
Department of Chemical Engineering

Advising Handbook

“OLD Curriculum”

for students who started at Penn State
before Summer 2015

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A. GENERAL INFORMATION

Foreword

This Handbook summarizes the academic requirements of the so-called “*Old Curriculum*” and is for *students who started at Penn State before summer 2015*. This Handbook will receive minimal maintenance until the students under the Old Curriculum graduate.

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August 20, 2015

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What is New in this Edition

1. ChE 360 may be replaced with 3 credits of ChE 4XX courses (Effective Fall 2014).
2. CH E 443 is a new elective that will satisfy the CHE 4XX requirement in the general option (Effective Spring 15).
3. The physical chemistry course can now be selected from the following list of courses:
 - 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)

This means that CHEM 466, which was previously required, can now be replaced by any of the above courses.

4. eLion has been replaced by LionPath.
5. This Handbook will receive minimal maintenance as the OLD curriculum is being phased out.

Chemical Engineering at Penn State

Chemical Engineering is the discipline devoted to the manipulation of molecular matter and energy. Founded on a set of core principles—the conservation of mass, momentum and energy—chemical engineering is a hierarchy of sub disciplines (thermodynamics, kinetics, catalysis, mass, heat and momentum transfer, control) that is able to solve complex problems spanning multiple characteristic time and length scales – from hours and meters to picoseconds and tenths of nanometers. The focus of the discipline is on molecular transformations, whether they are done stoichiometrically, with synthetic catalysts, bioenzymatically, in cells, or even with whole organisms. The emphasis on chemistry and molecular biology as core enabling sciences differentiates chemical engineering from the other engineering disciplines. However, chemical engineering shares in common with the other engineering disciplines, the high level use of mathematics, both as an essential tool for analysis and model building and, even more importantly, as a language for the expression and exchange of well-posed problems and the definition of their solutions.

During the 20th century, chemical engineers were employed for the most part in the chemical and petroleum industries. These two sectors still provide employment for many of today's chemical engineers, but our graduates also pursue careers in electronics, pharmaceuticals, biotechnology, consulting services, food processing, and many other areas. Chemical engineering of the 21st century can engage their skills across these many apparently disparate industries because of the breadth and depth of their training in the engineering core and the enabling sciences; chemical engineers are about to reduce very different problems to their basics, e.g. in molecular transformations, transport, phase behavior etc. With their foundation in quantitative logical thinking and problem solving, it is not surprising that chemical engineers successfully pursue advanced degrees in business (MBA), law (JD) and medicine (MD) as well as in their own disciplines (MS, PhD). Chemical engineering education provides the student with a powerful problem solving skill set comprised of a high level synthesis of mathematics, computation, chemistry, physics, and molecular biology with the engineering core of thermodynamics, transport, control, and design.

Academic Integrity

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts.

Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.

To protect the rights and maintain the trust of honest students and support appropriate behavior, faculty and administrators should regularly communicate high standards of integrity and reinforce them by taking reasonable steps to anticipate and deter acts of dishonesty in all assignments. At the beginning of each course, it is the responsibility of the instructor to provide students with a statement clarifying the application of University and College academic integrity policies to that course. It is the student's responsibility to understand and abide by that statement.

Advising

During the first and second year all advising takes place at the Engineering Advising Center:

Engineering Advising Center
208 Hammond Building
University Park, PA 16802
814-863-1033

adviser@enr.psu.edu

The Advising Center is staffed with professional advisers and with faculty representatives from all engineering majors who can help with all advising questions, including academic and scheduling problems, advanced registration, and schedule changes etc. A Chemical Engineering representative is available at the Advising Center once a week. If you do have a particular question regarding chemical engineering as a curriculum or profession and cannot meet with the CH E representative, do not hesitate to talk to any faculty member in the Chemical Engineering Department.

Once in the major, students are assigned an adviser in chemical engineering who will normally remain your adviser until you graduate, unless you request a change. Advisers are there to help but you must initiate the process. Be proactive and make it a point to meet your adviser regularly to make sure you are on track.

Options

All the requirements of the chosen Option must be satisfied. If you change your Option, all the requirements of the new Option must be satisfied.

Credit requirement

Graduation in chemical engineering requires 134 credits. This requirement is normally fulfilled automatically but if you have been exempted from a course requirement you must still take the equivalent number of credits.

General Education Requirements

Your GA/GH/GS and US/IL credits must be distributed properly (see section on [General Requirements](#)).

Other Requirements

The University requirements for "Writing/Speaking Skills," "Quantitative Skills," and "Natural Sciences" are built-in to the curriculum and are satisfied through the courses required in the major.

Prerequisites

Many courses, especially those that cover technical topics, have prerequisite requirements that must be completed successfully before a student enrolls for a more advanced topic. Prerequisites not only help present course material in a logical order, they are also important in building the necessary background that is required to advance to more difficult and sophisticated concepts. The Department of Chemical Engineering places great emphasis on prerequisites. A student will not be permitted to register in a course if he or she does not have completed successfully these requirements.

If you do not satisfy these requirements, you will not be allowed to register for a course. Even though e-Lion will let you enroll, the department will remove you from the course during the first week of classes. Exceptions to prerequisites will not be considered for frivolous reasons. Dropping a course halfway through the semester, or missing a satisfactory grade by a small margin are not valid excuses. If you feel you have a valid reason, you must see the course instructor and obtain written permission to enroll.

The Department of Chemical Engineering enforces the prerequisites rigorously – Without proper permission you will be dropped from all chemical engineering classes for which you do not satisfy the requirements.

It is your responsibility to know the prerequisite requirements. The list of prerequisites is available in the Blue Book maintained by the University. Prerequisites for chemical engineering courses are listed in this handbook, as well as on the departmental web page. If you follow the published course schedules in this Handbook and do not fall behind, you will have no problem with prerequisites. If you need to make changes to your schedule, you must consider the possibility that prerequisite requirements may lengthen the duration of your studies.

Petitions

A petition is a formal procedure to request substitution for or exception to a degree requirement. If you wish to file a petition, fill out a petition form (<http://www.engr.psu.edu/Forms/GeneralPetition.pdf>), obtain the signature of your academic adviser, and submit the form along with any necessary documentation to the department office in 158 Fenske. You will be notified when a decision is made.

Petitions are decided on an individual basis and judged on the merits of the request. Since a petition essentially asks that the university apply a different standard to the petitioner compared to other students, it is important to present a convincing argument in support of the request. Here are some tips that will help increase the chances of a successful petition:

E-mail or discuss your case with your adviser before you file the petition. If your adviser does not concur with your request, chances are that the petition will be unsuccessful. Notice that approval by the adviser does not guarantee success since additional layers of approval are required. Still, your adviser should be able to tell you whether your petition has a reasonable chance of success.

Document the request as fully as possible. If the space on the petition form is not sufficient, provide additional explanation in an attached letter. This is your only chance to influence the decision on your behalf. Include additional sheets of information (e.g., syllabi, course descriptions, notes from faculty, etc).

If you wish to take a substitute course, petition the substitution before you take the course. If you fail to do this, you are risking the possibility that the course may not be approved.

File any petitions before the beginning of your graduation semester. No petition will be granted after classes begin for the student's final semester.

Certain petitions require action by the Faculty Senate. This process could be time consuming and for this reason petitions should be filed as early as possible.

Your Responsibilities

By following a few basic steps you will be able to remain up-to-date with respect to academic requirements and avoid surprises come graduation time.

- It is your responsibility to ensure that you satisfy the prerequisite requirements before enrolling for Chemical Engineering or other classes. The prerequisite requirements are published in many places including this Handbook. The department enforces the prerequisite requirements rigorously.
- Any substitution or exception to degree requirements must be approved through a petition processed through your adviser and the department.
- No petition will be granted after classes begin for your final semester. Therefore, make such requests as early as possible.
- See your adviser during each Advance Registration period for the following semester to make sure you are scheduling the correct courses.
- Check your schedule with your adviser during the first week of each semester if you have even the slightest indication that you are not taking the correct courses.
- Familiarize yourself with the policies explained in this Handbook. If something remains unclear, see your adviser. Ignorance of policies and requirements is not a valid excuse!

B. CURRICULUM

General Requirements

First Year Seminar

Students who started at Penn State after July 1999 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.

Arts/Humanities/Social Science Electives

You must take 18 credits of courses from the areas of Arts (GA), Humanities (GH) and Social & Behavioral Sciences (GS). The GA/GH/GS credits must be split among the three areas in one of two ways:

6-6-6 This is the default split with 6 credits in each area

9-6-3 This split allows you to explore one area more at the expense of another (it does not matter which area has the 9 credits and which has the 6). This split requires a petition, which however is automatically approved.

The required Economics course (Econ 102 or 104) qualifies as a Social Studies elective (GS).

Only courses with the designation GA, GH or GS can satisfy this requirement. A listing can be found on the online Blue Book:

- **Arts Courses (GA):** <http://bulletins.psu.edu/undergrad/generaleducation/knowledge3>.
- **Humanities Courses (GH):** <http://bulletins.psu.edu/undergrad/generaleducation/knowledge4>.
- **Social & Behavioral Sciences (GS):** <http://bulletins.psu.edu/undergrad/generaleducation/knowledge5>.

US and International Cultures (US/IL requirement)

You must include 3 credits of courses with the designation US and 3 credits with the designation IL. The designation US refers to courses that deal with issues in contemporary US society; the designation IL refers to courses that deal with international societies. This requirement is most easily satisfied through the Arts/Humanities/Social Science electives as many courses in these categories carry the designations US or IL. Therefore, if you plan carefully, you will not have to take extra courses to satisfy this requirement. It is your responsibility to ensure that this requirement is met.

Note: Some courses carry the dual designation "US,IL". Such courses can be used to satisfy either the US or the IL requirement –but not both simultaneously.

A listing of courses can be found in the online Blue Book:

- US/IL Courses: <http://bulletins.psu.edu/undergrad/generaleducation/requirements1>

Language substitution

A language course at the 12th credit level or higher can be substituted for 3 credits of Arts, Humanities, or Social Science requirements. If this substitution is made, it cannot be the ONLY course in a category (i.e. it cannot be substituted for the 3 credit category in the 3-6-9 pattern shown on the previous page). Beginning language courses at Penn State are 4 credits each, so the 12th credit level would be a level III course (Span 003, Italian 003, French 003, etc.). If you intend to take a language course elsewhere, consult with an adviser first, as the 12th credit level may be defined differently at other institutions.

AP credits

Some credit gained through Advanced Placement tests in high school may be petitioned to count for Arts, Humanities, or Social Science courses. Students should seek the assistance of their academic advisers for the preparation and submission of such petitions.

Other course substitutions

Any course not designated as General Education, but which truly meets the spirit of the GA, GH, GS, or GI requirements, whether taken at Penn State or elsewhere, may be petitioned to count in the appropriate area. Key to the success of this type of petition is detailed documentation on what the course covered and, if possible, a written statement by the instructor of the course on the appropriateness of this course as a GA, GH, GS, or GI. Students should seek the assistance of their academic advisers for the preparation and submission of this type of petition.



Note

The GA/GH/GS and US/IL requirements are the most common sources of mistakes and can lead to delayed graduation, if you have the wrong distribution of credits. Think carefully before you take these electives and talk to an Adviser, if you are unsure about these requirements.

Nutrition & Physical Activity (GHA)

You need 3 credits in the Nutrition and Physical Activity category. These courses are designated as GHA and include courses in nutrition as well as various sports activities. You may choose any mix of these courses as long as you have a total of 3 credits. A list can be found in the online Blue Book (and notice that some of these courses also come with US/IL designations):

- Health and Physical Activity: <http://bulletins.psu.edu/undergrad/generaleducation/knowledge1>

The CH E Program

The CH E program requires 134 credits and can be completed in four years. Within the program there are five options. These are "sub-specializations" within the major and are based on 18 credits of technical and professional courses that focus on special subjects. Regardless of the option that you choose, your degree will be in Chemical Engineering and you will be eligible to work for any company that hires chemical engineers. Selection of an option is your decision and you should base it on your personal interests and career plans. The chemical engineering program offers the following options:

General Option

This option offers maximum flexibility through the broadest selection of elective courses. For the majority of students this will be the most suitable option. For more information see your adviser.

Bioprocess and Biomolecular Engineering Option

This option prepares students for careers in the biotechnology area. For more information, please contact Dr. Wayne Curtis (wrc2@psu.edu) in the Department of Chemical Engineering.

Energy and Fuels Engineering Option

This option prepares students for careers in the fields of energy production and management. For more information, please contact Dr. Semih Eser (seser@psu.edu) in the Department of Energy and Mineral Engineering.

Polymer Engineering Option

This option prepares students for careers in polymer synthesis and processing. For more information, please contact Dr. Ralph Colby (colby@matse.psu.edu) in the Polymer Physics Group with the Department of Materials Science and Engineering.

Research-Intensive Option

This option provides enhanced research experience and prepares students for graduate school.

All options have a common core of 116 credits plus an additional 18 credits of technical and professional electives chosen from special lists that are different for each option. The first four semesters are identical for all options but starting with the 5th semester the specific requirements for each option make it necessary to decide on an option at that point. To be eligible for selection of an Option, a student must be admitted to Chemical Engineering Major and have successfully completed CH E 210. Fill out a "Chemical Engineering Option Selection Form" (<http://www.che.psu.edu/ugrad/forms.htm>), and either scan and email this form to Sue Ellen Bainbridge (sesche@enr.psu.edu) or submit it to her in 158 Fenske. If you do not declare an option you will be automatically considered to be in the General Option. You may change your option at any point, however, you must satisfy all the requirements of the option that you pick. You cannot mix-and-match the requirements among options. To learn more about options see your adviser or the contact persons listed under each Option.

Common Requirements for All Options

All options share a common core of 116 credits. The remaining 18 credits consist of technical and professional electives, to be chosen from special lists depending on the option. The common requirements are summarized below:

GENERAL EDUCATION & OTHER GENERAL REQUIREMENTS (34 credits)

Arts (GA)/Humanities (GH)/Social Studies (GS) (18 cr)

ECON 2, 4 or 14 (counts as 3 credits in GS)
ENGL 15 or ENGL 30 (3 cr)
ENGL 202C (3 cr)
CAS 100A/B (3 cr)
ESACT/BBE (3 cr)
EDSGN 100 (3 cr)
Freshman Seminar (1 cr)

MATHEMATICS (16 credits)

MATH 140 Calculus with analytic geometry I (4)
MATH 141 Calculus with analytic geometry II (4)
MATH 230 Calculus and vector analysis (4)
MATH 251 Ordinary and partial differential equations (4)

CHEMICAL & LIFE SCIENCES (24 credits)

CHEM 110 Chemical principles I (3)
CHEM 112 Chemical principles II (3)
CHEM 111 Experimental chemistry I (1)
CHEM 113 Experimental chemistry II (1)
CHEM 213 Laboratory in organic chemistry (2)
CHEM 210 Organic Chemistry I (3)
CHEM 212 Organic Chemistry II (3)
CHEM 466 Molecular Thermodynamics (3)(*)
CHEM 457 Experimental Physical Chemistry (2)
B M B 251 (MICRB) Molecular And Cell Biology I (3)
(*) CHEM 466 may be replaced by CHEM 408, CHEM 448, CHEM 452, CHEM 464

PHYSICS (8 credits)

PHYS 211 General Physics: Mechanics (4)
PHYS 212 General Physics: Electricity And Magnetism (4)

CHEMICAL ENGINEERING (34 credits)

CH E 210 Introduction to material balances (3)
CH E 220 Chemical engineering thermodynamics (3)
CH E 300 Professional development seminar (1)
CH E 320 Phase and chemical equilibria (3)
CH E 330 Process fluid mechanics (3)
CH E 340 Introduction to biomolecular engineering (3)
CH E 350 Process heat transfer (3)
CH E 360 Mathematical modeling in chemical engineering (3)(**)
CH E 410 Mass transfer operations (3)
CH E 430 Chemical reaction engineering (3)
CH E 470 Process design (3)
CH E 480W Chemical engineering laboratory (3)
(**) CH E 360 may be replaced by a 400-elective CH E course or by a course from the list of approved engineering electives.

TECHNICAL & PROFESSIONAL ELECTIVES (18 credits)

These electives are chosen from special lists and are different in each of the four option.

Required Chemical Engineering (CH E) Courses

The required CH E courses form the core of the technical curriculum. These courses are briefly described here.

CH E 210 Introduction to Material Balances (3)

This course provides an introduction to chemical engineering calculations, establishes mathematical methodologies for the computation of material balances and offers an overview of industrial chemical processes. It is the introductory course in the chemical engineering curriculum and is normally taken in the sophomore year. It is prerequisite for all 300-level courses (except CH E 300) and requires a minimum grade of C before moving to any upper-level courses.

CH E 220 Introduction to Chemical Engineering Thermodynamics (3)

This is the first of two courses in chemical engineering thermodynamics. It covers the phase behavior and properties of pure fluids with applications to the analysis and preliminary design of power plants and refrigeration system. It lays the background for CH E 320 and requires a minimum grade of C.

CH E 300 Professional Development Seminar (1)

This course is a series of lectures by visiting engineers and Penn State faculty on various topics of chemical engineering interest, including careers, patents, licensing, ethics, and other professional skills.

CH E 320 Phase and Chemical Equilibria (3)

The course covers the fundamentals of phase and chemical equilibrium with emphasis on vapor/liquid systems and their applications to separation processes. It is the second course in chemical engineering thermodynamics and leads to the study of separations and reacting systems. It requires the completion of CH E 220 with a minimum grade of C.

CH E 330 Process Fluid Mechanics (3)

This course introduces the principles of fluid mechanics and its application to the design and analysis of fluid flow devices such as pumps and pipes. A minimum grade of C is required.

CH E 340 Introduction to Biomolecular Engineering (3)

The course provides an introduction to concepts and principles of biomolecular engineering, with emphasis on biotechnology and pharmaceutical industries. A minimum grade of C is required.

CH E 350 Process Heat Transfer (3)

The course covers the theory of heat transfer mechanisms in solids and fluids and with applications to the analysis and design of heat transfer equipment. A minimum grade of C is required.

CH E 360 Mathematical Modeling in Chemical Engineering (3)

This course covers the applied mathematical techniques necessary for the simulation of physical and chemical processes such as mass transfer and reacting systems, and the analysis of process dynamics.

Note: CH E 360 may be replaced by a 400-elective CH E course or by a course from the list of approved engineering electives (see Note later in this section).

CH E 410 Mass Transfer Operations (3)

The objective of this course is to present the principles of mass transfer and their application to separation and purification processes. The course integrates transport phenomena dynamics (CH E 330/350) and thermodynamics (CH E 320) in developing rate expressions for mass transfer in multiphase, multicomponent systems. A minimum grade of C is required.

CH E 430 Chemical Reaction Engineering (3)

This course teaches the principles of reaction engineering and reactor design. It is one of the core subjects in the chemical engineering curriculum and it is normally scheduled in the senior year. You

will learn how to apply stoichiometry in combination with a rate law to design a chemical reactor that produces the desired conversion of reactants. A minimum grade of C is required.

CH E 470 Design of Chemical Plants (3)

This course teaches the design and economic evaluation of chemical plants. It is the capstone design course in the curriculum and builds on nearly every previous course in the curriculum. Teamwork and communication skills (oral/written) are important elements of the course.

CH E 480W Chemical Engineering Laboratory (3)

This lab-based course provides hands-on experience with bench-top and pilot scale equipment on a variety of experiments that cover fluid flow, heat transfer, reactions and separations. It builds on material covered in the 300-level courses of the curriculum. Honors version 480M - available fall only. No exceptions. Plan honors courses accordingly.

CH E 480W is offered twice a year, both in the fall and in the spring. Enrollment is limited to 70 students per semester based on the experimental stations available. Highest priority is given to those students who will be graduating at the end of the semester. The remaining available spaces are offered to other students on a first-come-first serve basis.

Frequency of CH E Course Offerings

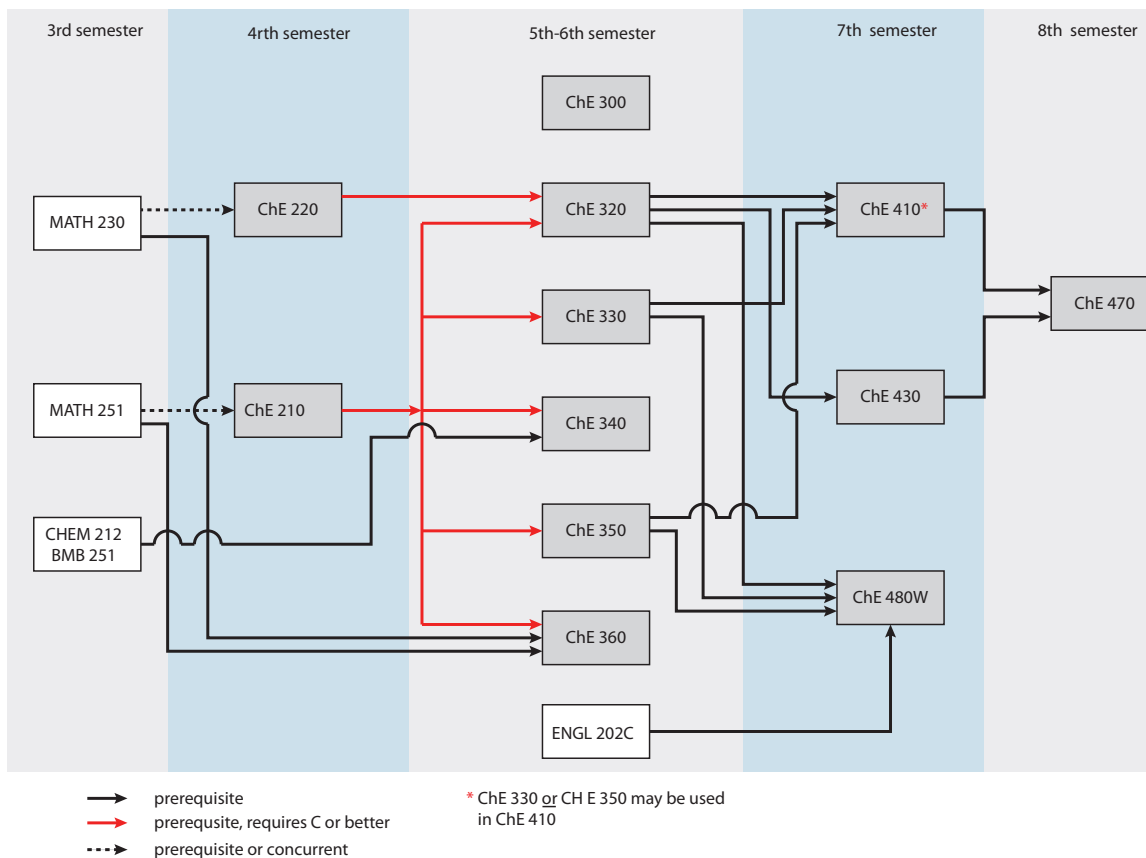
Currently, all required chemical engineering courses with the exception of CH E 300 are offered both in the fall and spring each year.

In order to continue successfully in the chemical engineering program you must pass CH E 210 and 220 with a grade of C or better. If you receive a lower grade in these two courses you will not be able to take any CH E classes until you repeat 210 and 220 successfully.

The chemical engineering department will make every effort to follow this schedule and expand its course offerings, however, the actual schedule is subject to the availability of instructors and resources that can vary from year to year. Please check with the department for the available offerings each semester.

Prerequisite Chain for CH E courses

The chemical engineering department has revised the current list of prerequisites according to the map below.



Notes

- The CH E courses normally start in the spring of the second year with CH E 210 and 220. The sequence takes 5 semesters to complete.
- CH E 210 and 220 must be completed with a minimum grade of C before taking subsequent courses that have 210/220 as prerequisites. CH E 210 in particular is a prerequisite for all 300-level courses except CH E 300.
- Math 230 and 251 cover material that is used in several chemical engineering courses. Math 230 is prerequisite/concurrent for CH E 220, and Math 251 is prerequisite/concurrent for CH E 210. **Do not take both MATH 230 and MATH 251 concurrently with CH E 210 and CH E 220.** The two CH E courses are very demanding and adding 8 credits of concurrent requirements in the same semester is going to make your schedule very challenging. If at all possible, complete both MATH courses before the fourth semester. If this is not possible, complete at least one of the two (preferably MATH 251) **before** you take CH E 210/220. If you do not heed this advice, you will be placing yourself at a disadvantage that could cause to fall behind by one year.

Information for Students at Campus Colleges

In order to be able to graduate in four years you must plan your academic courses carefully. The most important consideration is that you must transfer to University Park for your fourth semester. As you can see from the prerequisite chain, the chemical engineering sequence starts in the fourth semester (spring)

and takes five semesters to complete. You may choose to stay at your campus until the end of the second year and transfer to University Park in the Fall of the junior year. Although it is possible to catch up with the curriculum, chances are you will fall behind and will need an extra semester to graduate.

You should plan to finish MATH 230 and 251 before you take CHE 210 and 220. For most students this means taking the two MATH courses in the fall semester of the sophomore year. If your campus does not offer both courses, take the one that is offered, then take the other one in the spring along with CH E 210 and 220.

Upon transferring to University Park in the Spring your schedule should include CH E 210, CH E 220. Go easy on the credits during your first semester at University Park by keeping the total number between 15 and 17 credits. Doing so will not only give you the time you to do well in CH E 210 and CHE 220 but will also help you adjust to the transition to your new campus.

If you have questions about your academic plan or about your transfer to University Park, please contact the department of Chemical Engineering.

Tips for Freshmen & Sophomores

The MATH courses are especially important prerequisites in Chemical Engineering. You should plan to finish all MATH requirements by the fourth semester. If you fall behind in MATH, use the summer semester to catch up otherwise you may delay graduation by a year.

The Chemical Engineering program begins with CH E 210 and CH E 220, both offered in the spring. You should plan to take these classes in your fourth semester. These two courses must be completed with a grade of C or better and are prerequisites for other classes that follow. If a student has to repeat any of these two courses, he or she would most likely need to stay an extra year in order to graduate in Chemical Engineering. This is true even if the grade in the course is a D because with such grade the student will not be allowed to take subsequent courses that have CH E 210 or 220 as a prerequisite until a grade of C or better is received. Consider taking a lighter load in your fourth semester to ensure you have the time to concentrate in CH E 210 and 220.

The CH E course sequence is the backbone of your course schedule and guarantees graduation in five semesters beginning with the Spring semester in which you take CH E 210 and CH E 220. You should follow this schedule as closely as possible to avoid delays in graduation. If you need to make any changes to your CH E courses, you should talk to your adviser to make sure that you do not jeopardize your graduation.

Pay attention to prerequisites! It is your responsibility to ensure that you satisfy the prerequisites for the classes you register. The Chemical Engineering Department takes prerequisites seriously and you will receive a note to withdraw from a course if you do not have the proper prerequisites.

Options

General Option (GEN)

The General Option provides the maximum flexibility through its various technical electives in science and engineering. The specialized options, discussed in more detail later, can be viewed as variations of the General Option in which most or all electives are restricted to the specific area of focus. The General Option provides the broad background needed to succeed in the diverse technical fields that employ chemical engineers. The option shares 116 credits with the other three options and requires an additional 18 credits of electives, designated as follows:

6 credits in 400-level CH E electives (for a list of courses see page 28)

6 credits in engineering electives (for a list of courses see page 51)

6 credits in professional electives (see page 29)

The pool of available courses is fairly extensive and offers considerable flexibility in pursuing your individual interests. For many students this is the most suitable option.

Chemical Engineering Electives

The 6 credits of chemical engineering electives must be in 400-level chemical engineering courses (CH E 4xx) or in courses cross-listed in chemical engineering. The current list of electives includes the following:

CH E 423	Chemical Energy Technology (3)
CH E 432/F SC 432	Petroleum Processing (3)
CH E 438	Bioprocess Engineering (3)
CH E 442 (MATSE 448)	Polymer Processing Technology (3)
CH E 443	Introduction to Polymer Science (3)
CH E 446	Transport Phenomena (3)
CH E 448	Advanced Mass Transfer Operations (3)
CH E 449	Bioseparations (3)
CH E 450	Process Dynamics and Control (3)
CH E 452	Chemical Process Safety (3)
CH E 494	Up to 3 credits of undergraduate research in chemical engineering can be used towards the ChE 4xx requirement.
CH E 497	This number is reserved for specialty courses that do not have a permanent listing in the Blue Book. Such courses, whenever offered, will satisfy the ChE 4xx requirement.

- F SC 432 and MATSE 448 are cross listed in chemical engineering. These are the only courses outside CH E that will satisfy the CH E 4xx requirement.
- Up to 3 credits of CH E 294/494 can be used as a CH E 4xx elective. An additional 3 credits can be used as professional elective. A maximum of 6 credits of CH E 294/494 can be used to satisfy graduation requirements in CH E. The same rules apply to honors research (CH E 294H/494H).
- The frequency of offering varies depending on instructor availability and student interest. Typically, at least two different electives are offered each semester. You should check with the main office regarding the availability of electives each semester. These classes are normally taken in the senior year.

Engineering Electives

The 6 credits of Engineering electives may be chosen from several courses that cover engineering topics, including. Typically these are engineering subjects whose technical content is reflected in appropriate prerequisites in Math, Physics or Chemistry. A list of approved courses can be found at the end of this handbook. Courses in the approved list may require prerequisites beyond what is normally required in chemical engineering. It is your responsibility to ensure that you have the proper background to take such courses. Discuss with the course instructor whether a course is appropriate for your background.

Professional Electives

As a general rule, professional electives are any 200 level or higher course that you believe will enhance your career opportunities. Examples of courses that have been taken include various engineering courses (e.g., Mechanical Engineering, Civil Engineering, Electrical Engineering), Chemistry courses, Materials Science courses, language courses (Spanish, Japanese), business courses (e.g., accounting, finance, entrepreneurship), and many others. You may also use courses from the CH E elective category and from the Engineering Elective category (though you will not be able to double-count them in two categories simultaneously). Thus, Professional Electives can be chosen from a very broad selection, as you see fit to

develop your career. This is an excellent place to use course required in Minors, especially if the Minors are non technical (the Engineering Leadership Minor).

Courses with the designation GA/GH/GS cannot be used as professional electives. Exceptions may be made by petition for GA/GH/GS courses that are part of a Minor the student is pursuing, or for intermediate/advanced ECON courses as indicated by suitable prerequisites.

Using Courses from Minors as Engineering or Professional Electives

If you pursue a Minor, it may be possible to use courses that are required in the Minor to satisfy the Professional and/or the Engineering electives in the General Option. In general, any course required in a Minor can be used as a Professional elective. If the Minor involves technical courses, these may be used as Engineering electives. If a technical course in the Minor is not listed in the approved list on page 51, you may still petition it provided that the content is engineering as reflected in the course description and the course prerequisites. With planning, you will be able to count up to 12 credits in a Minor towards the elective requirements in the General Option. Discuss potential Minors with your adviser to confirm which courses of the Minor can be used in chemical engineering.



About Professional Electives

The Professional Elective Category is meant to give you an opportunity to take courses that will enhance your resume but do not fit elsewhere in the curriculum. Use them wisely to learn new skills or to get a Minor.

Recommended Schedule for the General Option

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Total Number of Credits = 134

Note: The schedule for semesters 1–4 is the same for all Options.

[‡]We strongly recommend that students complete MATH 230 and MATH 251 before taking CH E 210 and 220. If your campus does not offer both courses in the fall, take the one that is offered in the fall, then the other one in the spring along with CH E 210 and CH E 220.

Bioprocess & Biomolecular Engineering Option (BPBME)

Recent advances in the life sciences – the sequencing of the human genome, the development of transgenic animals and plants, the use of recombinant DNA technology, and the unraveling of the molecular basis of disease – have opened up exciting new opportunities for Chemical Engineers. By combining these advances in molecular biology with the unique capabilities of chemical engineering, Chemical Engineers are making novel contributions to the production of new medicines and biofuels, the development of artificial organs, the production of chemicals while generating less wastes via biorefineries, the detection of biological and chemical toxins, and to our quantitative understanding of complex biological processes and systems.

In order to effectively contribute to this diverse field, students in the Bioprocess and Biomolecular Engineering Option need to develop a strong foundation in molecular and cell biology, biochemistry, biomolecular engineering, and the biophysical processes required to purify biological molecules. This is accomplished through a combination of core science and engineering courses, along with a set of electives that give students an opportunity to pursue specialized areas of particular interest. The impact of biological advances on human health, agriculture, industry, and the environment will increasingly depend upon the skills of chemical engineers who have a strong understanding of the life sciences. Employment opportunities for students in the Bioprocess and Biomolecular Engineering Option are thus expected to be very good. There are currently over 1200 smaller biotechnology companies in the U.S., in addition to a number of very large pharmaceutical companies. And many traditional chemical companies are now developing significant "life sciences" programs. The American Institute of Chemical Engineers (AIChE) estimates that 15-20% of all chemical engineering graduates are currently employed in biotechnology related industries. In order to fulfill the Bioprocess and Biomolecular Engineering Option a student must take 18 credits from the list below. These credits replace the requirements for chemical engineering (6 cr), other engineering (6 cr) and professional (6 cr) electives of the general option.

Prescribed Courses (9 credits)

BMB 401	General Biochemistry (3)
CH E 438	Bioprocess Engineering (3)
CH E 449	Bioseparations (3)

Laboratory (3 credits)

B M B 442	Laboratory in Proteins, Nucleic Acids, and Molecular Cloning (3) (this course was previously B M B 342)
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Note: BIOTC 479 and BIOTC 489 are also acceptable; however, they have additional prerequisites and CH E students receive lower priority in enrolling.

BPBME Electives (6 credits)

B E 468	Microbiological Engineering (3) (Previously A B E 468)
BME 419	Artificial Organs and Prosthetic Devices (3)
BME 443 (MATSE 403)	Biomedical Materials (3)
BIOL 472	General Biochemistry (3)
B M B 252	Molecular and Cell Biology II (3)
B M B 4xx	Any 400-level course in B M B
CH E 501	Bioengineering Transport Phenomena (3)
MICRB 201	Introductory Microbiology (3)

Recommended Schedule for Bioprocess and Biomolecular Option

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Total Number of Credits = 134

Note: The schedule for semesters 1–4 is the same for all Options.

[‡]We strongly recommend that students complete MATH 230 and MATH 251 before taking CH E 210 and 220. If your campus does not offer both courses in the fall, take the one that is offered in the fall, then the other one in the spring along with CH E 210 and CH E 220.

Energy & Fuels Engineering Option (E&FE)

The aim of this degree Option in Energy and Fuels Engineering is to provide students with the technical skills needed to address national and global issues facing society arising from the complexities of assuring an abundant and efficient energy supply while responsibly preserving and managing the quality of the environment. The Option is designed to build on the solid core of Chemical Engineering training with specialized courses in fuel and energy science and technology. Because of building on the "core" Chemical Engineering curriculum, graduates of this Option are fully qualified chemical engineers. However, graduates of the Energy and Fuels Engineering Option will have specialized expertise and training in the areas of: (i) the chemical processing issues associated with energy production and use; (ii) the chemical processes of fuel refining, conversion, and utilization, including those which may lead to potential emissions of undesirable by-products; (iii) the choice of equipment and processes for efficient utilization of fuels, as well as conversion, refining, and upgrading of fuels to maximize efficient conversion or energy release and to minimize the impact of fuel utilization on the quality of the environment; and (iv) the design of equipment used for fuel processing, energy release from fuels, and for controlling undesirable emissions associated with fuel utilization. The 18 credits of specialty courses are to be chosen from the lists below:

Prescribed Courses (3 credits)

EGEE 411 Fuel Science Laboratory (3) (old number F SC 410)

Supporting Courses (choose 3 credits from list)

F SC 401 Introduction to Fuel Technology (3)
I H S 400 Principles of Industrial Health and Safety (3)
ENVSE 400 Safety Engineering (3)

Electives (choose 12 credits from list)

ChE 452 Process Safety
EGEE 430 Introduction to Combustion (3) (old number F SC 416)
F SC 431 The Chemistry Of Fuels (3)
F SC 432 Petroleum Processing (3)
F SC/CH E435 Industrial Organic Chemistry (3)
EGEE 420 Fuel Cells (3) (Previously EGEE 410)
P N G 410 Applied Reservoir Engineering (3)
P N G 480 Production Process Engineering (3)
ENVSE 420 Fire Protection (3)
ENVSE 445 Industrial Hygiene and Toxicology (3)
ENVSE 457 Industrial Hygiene Measurements (4)
ENVSE 450 Environmental Health and Safety (3)
ENVSE 470 Analytical Methods for System Safety (3)
GEOEE 427 Pollution Control in the Process Industries (3)

If you want to explore other possibilities in this option or need more information and advice on the most appropriate schedule for you, please contact Dr. Semih Eser (sxe2@psu.edu) in the department of Energy and Mineral Engineering.

Recommended Schedule for Energy and Fuels Option

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Polymer Engineering Option (PLMRE)

The polymer industry in the United States is extraordinarily broad, ranging from the giants of the chemical industry, traditional plastics manufacturers, the rubber, paint and coatings industry, fiber producers, all the way down to small companies that focus on extruding and molding plastic items. These industries have a need for chemical engineers with a broad knowledge of polymer materials and this Option is designed to provide the education and skills required in this area.

The Option builds on the solid core of basic chemical engineering training offered in the Department with specialized courses in polymer science and engineering. Because the Option is built on this core curriculum, graduates are fully qualified chemical engineers, but they will also have specialized expertise and training in the area of

- polymer chemistry; how polymers are synthesized and produced;
- the structure of polymers and the relationship to properties;
- the mechanical properties of polymers. This is, of course, the key to design-choosing a particular polymer for a given application;
- polymer rheology and processing. This is where the knowledge of the structure and properties of polymers are integrated with fundamental engineering principles.

The Polymer Engineering Option requires the same number of credits for graduation as does the general option in Chemical Engineering. The curriculum of the Option differs in that the 18 credits of electives must be selected as follows:

Required courses (9 credits)

MATSE 441	Polymeric Materials I (3)
MATSE 443	Introduction to the Materials Science of Polymers (3)
MATSE 446	Mechanical and Electrical Properties of Polymers and Composites (3)

Polymer Processing (6 credits)

MATSE 447	Rheology and Processing of Polymers (3)
MATSE 448 / CH E 441	Polymer Processing Technology (3)

Special topics (3 credits)

MATSE 444	Solid State Properties of Polymeric Materials (3)
MATSE 445	Thermodynamics, Microstructure and Characterization of Polymers (3)

Note: Students may petition to follow the Polymer Engineering Option of the *New Curriculum*:

REQUIRED COURSES (12 credits)

MATSE 202(3), MATSE 441(3), MATSE 446(3), MATSE 447(3)

ADDITIONAL COURSES

Select 6 credits from: CH E 443(3), MATSE 403/BME 443(3), MATSE 404/BME 444 (3), MATSE 445(3), M E 403(3)

Recommended Schedule for Polymer Engineering Option

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Research-Intensive Option

The chemical engineering program at Penn State has an active research program that covers a broad range of areas, from biotechnology and catalysis, to molecular simulations and nanomaterials, to novel polymers and fuel cells. While these resources are available to all undergraduate students, the Research-Intensive Option provides an organized way to become involved in cutting-edge research and prepare for an advanced post-graduate degree in chemical engineering. Chemical engineers with a PhD find employment in all major chemical industries, in National Research Labs, and in academia. Approximately 10% of our B.S. graduates directly enroll in a Ph.D. program upon completion of their undergraduate studies. This option is appropriate for students who are inquisitive about science and technology, want to work on open-ended problems in the broader area of chemical engineering, and who consider pursuing a graduate degree after graduation.

The 18 credits of the Research-Intensive Option must be scheduled as follows:

Thesis Research (6 cr)

CH E 494 or CH E 494H: Students must complete 6 credits of research in Chemical Engineering.

Advanced Transport Phenomena (3 cr)

CH E 446 Transport Phenomena (3) Fundamental treatment of mass, heat, and momentum transfer; emphasis on transport properties and mathematical models of chemical engineering transport processes; or

CH E 544 General Transport Phenomena (3) Formulation and solution of transport problems involving momentum, heat, and mass transfer, with chemical engineering applications.

Graduate level Chemical Engineering (3 cr)

Take 3 credits from any 500-level course in CH E

Technical Electives (6 cr)

Six credits of appropriate courses should be chosen in consultation with the academic and research advisers.

Recommended Schedule for Research–Intensive Option

SEMESTER 1	CR	SEMESTER 2	CR
CHEM 110 (Chemistry I)	3	CHEM 112 (Chemistry II)	3
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MATH 230 [‡] (Calc & Vectors)	4	CH E 220 (Thermo I)	3
MATH 251 [‡] (Differential Equations)	4	CHEM 212 (Organic II)	3
PHYS 212 (Electricity & Magnetism)	4	CHEM 213 (Organic Lab)	2
GA/GS/GA Elective 2	3	GA/GS/GA Elective 3	3
	18	Health & Physical Activity (GHA)	1.5
			15.5
SEMESTER 5	CR	SEMESTER 6	CR
CH E 320 (Thermo II)	3	CH E 300 (Professional Seminar)	1
CH E 330 (Fluids)	3	CH E 340 (Biomolecular Eng.)	3
ENGL 202C	3	CH E 350 (Heat)	3
B M B 251	3	CH E 360 (Math Modeling)	3
CAS 100A/B	3	CHEM 457 (P. Chem. Lab.)	2
GA/GH/GS Elective 4	3	CHEM 466 (P. Chem)	3
	18	CH E 494/494 [†]	3
			18
SEMESTER 7	CR	SEMESTER 8	CR
CH E 410 (Mass Transfer)	3	CH E 470 (Capstone Design)	3
CH E 430 (Reactors)	3	CH E 494/494H	2
CHE 480W (Chem. Eng. Lab)	3	Option Elective 1	3
CH E 494/494H	1	Option Elective 2	3
CH E 446 or 544	3	CH E 5xx Elective	3
GA/GH/GS Elective 5	3	GA/GH/GS Elective 6	3
	16	Health & Physical Activity (GHA)	1.5
			18.5

Total Number of Credits = 134

Note: The schedule for semesters 1–4 is the same for all Options.

[‡]We strongly recommend that students complete MATH 230 and MATH 251 before taking CH E 210 and 220. If your campus does not offer both courses in the fall, take the one that is offered in the fall, then the other one in the spring along with CH E 210 and CH E 220.

[†]The distribution of research credits per semester is only indicative. Consult with your research adviser to arrive at a distribution that is appropriate for you.

Academic Opportunities

Program For Schreyer Honors College Scholars

Although there is a general guideline for honors courses suggested below for University Scholars in the Department of Chemical Engineering, the reality is that virtually every scholars schedule will be unique based on advanced placement credit and personal interests. Assistance with the first year scheduling is provided in the Scholars FTCAP (Freshman Testing Counseling and Advising Program). Some additional comments for the freshmen year are provided below.

Program Requirements

The academic requirements of the honors program are listed at <http://www.shc.psu.edu/students/standing/>. Some of these requirements are summarized here:

- Take ENGL 137H or CAS 137H during your first semester at Penn State. This satisfies the prior ENGL20/30 requirement.
- Take ENGL 138T or CAS 138T in your second semester at Penn State. This satisfies the speech requirement (CAS 100 A/B).
- Complete 21 honor credits in your first two years at Penn State. It is preferable to complete 12 honor credits in your first year and 9 honor credits during your second year at Penn State.
- You must complete at least fourteen (14) honors credits during the junior/senior years. This includes 6 credits of honors thesis.

Thesis Selection

Identifying a thesis topic early – no later than the end of 1st semester Junior year – is highly encouraged. Consult the CH E Honors pages. You may also browse through the research topics of our faculty. The opportunity to start research early under CH E 294 (Research Project) may be available (and a big advantage). You must file academic plans annually with the scholars program and your adviser. (If you change your course work, you need to file an amended plan for the past year at the time of filing the next annual plan.)

Honors Advisers

You are assigned to an honors adviser your freshman year who you would normally keep as your adviser until you graduate. Changes between advisers can be requested if mutually agreed upon by the new adviser and student. The Honors advisers for Chemical Engineering students are:

Dr. Ali Borhan	borhan@psu.edu	122 Fenske Lab	865-7847
Dr. Wayne Curtis	waynecurtis@psu.edu	226B Fenske Lab	863-4805
Dr. Michael Janik	mjanik@engr.psu.edu	104 Fenske Lab	863-9366
Dr. Themis Matsoukas	matsoukas@psu.edu	150 Fenske Lab	863-2002
Dr. Darrell Velegol	velegol@psu.edu	108 Fenske Lab	865-8739
Dr. Andrew Zydney	zydney@engr.psu.edu	158 Fenske Lab	865-2574
Dr. Enrique Gomez	edgomez@engr.psu.edu	106 Fenske Lab	867-3428

Research Opportunities In Chemical Engineering

Research has much to offer students, especially if they plan to enter graduate school. Research is also required for University Scholars. The student chooses from available projects and is then assigned a member of the faculty with whom he/she consults at least weekly. The problem may be either modeling-based or experimentally-oriented.

To get started with undergrad research, one route is to examine the web pages of the faculty. Find one or more advisors or projects that interest you. Contact the faculty member by email, set up a brief appointment to discuss whether he or she has undergraduate research openings, and then let the discussion guide the next steps.

Because of the nature of the course, it is advisable to spread the work over a span of at least two semesters. Some advisors, for instance, require at least 2 semesters of work, with 3 credits each. Typically, a 3 credit research course requires at least 10 hours per week. A semester progress report is required at the end of the semester the student is taking the course, and a final report is required at the completion of the course. A formal thesis is required of University Scholars.

Up to three credits of research (CH E 294, 494) may be used towards the requirement for a CH E elective in the general option. Only research credits in Chemical Engineering may be used for this purpose. For students in options other than general, up to 3 research credits may be petitioned provided that the work is in an area appropriate for the option. Research credits are awarded under the numbers CH E 294, 296, 494 or 496, as explained below:

- CH E 294 - Research project.
- CH E 494 - Research projects in chemical engineering.
- CH E 296/496 - Independent studies.
- CH E 497 - Special topics.

Use 294/296 in semesters 2-4, and 496/497 in the 5th semester and higher.

Any of these courses may be taken but must be approved in writing by the sponsoring faculty member. Research project courses (294, 494) are limited to students with an overall GPA of at least a 3.0. Students below a 3.0 average may petition the department for permission to take research. These courses in total may only replace 3 credits of the 6-credit chemical engineering elective requirement. Additional credits may be used in the Other Course requirement or as extra courses above the graduation requirement.

A form must be completed and submitted to the Chemical Engineering Office, 158 Fenske, at the time of advanced registration. Otherwise the student will be dropped from the course during the first week of the semester or summer session.

ROTC Program

Students who complete the ROTC Program may use 3 credits of ROTC courses to substitute for the GHA requirement and 3 credits towards the professional electives. If a student drops from or is removed from the ROTC program, he/she may not normally use ROTC credits for any substitution. The use of ROTC credits as professional electives is possible only within the General Option, since all other options provide restricted pools for these electives.

Minors of Interest to CH E Students

A Minor requires 18 credits or more of course work in the chosen field. These credits may also be used to satisfy requirements of the Major, thus, depending how related the Major and Minor fields are, fewer than 18 additional credits may be needed to obtain some Minors. For students in the general option, some of the

professional, engineering, and in some cases CH E electives could count towards both the Major and the Minor. Such double-counting is not automatic or guaranteed. You should discuss this with your adviser to find out the best course of action.

Students interested in a Minor should contact the Department that administers that Minor. The information listed below refers to some Minors that have been of interest to chemical engineering students in recent years. However, many more minors are available at the University and you are encouraged to explore them based on your personal interests.

Environmental Engineering Minor (ENV E)

This minor is designed to provide students in engineering, science, and other majors with a comprehensive study of environmental issues and the skills necessary to solve problems associated with environmental pollution. Students interested in pursuing this minor should contact the Civil and Environmental Engineering Department (212 Sackett) or visit http://www.engr.psu.edu/ce/env_minor.html.

Bioengineering Minor (BIOE)

This interdisciplinary minor is designed for students interested in the application of engineering principles to medical and biological problems. Students interested in pursuing this minor should contact the Bioengineering Program Office - (233 Hallowell Bldg.). See also the following web link: <http://www.bioe.psu.edu/students/minor.html>.

Chemistry Minor (CHEM)

A minor in chemistry requires a minimum of 27 credits. Since chemical engineering students are required to take several of these chemistries as part of their degree requirements, the actual number of credits is smaller. For information see the following web link: <http://bulletins.psu.edu/undergrad/programs/minors/C/CHEMMI>.

Polymer Science Minor (PLMSC)

The goal of the polymer science minor is to produce graduates who have a first-hand knowledge of the relationships between the synthesis, structure, properties and processing of polymer materials. Students are required to take MATSE 443 (3 credits), which provides a broad overview of the subject, then select 15 credits chosen from a suite of courses that deal with polymer synthesis, microstructure and morphology, properties and processing. Students in the Polymer Engineering Option in CH E may find this Minor of interest. For additional information see the web link at: <http://bulletins.psu.edu/undergrad/campuses/details/24/PLMSCMIN>.

Engineering Leadership Development Minor (ELD)

The Engineering Leadership Development Minor was designed to enhance a technical education by supplementing it with the non-technical skills that will give students the edge to succeed in today's fast paced global environment. The program, which is open to all Penn State students, has many foci not usually found in undergraduate curricula including entrepreneurship, innovation, creativity, and leadership styles and development. Classes also explore public policy, ethics, and a host of business issues in the finance, marketing and investment areas. For more information see the web link at: <http://www.eldm.psu.edu/>.

Engineering Entrepreneurship Minor (ESHIP)

This interdisciplinary minor supports technology entrepreneurship development for all students, especially those majoring in engineering, business, and IST (Information Sciences and Technology). All segments of the U.S. and world economy are integrated with technology. The Engineering Entrepreneurship Minor addresses this new reality. Courses in the minor use problem-based learning, including business case studies and new product concept prototyping. Core courses include business plan presentations and competitions and open-ended design problems. For more information see the link at: <http://www.sedtapp.psu.edu/entrepreneurship/index.php>.

Other Minors

Many more minors are offered by various programs at Penn State. For more information go to the on-line Blue Book (<http://www.psu.edu/bulletins/bluebook/>), choose a College from the navigation bar at the top of the web page and follow the link that lists the Majors & Minors offered by the College.



About Minors

The requirements for the various Minors are under the control of the department that offers the Minor. Please meet with an adviser in the program of interest to obtain more information.

Professional Planning

Graduate School

If you maintain a high grade point average (typically 3.40 or better, although sometimes high and sometimes a bit lower), it is never too early to consider the possibility of attending graduate school after completing your bachelor's degree. Although this may seem to be a long way off at the moment, you should nevertheless leave the door open for choosing this path to additional education. An M.S. or Ph.D. in chemical engineering is a valuable degree and much sought after by industry and academia. What's more, at the present time almost any good student can get free tuition and a stipend in the range of \$20,000-\$30,000 per year for attending graduate school. The benefits of receiving an advanced degree are that you will command a higher salary than you can expect with a B.S. and, more importantly, it will greatly broaden your options in choosing a career path. There are many jobs that are only available to individuals with a Ph.D. degree, particularly those in research and development as well as almost all faculty positions.

If you are at all interested in attending graduate school, even if you should decide to work for a few years first, it will help you immensely if you arrange your undergraduate curriculum to prepare yourself academically for graduate work. In your Chemical Engineering elective courses, you should try to schedule some of the courses listed below. Additionally, you should take as many of the Chemical Engineering Electives as you can fit into your schedule and also consider taking additional math or science courses for your professional electives. Finally, since research is the backbone of most graduate work in chemical engineering, you should try to get a taste of this kind of experience by scheduling CH E 494 (Research Projects) or by doing research over the summer either here at Penn State or at another university through an NSF Research Experiences for Undergraduates (REU) Program. Most REU programs take students as early as the summer after their sophomore year, a time when it is often a challenge to find good summer intern positions.

If you have any questions regarding graduate work or related matters, please see your adviser who will be more than happy to discuss these opportunities with you.

Recommended Courses

The following courses, offered periodically as senior electives, are recommended if you plan to go to graduate school.

CH E 446 - Introduction to Transport Phenomena

CH E 494 - Research Projects in Chemical Engineering

Discuss with your adviser whether it might be appropriate for you to take a graduate course while at Penn State.



Note

The *Research-Intensive Option* in chemical engineering is an excellent way to incorporate undergraduate research in your schedule and prepare for graduate school. Talk to your adviser to find out more

Co-Op & Internships In Chemical Engineering

The College of Engineering offers credit-bearing cooperative education (co-op) opportunities, which may provide up to one full year of industry work experience for undergraduate students who wish to participate. Typically, students begin co-op rotations in their junior year, with two consecutive semesters of work assignments (spring-summer or summer-fall) followed by another summer assignment the following year. This co-op rotation schedule generally requires students to postpone graduation for an additional semester in order to finish degree requirements (4 ½ years vs. 4 years with no co-op).

The benefits of obtaining work experience prior to graduation are many and obvious:

- Challenging jobs related to the subject matter covered in the Chemical Engineering curriculum make coursework significantly more meaningful.
- Students get a firsthand look at the professional world and an opportunity to build professional networks, both of which can help them plan their futures. Finding out what you DON'T want to do is as important as finding your dream job.
- Students may earn one credit for each semester of co-op work, which can be used as a Professional Engineering elective credit (6 credits of Professional Elective are required).
- Many employers that hire our graduates for full-time positions expect previous co-op or summer internship experience. Students with experience have an edge over those without.
- Students can earn a substantial salary while working at a co-op, depending on the company and the length of service.
- Co-op students frequently receive full-time employment offers from their co-op employers, along with higher starting salaries than those offered to students without experience.

In order to be eligible for the co-op program, students must have a 2.0 GPA and have completed entrance-to-major requirements. Each student is responsible for securing a co-op position, but there are numerous offices on campus that can help students identify job opportunities, including Engineering Career Resources & Employer Relations, university-wide Career Services, and the ChE Department. Career fairs held in both the fall and spring semesters also provide students with opportunities to speak to hundreds of employers about job prospects.

Once students have secured their co-op positions, they work with their employers to develop plans to incorporate their co-op assignments into their academic schedules. Students are in no way obligated to accept jobs they find unsatisfactory, and may continue in the regular curriculum without any penalty. Students who do accept co-op employment, however, should plan to complete all work terms as pre-arranged with their employers. Co-op students may elect to register for one credit hour during each of their three co-op assignments (ENGR 295, 395, 495). These credits can be counted towards the Professional Elective requirement.

A word of caution: At this time, some required ChE courses are only taught once per year. Each class has its own set of prerequisites, so scheduling may be difficult. It is your responsibility to arrange the remaining classes around the ChE classes. Prerequisites will not be waived because of co-op conflicts. If there is any doubt about your remaining schedule, please meet with the department's Co-op Adviser (currently, Professor McFadden, dmcfadden@engr.psu.edu).

An *internship* is a short-term work experience at a company or organization, typically lasting one semester. Internships are usually completed during the summer and rarely interfere with coursework or lengthen the time required to graduate. Some students choose to do several internships during their time at Penn State, gaining work experience with different employers. Many companies regard internships as acceptable work experiences. The benefits of internships and the process to secure such opportunities are nearly identical to those noted above for seeking co-op experiences. Students may earn one credit for each semester of internship work, which can be used as a Professional Engineering elective credit (6 credits of Professional Elective are required).

Engineering Coop Office: <http://www.engr.psu.edu/career/>

Full - Time Employment After Graduation

Your most important campus resources for your entry-level full-time job search are Engineering Career Resources & Employer Relations (<http://www.engr.psu.edu/career>) and university-wide Career Services (<http://www.studentaffairs.psu.edu/career>). A wide variety of career events and on-campus interviewing opportunities are managed by these offices. In addition, these offices coordinate professional development workshops throughout the academic year, covering a range of topics including résumé writing, interview skills, networking, job search techniques, and job search correspondence.

Both Engineering Career Resources & Employer Relations and university-wide Career Services manage online job search systems that are available to all engineering students. While the eCareer job search system (<http://www.engr.psu.edu/Career/Students/resources/ecareer.aspx>) primarily provides opportunities to students seeking co-op or internship experiences, many employers also post full-time opportunities there. Nittany Lion Career Network (<http://studentaffairs.psu.edu/career/students/NLCN.shtml>) is the primary resource for graduating students seeking full-time job opportunities. On-campus interviewing is also coordinated through this system. Students are strongly encouraged to use both systems in order to maximize their job application options.

Many recruiting events have also been developed through these offices in order to provide students with in-person employer engagement opportunities. The largest of these are Fall Career Days (<http://careers.fairs.psu.edu/fall>) and Engineering Career Week (<http://www.engr.psu.edu/career/ecw>). All students who are seeking entry-level full-time positions should plan to attend, as many employers conduct job interviews as part of these events. A variety of niche events (e.g., for particular majors or class levels) occur throughout the academic year; details of these events are communicated directly to the students in question by the relevant career offices.

Graduating students who are preparing for a full-time job search should review the resources provided on the Engineering Career Resources & Employer Relations website (<http://www.engr.psu.edu/career/Students/Default.aspx>) in order to learn about the expectations of employers throughout the job search process, including how to write résumés and other forms of job correspondence, how to prepare for on-campus interviewing, how to prepare for on-site interviews, and etiquette for offer acceptance or rejection.

Assistance From The Chemical Engineering Department

The Department is willing to help seniors find employment in the following ways:

- **Aid in correspondence** If you wish, your adviser will review and critique your correspondence relating to your effort in seeking employment.
- **Surveys** Each spring we survey, sometimes several times, the employment situation of our graduating seniors. Your response to these surveys aids the Department in assessing the current job situation.
- **Advising** Finding a suitable job requires careful consideration of a person's assets, liabilities, etc. Often, talking to another person, such as another engineer or faculty member, can crystallize these matters. Feel free to contact any faculty member directly.
- **Letters of recommendation** Advisors often know students well, say from undergrad research or sometimes from a course. When employers ask for letters of reference, advisors will usually be willing to write these. Please email the advisor 1) a scan of a permission sheet (http://www.registrar.psu.edu/student_forms/request_for_recommendation.pdf), 2) a current resume or CV (with a photo if possible), 3) the name and title of the recipient(s), 4) the recipient's email and mailing address, 5) the due date(s) for the letter. Please fill out any forms required as well. Some advisors will ask for additional information when writing letters. NOTE: It is recommended that you seek out advisors who can mentor you through

your undergraduate program, and who know you and your work well enough to write a clear letter. It is never too early to cultivate good mentors, even in your first or second year at Penn State.

Student Societies

AIChE Student Chapter

Penn State's student chapter of the American Institute of Chemical Engineers (AIChE) is one of the most active professional organizations on campus. There are activities almost every week of the school year which are both social and professional in nature.

Chemical Engineering Identity/Interaction

Because Penn State is so large, it is easy to be left wondering 'Who are my classmates and faculty?' The AIChE student chapter tries to reach chemical engineering students at an early stage through sophomore and junior class representatives to get students involved in Department oriented activities. Announcements of activities are made as early as courses such as Chemistry 12. There are also outreach efforts to students at branch campuses.

There is a wide range of social activities to enhance student-to-student and student-to-faculty interaction. A student / faculty mixer is organized each year to provide feedback to the faculty on Department concerns. Picnics are organized each year on the 'Fenske lawn' to provide an informal setting for faculty and student interaction. Tailgates are held at every home football game which provides the opportunity to meet other students and network with alumni who return for the games.

The AIChE Lounge was put together with funds collected from industry by the Student Chapter. This includes computers, and printers as well as large tables to interact with other students and work on group projects.

Career Development/Job Placement Assistance:

Students are often faced with the question of 'What does a chemical engineer do?' This question is particularly relevant (and difficult to answer) for underclassmen who are trying to decide on a career choice, and are not yet taking Chemical Engineering Courses. Even for upperclassmen, the course work focuses on the development of knowledge and skills but not on an understanding of the engineering workplace. The AIChE Student Chapter plays an important role in the Department to fill this gap. In addition to simply providing information, AIChE takes a pro-active role in trying to provide means to assist in finding a job.

Company presentations are held frequently. These meetings provide the opportunity to meet recent graduates and learn what a chemical engineer does in the 'real world', and provide insight into the types of industry that Chemical Engineers work in. This information can be very helpful in helping you to decide about pursuing a minor degree and/or following a 'curriculum track' as described in this handbook.

Plant trips are arranged both locally and with companies throughout Pennsylvania to let you see the work environment.

The Student Chapter produces a resume book on CD which is sent to more than 100 potential employers including both permanent and summer positions. The resume book is generated early in the fall so that it can be used by recruiters throughout the school year. An updated resume book is usually generated later in the year. To find out more about the resume book, contact the "resume book coordinator".

Each year there is a Regional Student Paper Competition in which students conducting undergraduate research compete for monetary prizes and the opportunity to compete at the National AIChE meeting. Coordination of the students who will represent Penn State in the competition is done through the Student Chapter.

The student chapter also coordinates applications for AIChE National Membership. As a member of National AIChE, you will receive student oriented AIChE publications, and be able to participate in a group

Old Curriculum – For students who started at Penn State before Summer 2015

discount purchase of Perry's Handbook of Chemical Engineering. National membership for students is very cheap, so the sooner you join, the better.

AIChE Adviser: Dr. Wayne Curtis, E-mail: wrc2@psu.edu

AIChE Office: 116 Fenske.

Bulletin Board: Across from room the mailroom

Omega Chi Epsilon

Omega Chi Epsilon is an Honor Society for Chemical Engineering students. Membership is by invitation from the officers of the Chapter to outstanding undergraduate students, and is based on the academic achievement of those students.

Membership in Omega Chi Epsilon entails active participation in a variety of projects aimed at improving the academic performance of Chemical Engineering undergraduates and encouraging students to consider entering graduate schools.

One of the major functions the chapter has undertaken is to provide free tutoring service for lower level chemical engineering courses. The time and place of such tutoring service is posted each semester on the Omega Chi Epsilon bulletin board. All undergraduates in the Department are free to avail themselves of this valuable service.

Omega Chi Epsilon Adviser

Dr. Michael Janik, 104 Fenske Laboratory, Phone 863-9366, E-mail, mjanik@engr.psu.edu

C. ADDITIONAL MATERIAL

Approved Engineering Electives (General Option)

The course descriptions shown below are based on the Blue Book as of August 2012. Please refer to the Blue Book for current information.

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. Questions about prerequisites should be directed to the program that offers the course of interest.

Biological Engineering

- B E 302 TRANSPORT PROCESSES FOR BIOLOGICAL SYSTEMS (3)
- B E 304 ENGINEERING PROPERTIES OF FOOD AND BIOLOGICAL MATERIALS (3)
- B E 308 ENGINEERING ELEMENTS OF BIOCHEMISTRY AND MICROBIOLOGY (3)
- B E 465 FOOD AND BIOLOGICAL PROCESS ENGINEERING (3)
- B E 468 MICROBIOLOGICAL ENGINEERING (3)

Biomedical Engineering

- 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)

Civil Engineering

- C E 370 INTRODUCTION TO ENVIRONMENTAL ENGINEERING (3)
- C E 371 WATER AND WASTEWATER TREATMENT (3)

Computer Science

- CMPS 200 (GQ) PROGRAMMING FOR ENGINEERS WITH MATLAB (3)
- CMPS 201 (GQ) PROGRAMMING FOR ENGINEERS WITH C++ (3)
- CMPS 202 (GQ) PROGRAMMING FOR ENGINEERS WITH FORTRAN (3)

Engineering Mechanics

- E MCH 211 STATICS (3)

E MCH 212/212H DYNAMICS (3)

E MCH 212/212H DYNAMICS (3)

Engineering Science

E SC 312 ENGINEERING APPLICATIONS OF WAVE, PARTICLE, AND ENSEMBLE CONCEPTS (3)

E SC 313 INTRODUCTION TO PRINCIPLES, FABRICATION METHODS (3)
AND APPLICATIONS OF NANOTECHNOLOGY (3)

E SC 314 ENGINEERING APPLICATIONS OF MATERIALS (3)

Energy And Geo-Environmental Engineering

EGEE 302 PRINCIPLES OF ENERGY ENGINEERING (3)

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 FUNDAMENTALS OF RENEWABLE ENERGY (3)

EGEE 441 ELECTROCHEMICAL ENERGY CONVERSION (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)

Energy, Business & Finance

E B F 473 RISK MANAGEMENT IN ENERGY INDUSTRIES (3)

E B F 484 ENERGY ECONOMICS (3)

Environmental Systems Engineering (ENVSE)

ENVSE 400 ENVIRONMENTAL SYSTEMS ENGINEERING (3), formally IHS 400.

ENVSE 420 FIRE SAFETY ENGINEERING (3), formally IHS 420.

ENVSE 450 ENVIRONMENTAL HEALTH AND SAFETY (3), formally IHS 450.

ENVSE 457 INDUSTRIAL HYGIENE MEASUREMENTS (4), formally IHS 447.

ENVSE 470 SYSTEMS SAFETY AND RISK ENGINEERING (3), formally IHS 470.

Fuel Science

F SC 401 INTRODUCTION TO FUEL TECHNOLOGY (3)

F SC 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 (BIOE 443) BIOMEDICAL MATERIALS (3)

MATSE 404 (IL) (BIOE 444) SURFACES AND THE BIOLOGICAL RESPONSE TO MATERIALS (3)

MATSE 409 (NUC E) NUCLEAR MATERIALS (3)ALS 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)

MATSE445 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)

Mechanical Engineering/ Nuclear Engineering

M E 401 REFRIGERATION AND AIR CONDITIONING (3)

402 POWER PLANTS (3)

M E 403 POLYMER ELECTROLYTE FUEL CELL ENGINES (3)

M E 405 INDOOR AIR QUALITY ENGINEERING (3)

M E 406 (NUC E) INTRODUCTION TO STATISTICAL THERMODYNAMICS (3)

M E 433 FUNDAMENTALS OF AIR POLLUTION (3)

Petroleum And Natural Gas Engineering

P N G 405 ROCK AND FLUID PROPERTIES (3)

P N G 410 APPLIED RESERVOIR ENGINEERING (3)

P N G 480 PRODUCTION PROCESS ENGINEERING (3)

Statistics

STAT 401 EXPERIMENTAL METHODS (3)

Useful Links

HANDBOOKS

Chemical Engineering (this handbook). <http://assets.engr.psu.edu/CHE/docs/advising-handbooks/che-advising-handbook-old-2017-01-17.pdf>

College of Engineering Programs Guide. <http://www.engr.psu.edu/AdvisingCenter/programguide.aspx>

Schreyer Honors College. <http://www.shc.psu.edu/students/handbook.pdf>

Penn State Blue Book. <http://bulletins.psu.edu/bulletins/bluebook/>

Penn State University Bulletin, Undergrad Programs.
http://bulletins.psu.edu/bulletins/bluebook/college_campus_details.cfm?id=35

FORMS

Chemical Engineering (pre-req waiver, ChE 494 research, option selection).
<http://www.che.psu.edu/ugrad/forms.htm>

COE forms for students (including petitions). <https://coursesub.psu.edu/>

COE Extension to Qualify petition (for ETM). <http://www.engr.psu.edu/Forms/ExtensionToQualify.pdf>

Penn State University forms: http://www.registrar.psu.edu/student_forms/index.cfm

Schreyer Honors College. <http://www.shc.psu.edu/faculty/forms/index.cfm>

Letter of recommendation permission.
http://www.registrar.psu.edu/student_forms/request_for_recommendation.pdf

ADVISING

Penn State ChE undergrad homepage. <http://www.che.psu.edu/Ugrad/Handbook/index.html>

ChE undergrad handbook (checklist on back page).
http://www.che.psu.edu/Ugrad/Handbook/download/ugrad_hb.pdf

ChE courses being offered. <http://fenske.che.psu.edu/Ugrad/courses.htm>

ChE alumni mentoring program. <http://www.che.psu.edu/alumni/mentor/index.htm>

ChE FAQs. <http://www.che.psu.edu/Ugrad/current/faq.htm>

Registrar course search. <http://soc.our.psu.edu/soc/>

Timetable for registration.
http://www.registrar.psu.edu/Reg_Timetable/RegTimetable_Main.cfm

COE Advising Center. <http://www.engr.psu.edu/AdvisingCenter/>

Entrance to Major (ETM). http://www.engr.psu.edu/advisingcenter/StudentActions/sa_majentrance.aspx

E Lion. <https://elion.psu.edu/>

General Education requirements. http://bulletins.psu.edu/bulletins/bluebook/general_education.cfm

GA courses. http://bulletins.psu.edu/bulletins/bluebook/general_education.cfm?section=knowledge3

GH courses. http://bulletins.psu.edu/bulletins/bluebook/general_education.cfm?section=knowledge4

GS courses. http://bulletins.psu.edu/bulletins/bluebook/general_education.cfm?section=knowledge5

GHA (Healthy & Physical Activity).

http://bulletins.psu.edu/bulletins/bluebook/general_education.cfm?section=knowledge1

US and IL courses.

http://bulletins.psu.edu/bulletins/bluebook/general_education.cfm?section=requirements1

ChE undergrad options (video link available). <http://www.che.psu.edu/news/media.htm>

SHC website. <http://www.shc.psu.edu>

SHC contacts. <http://www.shc.psu.edu/contact.cfm>

Entrance to Major. http://www.engr.psu.edu/advisingcenter/StudentActions/sa_majentrance.aspx

General advising questions (College of Science, but includes ROTC, AP credits, etc.)

<http://www.science.psu.edu/advising/advisingissues/>

STUDENT SUPPORT

Student Support Services Program (financial, disabilities). <http://www.equity.psu.edu/sssp/>

CAPS (Counseling & Psychological Services). <http://www.sa.psu.edu/caps/message.shtml>.

ChE tutoring (OXE). <http://www.clubs.psu.edu/up/oxe/tutoring.html>

TRANSFER / WITHDRAWAL

requirements for transferring colleges/universities. <http://admissions.psu.edu/info/future/transfer/index.cfm>

transferring credit tool. http://admissions.psu.edu/my_admissions/tas/

course transfer list. https://www.admissions.psu.edu/my_admissions/tas/specificInstitution.cfm

ask questions about transfers. <http://admissions.psu.edu/academics/credit/transfer/>

withdrawal form. http://www.registrar.psu.edu/student_forms/withdrawal.pdf

OPPORTUNITIES

co-op/internship credits (ENGR 195/295/395/495).

<http://www.engr.psu.edu/career/students/search/short-term/for-credit/using-credits.aspx>

pre-med. <http://www.bioe.psu.edu/students/HealthProfessionsPrepforBIOE.pdf>, <http://www.bioe.psu.edu/students/curriculum.html>

World Campus (including summer courses). <http://www.worldcampus.psu.edu/>

scholarships. <http://www.engr.psu.edu/scholarships/>

International Engineering Certificate. <http://www.engr.psu.edu/departments/intlcertificate.aspx>

Integrated Undergraduate / Graduate (IUG) Study.

<http://www.che.psu.edu/Ugrad/Honors/IUG-cheguide.htm>

Engineering Career Resources & Employer Relations, <http://www.engr.psu.edu/career>

Penn State doctoral degrees requirements. http://bulletins.psu.edu/bulletins/whitebook/degree_requirements.cfm

STUDY ABROAD / GLOBAL ENGINEERING EDUCATION

General COE global education site. <http://www.engr.psu.edu/Global/>

Email link to student advisors about Study Abroad. international@engr.psu.edu

IAESTE (International Association for the Exchange of Students for Technical Experience)
<http://www.iaesteunitedstates.org/> (due early January, for Summer applicants)

Old Curriculum – For students who started at Penn State before Summer 2015

CH E CHECK SHEETS (ALL OPTIONS – OLD CURRICULUM)

NAME: _____

STUDENT ID: _____

PSU E-MAIL _____

Chemical Engineering (34 credits)	CR	Grade
CH E 210 (C) - Material Balances	3	
CH E 220 (C) - Thermodynamics I	3	
CH E 300 - Professional Seminar	1	
CH E 320 (C) - Thermodynamics II	3	
CH E 330 (C) - Fluids	3	
CH E 340 - Bioprocessing	3	
CH E 350 (C) - Heat Transfer	3	
CH E 360 (C) - Math Modeling	3	
CH E 410 (C) - Mass Transfer	3	
CH E 430 (C) - Reactor Design	3	
CH E 470 - Capstone Design	3	
CH E 480W - ChE Lab	3	

Physics (8 credits)	CR	Grade
PHYS 211 - Mechanics	4	
PHYS 212 - Electricity	4	

GEN Option (18 credits)	CR	Grade
CH E 4_____ - CH E Elective I	3	
CH E 4_____ - CH E Elective 2	3	
ENG Elective 1	3	
ENG Elective 2	3	
PROF Elective 1	3	
PROF Elective 2	3	

BPBME Option (18 credits)	CR	Grade
B M B 401	3	
CH E 438	3	
CH E 449	3	
Select 3 cr from list		
B M B 442 or BIOTC 479	3	
Select 6 cr from list		
BIOE 419	3	
BIOL 472	3	
B M B 252	3	
B M B 474	3	
CH E 501	3	
MICRB 201	3	
MATSE 403	3	

Chemical Sciences (24 credits)	CR	Grade
CHEM 110 - General Chemistry I	3	
CHEM 111 - Lab I	1	
CHEM 112 - General Chemistry II	3	
CHEM 113 - Lab II	1	
CHEM 210 - Organic I	3	
CHEM 212 - Organic II	3	
CHEM 213 - Organic Lab	2	
CHEM 466 - P-Chem	3	
CHEM 457- P-Chem Lab	2	
BMB/MICRB 251- Mol. Biology	3	

MATH (16 credits)	CR	Grade
MATH 140 - Calculus I	4	
MATH 141 - Calculus II	4	
MATH 230 - Multivariate Calculus	4	
MATH 251 - Differential Equations	4	

E&FE Option (18 credits)	CR	Grade
EGEE 411	3	
Select 3 cr from list		
F SC 401	3	
I H S 400	3	
Select 9 cr from list		
EGEE 430	3	
F SC 431	3	
F SC 432	3	
F SC/CH E 435	3	
EGEE 420	3	
P N G 410	3	
P N G 480	3	
ENVSE 420 (I H S 420)	3	
ENVSE 457 (I H S 447)	3	
ENVSE 450 (I H S 450)	3	
ENVSE 470 (I H S 470)	3	
GEOEE 427	3	

GENED (18 credits)	GA/G H GS	US/ IL	CR	Grade
ECON	GS	--	3	

Other Reuirements (16 credits)	CR	Grade
First Year Seminar	1	
ENGL 15/30 - Rhetoric	3	
CAS 100 A/B - Speech	3	
ENGL 202C - Technical Writin	3	
EDSGN 100 -Intro Design	3	
GHA	1	
GHA	1	
GHA	1	

PLMRE Option (18 credits)	CR	Grade
MATSE 441	3	
MATSE 443	3	
MATSE 446	3	
MATSE 447	3	
MATSE 448	3	
Select 3 cr		
MATSE 444	3	
MATSE 445	3	

Research Intensive Option (18 credits)	CR	Grade
CH E 494	6	
Select 3 cr from list		
CH E 466	3	
CH E 544	3	
Select 3 cr from CH E 5XX		
CH E 5_____	3	
Select 6 cr of appropriate electives		
Tech/Prof Elective 1 -		
Tech/Prof Elective 2 -		

rev: 2012.09.05