I (1)

CHEM 112 Chemical Principles II (3)

CHEM 113 Experimental Chemistry II (1)

CHEM 210 Organic Chemistry I (3)

CHEM 212 Organic Chemistry II (3)

CHEM 213 Laboratory in Organic Chemistry (2)

CHEM 457 Experimental Physical Chemistry (2)

B M B 251/MICRB 251 Molecular and Cell Biology I (3)

Take 3 credits of physical chemistry from the list below:

 CHEM 408 Computational Chemistry (3)

 CHEM 448 Surface Chemistry (3)

 CHEM 452 Physical Chemistry - Quantum Chemistry (3)

 CHEM 464 Chemical Kinetics and Dynamics (3)

 CHEM 466 Molecular Thermodynamics (3)

Note on Physical Chemistry course: Some classes on this list have pre-requisites that a CHE student may not have completed. CHE students are encouraged to contact the CHEM course

instructor to check if they may take the class without the pre-reqs, as in many cases CHEs have sufficient background for the course.

REQUIRED CHEMICAL ENGINEERING COURSES (35 credits)

- CHE 210 Introduction to Material Balances (3)
- CHE 220 Introduction to Chemical Engineering Thermodynamics (3)
- CHE 230 Computational Tools for Chemical Engineering (1)
- CHE 300 Professional Development Seminar (1)
- CHE 320 Phase and Chemical Equilibria (3)
- CHE 330 Process Fluid Mechanics (3)
- CHE 340 Introduction to Biomolecular Engineering (3)
- CHE 350 Process Heat Transfer (3)
- CHE 410 Mass Transfer Operations (3)
- CHE 430 Chemical Reaction Engineering (3)
- CHE 452 Chemical Process Safety (3)
- CHE 470 Design of Chemical Plants (3)
- CHE 480W Chemical Engineering Laboratory (3)

CHEMICAL ENGINEERING ELECTIVES (6 credits)

Take 6 credits in 400-level engineering electives from the following list:

- CHE 412 CHE and the Environment
- CHE 423 Chemical Energy Technology
- CHE 432 (F SC 432) Petroleum Processing
- CHE 438 Bioprocess Engineering
- CHE 442 (MATSE 448) Polymer Processing Technology
- CHE 443 Introduction to Polymer Science
- CHE 445 Bioremediation/Green Chemistry
- CHE 444 Chemical Game Theory
- CHE 445 Bioremediation/Green Chemistry
- CHE 446 Transport Phenomena
- CHE 449 Bioseparations
- CHE 450 Process Dynamics and Control
- CHE 455 Drug Delivery, Pharmacokinetics, and Artificial Organs
- CHE 494 Research Projects in Chemical Engineering (see Note below)
- CHE 496 Independent Studies
- CHE 497 Special Topics in Chemical Engineering (see Note below)

Note on CHE 494: Students may use **up to 6 credits of CH E 494** towards graduation requirements in chemical engineering. Up to 3 credits may be used as a CH E 4XX electives and another 3 credits may be used as engineering elective or professional elective.

Note on CHE 496: This course is used for Independent Study of a topic under the direction of a faculty member. It is not to be used for scientific research.

Note on CHE 497: This is a generic course number for special topics that do not have a permanent course number. When multiple courses are offered on special topics, they will appear with numbers such as 497A, 497B etc.

MATERIALS ELECTIVE (3 credits)

Select 3 credits from the list:

MATSE 201 Introduction to Materials Science (3)

MATSE 202 Introduction to Polymer Materials (3)

EGEE 455 Materials for Energy Applications (3)

BME 443 (MATSE 403) Biomedical Materials (3)

ENGINEERING ELECTIVE (3 credits)

Select 3 credits from approved list of engineering courses. This list is rather long and can be found at the end of this handbook. Engineering electives must be courses that have a strong technology component and build from a background in mathematics and science. Computer programming is not required of the CHE major, but is a recommended and popular topic to pursue with this elective requirement (CMPSC 200 or 201, for example). Please check with your adviser and submit a petition through coursesub.psu.edu for consideration before assuming that any course not on the list in this handbook would count as an Engineering Elective. Many ENGR courses DO NOT count as Engineering Electives.

PROFESSIONAL ELECTIVES (6 credits)

Professional electives is a broad category of electives that give you the opportunity to enhance your portfolio of professional skills, to pursue minors, or to pursue topics of personal interest that are not covered by other elective categories. Acceptable courses must be at the 200-level or above. As a wide variety of courses may count as Professional Electives, all courses that are appropriate will not automatically be placed in this category on your "Academic Requirements" record in LionPath. If a course you intend as a Prof. Elec. does not automatically fall into that category in LionPath, please submit a petition through coursesub.psu.edu.

Prerequisites

The Chemical Engineering Department generally enforces all pre-requisites for required CHE classes. The current process (as of Fall 2021) removes all students who do not have the pre-requisites from the course enrollment at the end of the add/drop period at the beginning of each semester. Pre-requisite waiver requests can be completed (form available in department office), and require the signature of the course instructor and Undergraduate Program Coordinator. These waivers are only granted in exceptional conditions, such as when a student took the pre-requisite course at another university and the credits are yet to transfer. In the near future, all College of Engineering courses will enforce pre-requisites when scheduling in LionPath, and students will not

be able to add classes to their schedule for which they do not have the pre-requisites. Once this policy goes into effect, and exception procedure will be announced.

C Requirement

The following courses require C for graduation in chemical engineering:

CHE 210, 220, 320, 330, 350

CHE 210 and 220 are special courses and require a minimum grade of C before you can take **any CHE course** that has these courses as prerequisites. Notice that CHE 210 is a prerequisite for all 300-level courses (except CHE 300); this means that a D in 210 will require you to retake 210 before you can start taking 300-level courses.

General Scheduling Tips

- During the semester you take CHE 210 and 220, plan on a lighter credit load (~15-16 credits), especially if you are transferring from a Commonwealth Campus. It takes some effort to get used to the format and study style of chemical engineering classes and since both CHE 210 and 220 require a minimum grade of C, you should make sure you have the time to devote the required effort.
- The 300-level courses can be taken almost in any sequence. We recommend that you take CHE 320 and 330 in the fall of the junior year, then CHE 300, 350 and 340 in the spring. It is highly recommended to take CHE 330 before taking CHE 350.
- CHE 410 and 430 are prerequisites for CHE 470. A typical plan is to take 410 and 430 in the fall of the senior year, and 470 in the spring.
- The chemical engineering lab, CHE 480W, can be taken concurrently with CHE 410/430, therefore you can take it either in the fall or spring of the senior year. It is not recommended to take both 410 and 430 concurrently with the lab.
- All required CHE courses are offered both fall and spring, with the exception of CHE 300 (spring only). Some of our core courses are offered over the summer online, though specific offerings any given summer will vary.

Sample course plans are shown on page **8 and 9**. Though these are typical plans, there are many possible progressions through the curriculum. It is your responsibility to ensure that the courses you want to take are available in the semester you plan to take them, and that all prerequisites are satisfied. Before making modifications to this plan see your advisor to make sure that everything will work as planned.

Sample Schedule 1 – Starting at UP and beginning CHE courses in Semester 3

Semester 1	Credits	Semester 2	credits
CHEM 110	3	CHEM 112	3
CHEM 111	1	CHEM 113	1
MATH 140	4	MATH 141	4
EDSGN 100	3	PHYS 211	4
First Year Seminar	1	ENGL 15 or ENGL 30	3
ECON 102 or 104 (Gen Ed 1)	3	Gen Ed 2	3
	15		18
Semester 3	credits	Semester 4	credits
CHE 210	3	MATH 231	2
CHEM 210	3	CHE 220	3
MATH 251	4	CHE 230	1
PHYS 212	4	CHEM 212	3
Gen Ed 3	3	BMB 251	3
		Gen Ed 4	3
		Health & Physical Activity (GHW)	1.5
	17		16.5
Semester 5	credits	Semester 6	credits
CHE 320	3	CHE 300	1
CHE 330	3	CHE 340	3
CHEM 213	2	CHE 350	3
Professional Elective	3	CHEM 457	2
Gen Ed 5	3	Physical chemistry elective	3
Gen Ed 6	3	CAS 100A/B	3
		Health & Physical Activity (GHW)	1.5
	17		16.5
Semester 7	credits	Semester 8	credits
CHE 410	3	CHE 470	3
CHE 430	3	CHE 480W	3
CHE 452	3	Chemical Engineering Elective	3
ENGL 202C	3	Engineering Elective	3
Materials Elective	3	Professional Elective	3
Chemical Engineering Elective	3		
	18		15

Total number of credits: 133

Sample Course Schedule 2 – Non-UP start, begin CHE classes in Semester 4

Semester 1	Credits	Semester 2	credits
CHEM 110	3	CHEM 112	3
CHEM 111	1	CHEM 113	1
MATH 140	4	MATH 141	4
EDSGN 100	3	PHYS 211	4
First Year Seminar	1	ENGL 15 or ENGL 30	3
ECON 102 or 104 (Gen Ed 1)	3	Gen Ed 2	3
	15		18
Semester 3	credits	Semester 4	credits
CHEM 210	3	CHE 210	3
MATH 231	2	CHE 220	3
MATH 251	4	CHE 230	1
PHYS 212	4	CHEM 212	3
Gen Ed 3	3	BMB 251	3
		Gen Ed 4	3
		Health & Physical Activity (GHW)	1.5
	16		17.5
Semester 5	credits	Semester 6	credits
CHE 320	3	CHE 300	1
CHE 330	3	CHE 340	3
CHEM 213	2	CHE 350	3
Professional Elective	3	CHEM 457	2
Gen Ed 5	3	Physical chemistry elective	3
Gen Ed 6	3	CAS 100A/B	3 credits
	7	GHW	1.5 credits
			16.5
Semester 7	credits	Semester 8	credits
CHE 410	3	CHE 470	3
CHE 430	3	CHE 480W	3
CHE 452	3	Chemical Engineering Elective	3
ENGL 202C	3	Engineering Elective	3
Materials Elective	3	Professional Elective	3
Chemical Engineering Elective	3		
	18		15

Total number of credits: 133

1st year

2nd year

3rd year

4th year

Plan for Chemical Engineering

MATH140 (4)	MATH141 (4) (MATH140)	MATH231 (2) (MATH141)	CHE210 (MATH141, CHEM112)	CHE320 (210, 220, MATH231)	CHE350 (210, 230, MATH251)	CHE430 (320)	CHE470 (350, 410, 430)
EDSGN100	PHYS211 (4) (co:MATH140)	MATH251 (4) (MATH141)	CHE220 (MATH141, CHEM112)	CHE330 (210, MATH251)	CHE340 (210, MATH251, CHEM212, B251)	CHE410 (230, 320, 330 or 350)	CHE480W (230, 320, 330, 350, co:410)
CHEM110	CHEM112 (CHEM110)	PHYS212 (4) (PHYS211, co:MATH141)	CHE230 (1) (MATH251)	CHEM213W(2), (CHEM210, co: CHEM212)	CHE300 (1) (5 th semester Spring only)	CHE452 (320, co:330, 350)	Professional electives
CHEM111 (1) (co-CHEM110)	CHEM113 (1) (co-CHEM112)	CHEM210 (CHEM112)	CHEM212 (CHEM210)	Professional electives	CHEM466 or CHEM4XX*	CHE4XX	CHE4XX
ECON102 or 104 (GS)	ENGL 015	Gen Ed	BMB 251 (CHEM112)	Gen Ed	CHEM457 (2) (320)	Mat. Science elective	Engineering electives
First year seminar	Gen Ed	Gen Ed	Gen Ed	Gen Ed	CAS100A/B	ENGL 202C	
15 credits	18 credits	16 credits	17.5 credits	17 credits	16.5 credits	18 credits	15 credits

Red and pink courses are required with a C or better.

Gray courses are entrance to major (C or better)
(Pre-requisites are shown in parenthesis)

* CHEM4XX can be 408, 448, 452, 464, 466

** ECON102 or 104 counts as 3 cr of GS. You must have at least 3 cr of GA and GH.

Petitions at <https://coursesub.psu.edu>

Partial list of EEs (see handbook for complete list:

BME442, 443, MATSE401, 402, 404, 443, 445, 446
CMPSC200, 201, 202, STAT 401
EBF473, 484, EGEE 420, 441, 451, 455
EMCH210, 211, 213, ESC203, 312, 452, 483, 484
ENVSE450, 470, FSC431, 432

Material Science electives:

MATSE 201, MATSE202,
EGEE455, MATSE403 (BME443)

Academic Integrity

Professional integrity will be important to your career as a Chemical Engineer, as acting with integrity is essential to being an effective team member in the workplace. Surveys consistently show that people select co-workers who they perceive as having high integrity, and a large percentage of disciplinary issues in the workplace (including firing) occur due to integrity violations. Academic integrity is your chance to practice acting with integrity while you are a student. Our instructors and students both have responsibility to act with integrity to create a positive and professional learning environment. As a student, acting with integrity includes:

Coming prepared for class

Treating your peers and instructors with respect

Handing in assignments on time that honestly represent your work

Coming to exams prepared and demonstrating your knowledge and abilities on exams

Any violations of academic integrity will follow university procedures to record violations and enact sanctions. You can learn more about academic integrity policies and the procedures for violations at this website:

<https://www.engr.psu.edu/faculty-staff/academic-integrity.aspx>

Substitutions and Recording Elective Choices

All requests to make substitutions for required courses are to be submitted through the **coursesub.psu.edu** system. Some Professional Elective choices need to be submitted through this system to have the course recorded in LionPath as your choice as a Professional Elective. Many Professional Electives, and most Chemical Engineering and Engineering Electives are automatically moved to count towards these requirements in your LionPath record. If a course is not appearing in the correct location on your “Academic Requirements” (also known as “degree audit”) record in LionPath, you should submit a petition to have the course moved through the coursesub system.

General Education Requirements

The “General Education” requirements of Baccalaureate degrees at Penn State are most clearly conveyed at the university’s bulletin website:

<http://undergraduate.bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program/>

These are not repeated here, but we provide some specific notes on General Requirements to help students adapt the general university requirements to the College of Engineering and Chemical Engineering BS.

First Year Seminar

Students must select a 1-credit freshman seminar during their first year. Students are not required to take the seminar offered by their major – any freshman seminar will satisfy the requirement. This requirement must be completed during the first year.

In some cases, the FYS requirement is incorporated in certain 3-credit courses (this includes SHC students taking the first year ENGL/CAS sequence and some EDSGN courses at commonwealth campuses). In such case you must still provide an additional credit to satisfy the total credit requirement of the Chemical Engineering Major and petition this credit at coursesub.psu.edu (133 credits). See your advisor for further information.

Knowledge Domains (GA/GH/GS/GN/GHW)

Chemical Engineering students meet the GQ (Quantification) and GN (Natural Sciences) requirements with courses otherwise already required of the major.

Generally, CHE students must take 18 credits of courses from the areas of Arts (GA), Humanities (GH) and Social & Behavioral Sciences (GS) areas and 3 credits of Health and Wellness (GHW). Note that you must take a stand-alone GA, GH, and GS. The required Economics course (Econ 102 or 104) qualifies as a Social Sciences elective (GS). Interdomain courses can be used for the 2nd course within each of these domains.

Advising

CHE majors are assigned a faculty member from our advising team as their faculty adviser. In some cases, 2nd year students who declared the major but have not yet begun taking CHE classes, will be left with an adviser in the Engineering Advising Center rather than being assigned an in-major CHE adviser. Students can schedule appointments with their adviser in Starfish at: <http://starfish.psu.edu/>. Find your advisor under “my success network”. Schreyer Honors students will need to email their advisor for an appointment.

Advisers can serve as your primary resource for any academic questions that arise, including course scheduling, study habits, career planning, and integrating courses and extra-curricular activities. Students can meet with their adviser to address specific issues (scheduling next semester’s classes, developing a plan of study for the next few semesters, getting advice on struggles in their courses, planning study abroad or a co-op) or for a general “check-up” on their academic progress and plans. Many students check-in with their adviser each semester.

Transferring courses from other universities towards the major

Students are permitted to transfer courses from other universities towards their graduation requirements at PSU. The following website provides information on how courses are transferred to PSU:

<https://admissions.psu.edu/info/future/transfer/credit/>

Note that a “Transfer Tool” is linked to on this website where students can find specific courses at other universities and their PSU equivalence.

In many cases, CHE courses of interest to students at other universities will not be listed as a direct-equivalent. Students often would like to know if a CHE course at another university can count towards a specific CHE major requirement before enrolling in the course (including when studying abroad). Students are encouraged to email the undergraduate program coordinator, Michael Janik (mjanik@psu.edu) if they would like to know whether a specific course at another university can be used to count towards a CHE course requirement. In the email, students should specify the university where the course is to be taken, attach the syllabus for the course, and note what PSU CHE course they are hoping the course would substitute as. Such requests cannot typically be evaluated without a syllabus, so students should contact the other university to request a syllabus before emailing.

For non-CHE courses, students will need to contact the specific department that offers the related PSU course for any pre-evaluation of equivalence.

Repeating courses

University policy limits the number of times a student can repeat a course, limiting students to *two attempts*. Both receiving a failing grade (including D in a “C or better” course) or late dropping a course counts as an attempt. Students can request a third attempt by completing the form (towards bottom of the page) at:

<https://advising.engr.psu.edu/academic-support/policies-and-procedures.aspx>

A third attempt will generally be approved if the student can provide a justification as to what will be done differently to allow for success on the third attempt. Though this form can also be used to request a fourth attempt at a class, fourth attempts are only approved under extreme circumstances.

Minors of Interest to Chemical Engineering Students

Chemical Engineering BS students can consider a wide array of Minors to add to their undergraduate curriculum. A typical PSU Minor requires 18 credits, but many Minors have some overlap with CHE such that credits can count towards both the CHE Major and a Minor. Some Minors count courses required of the CHE Major towards the Minor requirements. Courses in many Minors can be counted as Professional Electives or Engineering Electives within the major, or towards General Ed requirements.

The requirements of any Minor are defined by the Department in which that Minor is housed. Students are referred to the undergraduate bulletin (undergraduate.bulletins.psu.edu) and individual department websites to find more information about specific minors. For example, a “Program” search for “Chemistry Minor” will quickly bring up the requirements of the minor. With the range of minors of possible interest to CHE students, we cannot attempt to list all possibilities or the requirements of all minors here. However, some minors popular with CHE majors are listed below, along with notes regarding overlap in course content.

Table. A partial list of Minors of particular interest to CHE students.

MINOR	DEPARTMENT	CREDITS BEYOND CHE MAJOR*
Chemistry	Chemistry	6
Environmental Engineering	Civil and Environmental Engineering	0
Mathematics	Mathematics	6
Nanotechnology	Engineering Science and Mechanics	6
Energy Engineering	Energy and Mineral Engineering	0
Materials Science and Engineering	Materials Science and Engineering	6
Polymer Science	Materials Science and Engineering	6
Biochemistry and Molecular Biology	Biochemistry and Molecular Biology	12
Biomedical Engineering	Biomedical Engineering	0
Engineering Leadership Development	SEDTAPP	12
Entrepreneurship & Innovation	SEDTAPP	12

* This value is the minimum number of extra credits needed provided a student maximize the number of courses from the Minor that can also count towards the CHE Major, including as Professional or Engineering Electives.

Chemistry Minor

The Chemistry Minor requires many courses CHE students take for the Major, including CHE 110, 111, 112, 113, 210, 212, and 213. Completing this Minor typically requires CHE students to take 3 to 6 credits in Chemistry beyond those needed for the Major. These additional Chemistry courses can be counted as Professional Electives in the CHE major. Note that Chemistry 450 (Thermodynamics) cannot be counted towards the CHE major for anything due to the overlap in material with CHE 320. CHE students should not take CHEM 450. Chemistry courses cannot be counted as Engineering Electives or Chemical Engineering Electives.

Mathematics Minor

The Mathematics Minor requires a number of courses CHE students take for the Major, including Math 140, 141, 231, and 251. Completing this Minor typically requires CHE students to take 12 credits of Mathematics courses beyond those needed for the Major. Up to 6 of these additional Mathematics credits can be counted towards a CHE student's Professional Electives. Mathematics courses cannot be counted as Engineering Electives or Chemical Engineering Electives.

Environmental Engineering Minor

This minor requires 18 credits, and a number of courses CHE students take for the Major also count towards this minor, including CHEM 210, CHE 210, and CHE 330. The additional 9 credits required of this minor can be used to count towards the CHE Major as Engineering Electives or Professional Electives.

Energy Engineering Minor

The Energy Engineering Minor requires 18 credits. A number of these credits cover topics that are foundational to Chemical Engineering (material and energy balances, thermodynamics, heat and mass transfer), and CHE students are encouraged to check with the Energy and Mineral Engineering advisors as to if any CHE courses can count towards the minor. Most courses in this Minor can be counted as Engineering or Professional Electives, and FSC 432 can be counted as Chemical Engineering 4xx elective.

Materials Science and Engineering Minor

The MATSE Minor requires 18 credits. CHE students are required to take a Materials class, which can count towards 3 of these credits. 3 additional credits from the Minor can be counted as Engineering Electives, and up to 6 credits from the Minor can be counted as Professional Electives. The CHE department offers some electives that concentrate on materials science and engineering topics, and students are encouraged to discuss with a MATSE advisor whether such electives could also be used to count towards the MATSE Minor.

Nanotechnology Minor

The Nanotechnology Minor is housed in the Engineering Science and Mechanics Department. This minor requires 18 credits. The CHE 340 course can be counted towards this minor, and most courses in this minor can be counted as Engineering Electives (up to 3 credits) or Professional Electives (up to 6 credits) in the CHE major.

Polymer Science Minor

The Polymer Science Minor is housed in the Materials Science and Engineering Department. This minor requires 23 credits. 5 of these credits (CHEM 210, MATH 231) are required of the CHE major. Up to an additional 12 credits from this minor can be counted towards the CHE major as the Materials Elective, Engineering Elective, or Professional Electives. The CHE department also offers some CHE 4xx electives that concentrate on polymeric materials, and CHE students are encouraged to check with MATSE advisors if these courses can be counted towards the Polymer Science Minor.

Biochemistry and Molecular Biology

The BMB minor requires 33 to 35 credits to complete, and overlap in required courses with the CHE major include CHEM 110, CHEM 112, CHEM 210, CHEM 212, and BMB 251 (15 credits). Up to an additional 6 credits of this Minor can be counted as Professional Electives in the CHE major.

Biomedical Engineering

The Biomedical Engineering Minor requires 18-20 credits to complete. These credits include 6 credits of direct overlap with the CHE major in BMB 251 and CHE 340. CHE 438 is also an elective in this Minor, and could also be counted towards a student's CHE 4xx requirement. An additional 9 credits from the Minor can be counted as Professional Electives (up to 6) or Engineering Electives (up to 3) in the CHE major.

Engineering Leadership Development

The ELD Minor requires 18 credits and is housed in the School of Engineering Design, Technology, and Professional Programs (SEDTAPP). Up to 6 credits from the Minor may be used by CHE students towards their Professional Electives requirement. Note that courses in this Minor are not typically approved to count as Engineering Electives.

Entrepreneurship and Innovation (ENTI) Minor

The School of Engineering Design, Technology, and Professional Programs (SEDTAPP) in the College of Engineering coordinates the Technology Cluster within the ENTI Minor. This minor requires 18 credits to complete. Up to 6 credits from the Minor may be used by CHE students towards their Professional Electives requirement. Note that courses in this Minor are not typically approved to count as Engineering Electives.

Extra-Curricular Activities

AICHE Undergraduate Student Chapter

Our department has a very active and vigorous student chapter of the American Institute of Chemical Engineers. This chapter organizes academic, social, and career oriented activities to help students integrate into the department and the profession. Activities include networking sessions with companies, outreach activities to educate K-12 students about science and engineering, intramural sports teams, a graduation celebration, and the Penn State THON fundraiser. Students can begin involvement at any time during their studies, including during their first semester at PSU. For more information, visit:

<http://sites.psu.edu/aiche/>

Omega Chi Epsilon (Beta Alpha Student Chapter)

Omega Chi Epsilon (OXE) is the national honor society for the Chemical Engineering field. Students become eligible for induction to the chapter following completion of 6 credits (typically, CHE 210 and CHE 220) in Chemical Engineering, and must have a 3.5 GPA or higher at the time of induction. Students are also asked to participate in service activities prior to induction. The main service activity OXE participates in is providing tutoring to students in the 2xx and 3xx CHE courses. OXE also holds luncheon meetings with faculty to learn about research and other academic issues, holds resume workshops, and participate in high school outreach. For more information, please visit:

<https://sites.google.com/a/psu.edu/oxe/home>

CO-OPs/Internships

Chemical Engineering undergraduate students participate in paid internships (during the summer) and CO-Ops (during the academic year) with companies in the field. These experiences provide a

great chance to learn about possible career paths, and build experience that helps make students competitive for job opportunities following graduation. In our 2017-2018 exit surveys, 77% of CHE majors reporting participating in a paid industrial internship or CO-OP while an undergraduate in our program. Students are encouraged to discuss career options with their advisors and CHE professors, and to attend company information sessions. Career Fairs are held in fall and spring semesters, and students are encouraged to attend these beginning during their first year to help learn about opportunities and build relationships with possible future employers. For CHE-specific questions about CO-OPs and internships, students are referred to Professor Gary Aurand, our department's co-op officer (gza140@psu.edu).

If students register for the ENGR 195/295/395 CO-OP/internship courses, these can count as a Professional Elective in the CHE major. If the experience has sufficient technical content, it can be used as an Engineering Elective. Students wanting this to count as an Engineering Elective should submit a petition in coursesub.psu.edu and include their final report, explaining the technical content of the experience, as an attachment.

Undergraduate Research

There are many opportunities in the CHE department for undergraduate students to get involved in research activities. Students pursuing honors in Chemical Engineering are typically involved in research over multiple semesters and complete a thesis. Though there are many Schreyer Honor's students pursuing research in the department, research is not restricted to honors students. On our 2017-2018 graduation surveys, 48% of all CHE BS students reported getting involved in research during their undergraduate careers. Students can complete research for credit (CHE 294 or CHE 494) during the school year. There are also opportunities through department endowments and National Science Foundation sponsorship to get paid to do research during the summer. To get involved in research, students are encouraged to peruse the research descriptions of faculty on our department website and contact (email, or in person) faculty that lead groups with research in an area of interest. Students should get agreement from a faculty member to perform research for credit before registering for CHE 294(H) or 494(H).

LIST OF ENGINEERING ELECTIVES

Courses listed below are approved to count as Engineering Electives within the Chemical Engineering Major. Many of these courses have enrollment controlled by the department offering the course, and the availability of seats in these courses may vary from semester to semester.

Courses outside this list with sufficient technical content can be petitioned. Such courses are expected to be at the 300-400 level and have prerequisites in Math, Physics or Chemistry as appropriate for the subject.

Co-Op credits may be petitioned as Engineering Electives. Approval is subject to review of the final Co-Op report, which is expected to demonstrate sufficient depth in the application of chemical engineering principles. Since approval is not automatic, consult with your advisor before submitting such petition.

Many of the courses in the list below require prerequisites that are outside the courses normally taken by chemical engineering students. It is the student's responsibility to ensure that he or she has the proper prerequisites for the course of their choice. For some courses, students may find they can substitute a CHE course for a pre-req required in other departments (for example, an advanced ME course might list a ME Thermodynamics pre-req, but CHE 220/320 may also be acceptable). Questions about prerequisites should be directed to the department or instructor that offers the course of interest.

Biological Engineering

- BE 302 HEAT AND MASS TRANSPORT IN BIOLOGICAL SYSTEMS (3)
- BE 303 STRUCTURAL SYSTEMS IN AGRICULTURE (3)
- BE 304 ENGINEERING PROPERTIES OF FOOD AND BIOLOGICAL MATERIALS (3)
- BE 305 AGRICULTURAL MEASUREMENTS AND CONTROL SYSTEMS (3)
- BE 306 MACHINES FOR AGRICULTURAL AND BIOLOGICAL PROCESSING (3)
- BE 307 PRINCIPLES OF SOIL AND WATER ENGINEERING (3)
- BE 308 ENGINEERING ELEMENTS OF BIOCHEMISTRY AND MICROBIOLOGY (3)
- BE 463 DESIGN PRINCIPLES OF MECHATRONICS FOR BIOSYSTEMS (3)
- BE 464 BIOENERGY SYSTEMS ENGINEERING (3)
- BE 465 FOOD AND BIOLOGICAL PROCESS ENGINEERING (3)
- BE 468 MICROBIOLOGICAL ENGINEERING (3)

Biomedical Engineering

- BME 401 NUMERICAL SIMULATIONS IN BIOMEDICAL ENGINEERING (3)
- BME 402 BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS (3)
- BME 406 MEDICAL IMAGING (3)
- BME 408 SOLID MECHANICS OF BIOLOGICAL MATERIALS (3)
- BME 409 BIOFLUID MECHANICS (3)

BME 410 BIOMEDICAL APPLICATIONS OF MICROFLUIDICS (3)
BME 419 ARTIFICIAL ORGANS AND PROSTHETIC DEVICES (3)
BME 423 REACTION KINETICS OF BIOLOGICAL SYSTEMS (3)
BME 433 DRUG DELIVERY (3)
BME 443 BIOMEDICAL MATERIALS (3)
BME 444 SURFACES AND THE BIOLOGICAL RESPONSE TO MATERIALS (3)
BME 445 TISSUE ENGINEERING: CONCEPTS, CALCULATIONS, AND APPLICATIONS (3)
BME 446 POLYMERS IN BIOMEDICAL ENGINEERING (3)
BME 455 STEM CELL BIOLOGY AND THERAPY (3)

Civil Engineering

CE 370 INTRODUCTION TO ENVIRONMENTAL ENGINEERING (3)
CE 371 WATER AND WASTEWATER TREATMENT (3)
CE 461 WATER-RESOURCE ENGINEERING (3)
CE 475 WATER QUALITY CHEMISTRY (3)
CE 479 ENVIRONMENTAL MICROBIOLOGY FOR ENGINEERS (3)

Computer Science

CMPS 121 INTRODUCTION TO PROGRAMMING TECHNIQUES (3)
CMPS 131 PROGRAMMING AND COMPUTATION 1: FUNDAMENTALS (3)
CMPS 200 PROGRAMMING FOR ENGINEERS WITH MATLAB (3)
CMPS 201 PROGRAMMING FOR ENGINEERS WITH C++ (3)

Engineering Mechanics

EMCH 211 STATICS (3)
EMCH 212/212H DYNAMICS (3)

Engineering Science

ESC 312 ENGINEERING APPLICATIONS OF WAVE, PARTICLE, AND ENSEMBLE CONCEPTS (3)
ESC 313 INTRODUCTION TO PRINCIPLES, FABRICATION METHODS AND APPLICATIONS OF NANOTECHNOLOGY (3)
ESC 314 ENGINEERING APPLICATIONS OF MATERIALS (3)
ESC 386 ENGINEERING PRINCIPLES OF LIVING ORGANISMS (3)
ESC 420 NANOSTRUCTURES AND NANOMATERIALS (3)
ESC 430 ADVANCED BIOFABRICATION PROCESSES (3)

Energy And Geo-Environmental Engineering

EGEE 401 ENERGY IN A CHANGING WORLD (3)
EGEE 411 ENERGY SCIENCE AND ENGINEERING LAB (3)
EGEE 412 GREEN ENGINEERING & ENVIRONMENTAL COMPLIANCE (3)
EGEE 420 HYDROGEN AND FUEL CELLS (3)

EGEE 430 (M E) INTRODUCTION TO COMBUSTION (3)
EGEE 436 MODERN THERMODYNAMICS FOR ENERGY SYSTEMS (3)
EGEE 437 DESIGN OF SOLAR ENERGY CONVERSION SYSTEMS (3)
EGEE 438 WIND AND HYDROPOWER ENERGY CONVERSION (3)
EGEE 439 ALTERNATIVE FUELS FROM BIOMASS SOURCES (3)
EGEE 441 ELECTROCHEMICAL ENGINEERING FUNDAMENTALS (3)
EGEE 442 ELECTROCHEMICAL METHODS (3)
EGEE 451 ENERGY CONVERSION PROCESSES (3)
EGEE 455 MATERIALS FOR ENERGY APPLICATIONS (3)
EGEE 456 (E E;E SC) INTRODUCTION TO NEURAL NETWORKS (3)
EGEE 464W ENGINEERING DESIGN PROJECT (3)
EGEE 470 AIR POLLUTANTS FROM COMBUSTION SOURCES (3)

Environmental Systems Engineering (ENVSE)

ENVSE 400 ENVIRONMENTAL SYSTEMS ENGINEERING (3)
ENVSE 404 SURFACES AND INTERFACIAL PHENOMENA IN ENVIRONMENTAL SYSTEMS (3)
ENVSE 408 CONTAMINANT HYDROLOGY (3)
ENVSE 420 FIRE SAFETY ENGINEERING (3)
ENVSE 450 ENVIRONMENTAL HEALTH AND SAFETY (3)
ENVSE 457 INDUSTRIAL HYGIENE MEASUREMENTS (3)
ENVSE 470 ENGINEERING RISK ANALYSIS (3)

Fuel Science

FSC 401 INTRODUCTION TO FUEL TECHNOLOGY (3)
FSC 431 THE CHEMISTRY OF FUELS (3)

Materials Science And Engineering

MATSE 400 CRYSTAL CHEMISTRY (3)
MATSE 401 THERMODYNAMICS OF MATERIALS (3)
MATSE 402 MATERIALS PROCESS KINETICS (3)
MATSE 403 BIOMEDICAL MATERIALS (3)
MATSE 409 (NUC E) NUCLEAR MATERIALS (3)
MATSE 411 PROCESSING OF CERAMICS (3)
MATSE 413 SOLID-STATE MATERIALS (3)
MATSE 415 INTRODUCTION TO GLASS SCIENCE (3)
MATSE 419 COMPUTATIONAL MATERIALS SCIENCE AND ENGINEERING (3)
MATSE 421 CORROSION ENGINEERING (3)
MATSE 430 MATERIALS CHARACTERIZATION (3)
MATSE 441 POLYMERIC MATERIALS I (3)
MATSE 442 POLYMER SYNTHESIS (3)
MATSE 443 INTRODUCTION TO THE MATERIALS SCIENCE OF POLYMERS (3)
MATSE 444 SOLID STATE PROPERTIES OF POLYMERIC MATERIALS (3)

MATSE 445 THERMODYNAMICS, MICROSTRUCTURE, AND CHARACTERIZATION OF POLYMERS (3)

MATSE 446 MECHANICAL AND ELECTRICAL PROPERTIES OF POLYMERS AND COMPOSITES (3)

MATSE 447 RHEOLOGY AND PROCESSING OF POLYMERS (3)

MATSE 448 POLYMER PROCESSING TECHNOLOGY (3)

MATSE 455 PROPERTIES AND CHARACTERIZATION OF ELECTRONIC AND PHOTONIC MATERIALS (3)

Mechanical Engineering/ Nuclear Engineering

ME 401 REFRIGERATION AND AIR CONDITIONING (3)

ME 402 POWER PLANTS (3)

ME 403 POLYMER ELECTROLYTE FUEL CELL ENGINES (3)

ME 404 GAS TURBINES (3)

ME 405 INDOOR AIR QUALITY ENGINEERING (3)

ME 406 INTRODUCTION TO STATISTICAL THERMODYNAMICS (3)

ME 408 ENERGY SYSTEMS (3)

ME 428 APPLIED COMPUTATIONAL FLUID DYNAMICS (3)

ME 430 INTRODUCTION TO COMBUSTION (3)

ME 431 INTERNAL COMBUSTION ENGINES (3)

ME 433 FUNDAMENTALS OF AIR POLLUTION (3)

Petroleum And Natural Gas Engineering

PNG 405 ROCK AND FLUID PROPERTIES (3)

PNG 410 APPLIED RESERVOIR ENGINEERING (3)

PNG 480 SURFACE PRODUCTION ENGINEERING (3)