Department of Chemical and Biomolecular Engineering

Undergraduate Studies Handbook

2023-2024

Academic Year

CBE Department
Contact Information

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Contents

1 Advising Information

1.1 Introduction

This document provides a guide to the policies and procedures for undergraduate studies in the Department of Chemical and Biomolecular Engineering at the University of Notre Dame (herein after Department). It serves both to elaborate items such as contact information and advising roles, curricular requirements and options for majors, minors and concentrations, and to summarize certain information of frequent interest to students. It supplements two University of Notre Dame undergraduate policy documents: 1) the Undergraduate Academic Code and 2) the Bulletin of Information.

Nothing herein is to be interpreted as contrary to the regulations of the Undergraduate Affairs and Programs. Circumstances will arise that either have not been included or will require a decision on the part of the Department. The advisor is always the first person to contact if a question should arise. If a problem cannot be resolved, then the Director of Undergraduate Studies (DUS) or the Department Chair should be approached. Modifications to the department undergraduate program regulations are approved from time to time by the CBE Undergraduate Studies Committee and are made known by publishing a new version of the Undergraduate Studies Handbook.

1.2 CBE Web Page

The Undergraduate webpage is the best resource for:

- Standard major planning: degree requirements for CBE programs
- Courses satisfying minor and concentration requirements
- Links to Study Abroad

1.3 The Undergraduate Academic Program Administrator

Jennifer Pavlick can help if you need:

- Department updates
- CBE Undergraduate Opportunities email-sent Thurs/Fri
- Required Safety training (UG labs, Chem E car, UG research)
- CBE student calendar-add yourself by clicking link

1.4 The Academic Advisor

Prof. Leonor Wangensteen and Aaron Burdin can help if you have question about:

- Course major planning/4 year plan
- Consequences of dropping courses, particularly required courses
- Consequences of switching into/out of CBE major sophomore year or later
- University and College degree requirements
- Questions about official CBE requirements and policies
- Minors and concentrations
- Academic performance issues and questions

- eForm approvals
- GPS questions (Graduation progress System)
- Add and drop forms
- If you don't know ask your advisor

1.5 The Director of Undergraduate Studies

Prof. Troy Vogel is the best resource for specifics about the CBE majors:

- Planning for Study abroad
- Transfer, 3-2 students
- Specialized curricular 4-year planning
- eForm approvals
- Course substitutions
- Advice on transfer credit for courses taken at another institution
- What, if anything, can be double-counted for various types of requirements
- Return plan for leave of absence from University

1.6 The Associate Dean for Advising and Academic Affairs

Associate Dean Mike Ryan can help if you have:

- Issues related to academic probation or dismissal
- X grade approval
- Leaves of absence from University
- Course overload approval (19+ credit hours/semester)-eform approval
- P/F grading approval-eform

1.7 Faculty Advisors

They are the best resource for general, "big picture" discussions:

- All things related to 'professional' career path
- Graduate school mentoring
- Letters of recommendation
- Choosing minors and concentrations
- Research opportunities in CBE

1.8 Other Resources

Registrar's Office (transcripts, enrollment verification, registration information, university calendars)

Path Class Search and NOVO Browse Classes on InsideND are the best resources for:

- Course offerings and descriptions
- Course attributes, which indicate what requirements a course satisfies, e.g.

  WRIT – Writing Intensive core requirement, etc.

The Graduation Progress System (GPS) on InsideND:

- The GPS degree audit report is a guide when planning progress towards completion of degree. Your academic advisor may be contacted for assistance in interpreting the report.

The Maruelo Family Center for Career Development is the best resource for:

- Opportunities available at specific companies
- Mock interviews, Scheduling interviews, Resume preparation, and more
- Chris Washko serves as Assistant Director, Engineering Careers

University Health Services

UHS is passionate about providing you with prompt and exemplary medical care so you can focus on why you came to Notre Dame in the first place: to receive an experience you can't get anywhere else.

This site is not intended to replace a face-to-face interaction with one of our medical professionals, but to introduce you to all the resources that reside right here on Notre Dame's campus.

University Student Affairs

- **The Division of Student Affairs exists to serve you, the students of Notre Dame.**

We are a mission-driven team of over 275 professionals that aim to enrich the Notre Dame experience for all students in the Holy Cross tradition.

Through engagement with the Division's opportunities, services and resources, we encourage you to develop your full potential as individuals, community members and future leaders in our Church, society, and world.

We aspire to serve as trusted resources, helping connect you with information regarding residential life, your extracurricular interests, and discovering—and planning for—your future. Please don't be shy—come see us whenever you need help.

Office of Community Standards

The Office of Community Standards serves Notre Dame students by...

- educating the campus community on expectations for student conduct
- administering the University's student conduct process by providing a developmentally-based opportunity for students to
  - reflect on their behavior,
  - take responsibility for their actions, and
  - understand the value of the behavioral standards in place at the University

2 CBE Undergraduate Curriculum

2.1 Program Information

Program in Chemical and Biomolecular Engineering

The undergraduate program at Notre Dame is notable for its combination of a strong fundamental focus in chemical engineering courses with a broad humanities and science education provided in courses other than chemical engineering. The science and humanities courses prepare students both for the study of chemical engineering and to understand complex problems of today which need consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Our intention in emphasizing fundamentals is to develop students' intellect and equip them with enduring knowledge in chemical engineering and related fields. Thus, our undergraduate chemical engineering curriculum provides students with not only a preparation for a career as a chemical engineer, but for a lifetime of learning and a lifelong career in areas that may include law, medicine, or business.

2.2 Combining Chemical Engineering with other programs

Reilly Program 5-year EG/AL Dual Degree

The five-year dual degree program between the College of Arts and Letters and the College of Engineering enables the student to acquire degrees from both colleges. This combination program, instituted in 1952, offers students the advantages of both a liberal and a technical education. The student completing one of these combination programs has a background in the humanities and social sciences as well as a degree from one of the programs offered by the College of Engineering. Advisors for the program are available for consultation about the advisability of entering the program and about meeting the particular needs of each student pursuing this program. Qualified students are eligible to receive modest scholarship support from the John J. Reilly Endowed Scholarship program during their third, fourth, and fifth years of study. The decision to enter the program ideally should be made prior to beginning the sophomore year, although students can also enter the program at a later stage. See more info at https://reilly.nd.edu/undergraduate/dual-degree and in the Bulletin of Information.

Dual Degree with the College of Science

The five-year dual degree program between the College of Science and the College of Engineering enables the student to acquire degrees from both colleges—the bachelor of science from the College of Science and the bachelor of science degree in a chosen program of the College of Engineering. This combination program, instituted in 2013, offers students the advantages of the liberal arts aspects of natural science and mathematics education coupled with a strong technical education. Because a student may enter the program from either college, both colleges have agreed to a certain degree of flexibility in allowing students to meet degree requirements. See more info in the Bulletin of Information.

Dual Degree with the Mendoza College of Business

The five-year dual degree program between the Mendoza College of Business and the College of Engineering enables the student to earn the bachelor of science in a chosen field of the College of Engineering and the master of business administration. This program, instituted in 1991, offers students the opportunity to better integrate study in engineering and in management. The student completing this program has a background in the management sciences, as well as

the first professional degree in one of the fields of engineering. See more info at https://mendoza.nd.edu/graduate-programs/mba-engineering-dual-degree/ and in the Bulletin of Information.

2.3 Curricular Planning

It is recommended that all CBE majors initiate a 4-year graduation plan by the end of their first year. This curricular plan should be reviewed by academic advisors or Director of Undergraduate Studies (DUS) before the start of each new semester to ensure the student is on track to graduate on time. Planning resources include the CBE Department website, the Bulletin of Information, this CBE Undergraduate Handbook, and Grade History and the Graduation Progress System (GPS), which are both found on Inside ND.

Curriculum Planning Tools

For now, it is recommended to use Google Sheets when building a 4-year graduation plan, so that it may be more easily shared with advisors and DUS. Some students find it helpful to color code each type of requirement (core, college, major, and any additional courses).

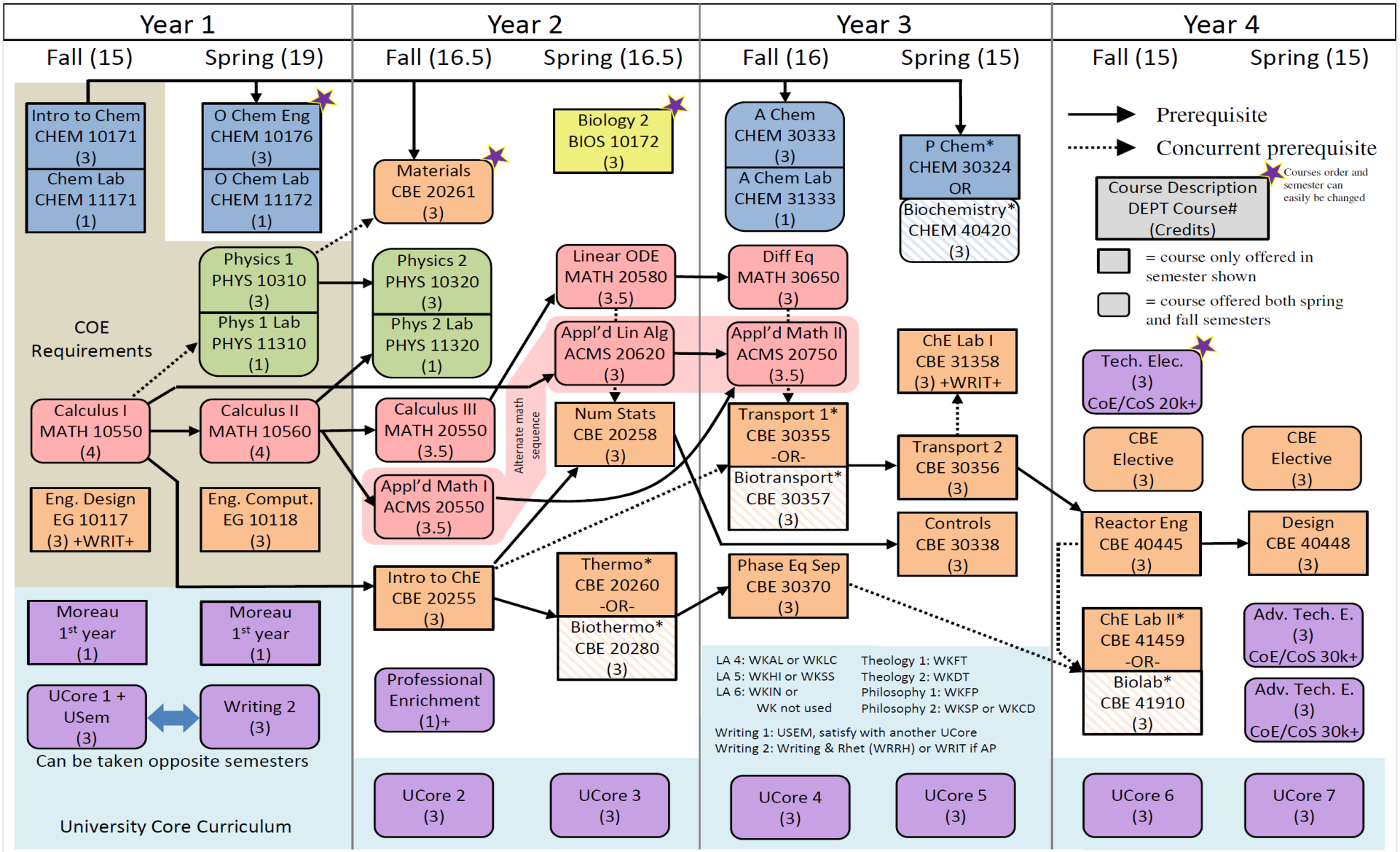
Chemical Engineering Curriculum

CBE Course Flowsheet

CBE Pre-med Flowsheet

Chemical Engineering Suggested 4 Year Curriculum University of Notre Dame

(Entering FA23, Standard curriculum, no AP/transfer credit, 128 hours)



+Professional Enrichment course. Options include: CBE 20290 (careers course), CBE 28901/48901 (UG research), CBE 28980 (ChemE Car), SCPP 40001 (Applying to Health Professions), other courses by petition to DUS.

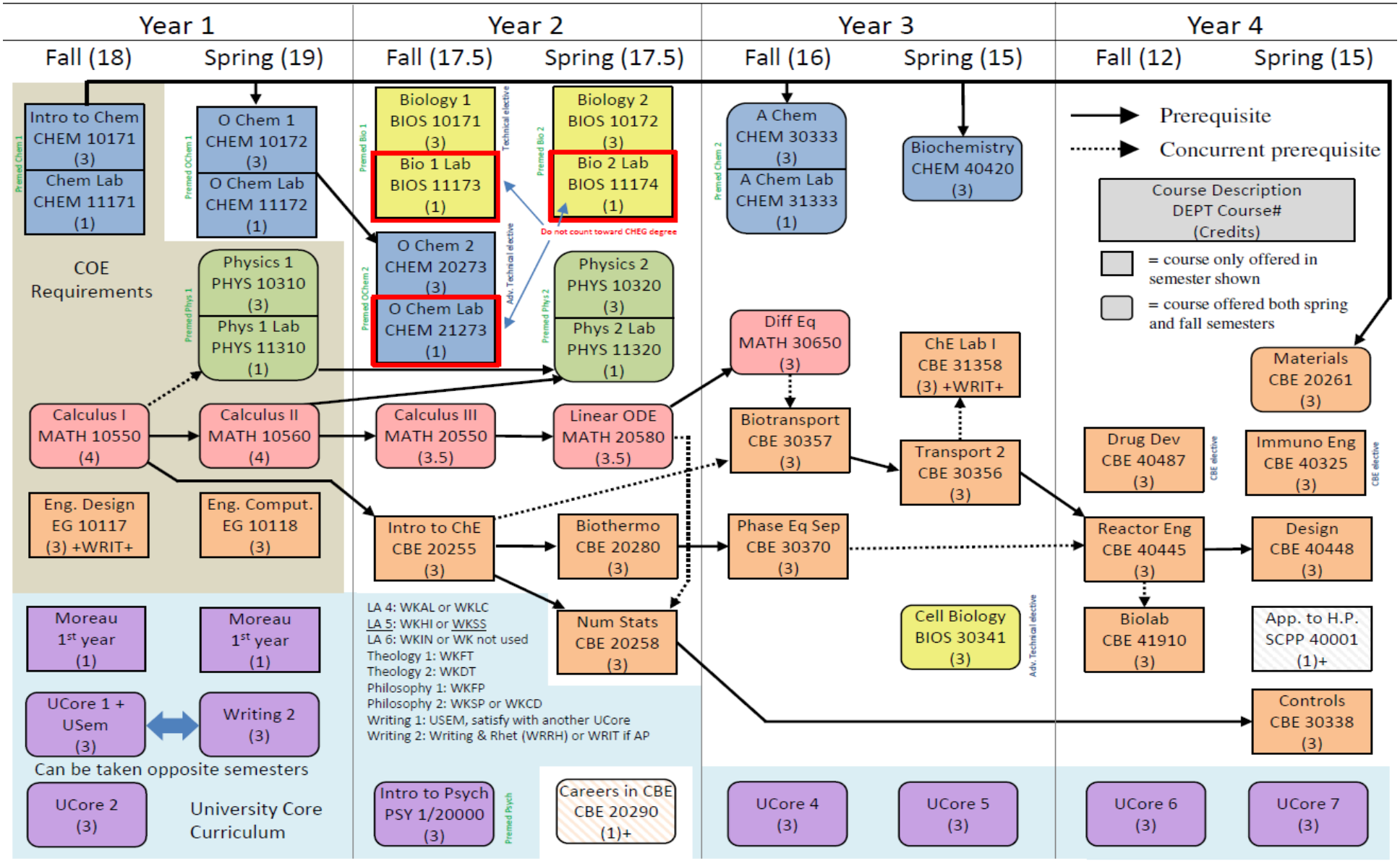
Last updated: 10/2023 tjv

2.4 CBE Curriculum-Fall 2022+

First Year					
Fall Semester (Credit Hours:15)			**Spring Semester (Credit Hours:16)**		
MATH 10550	Calculus I	4	MATH 10560	Calculus II	4
CHEM 10171	Intro to Chemical Principles	4	CHEM 10176	Organic Chem for Eng w/lab	4
EG 10117	Engineering Design	3	EG 10118	Engineering Compt.	3
USEM or WR 13100	University Seminar or Writing & Rhetoric (or WRIT)	3	PHYS 10310	Engineering Physics I	4
FYS 10101	Moreau First Year Experience	1	FYS 10101	Moreau First Year Experience	1
Sophomore Year					
Fall Semester (Credit Hours:16.5)			**Spring Semester (Credit Hours:16.5)**		
MATH 20550	Calculus III	3.5	MATH 20580	Intro to Linear Algebra and Differential Equations	3.5
PHYS 10320	Engineering Physics II	4	BIOS 10172	Biology II	3
CBE 20261	Intro to Sci of Eng. Materials	3	CBE 20260	Thermodynamics I	3
CBE 20255	Intro to Chem Eng.	3	CBE 20258	Numerical & Stats.	3
	Core Curriculum	3		Core Curriculum	3
			CBE 20290 or Free Elective	Careers in CBE or free elective	1
Junior Year					
Fall Semester (Credit Hours:16)			**Spring Semester (Credit Hours:15)**		
MATH 30650	Differential Equat.	3	CHEM 30324 or CHEM 40420	P Chem or Biochemistry	3
CHEM 30333	A Chem+Lab	4	CBE 31358	ChE Lab I	3
CBE 30355/30357	Transport or Biotransport	3	CBE 30356	Transporter II	3
CBE 30370	Phase Eq. and Separations	3	CBE 30338	Controls	3
	Core Curriculum	3		Core Curriculum Course	3
Senior Year					
Fall Semester (Credit Hours:15)			**Spring Semester (Credit Hours:15)**		
	CBE Technical Elective	3		CBE Elective	3
	CBE Elective	3		Adv. Technical Elective	3
CBE 40445	Reactor Eng.	3	CBE 40448	Design	3
CBE 41459 or CBE 4190	ChE Lab II or Biolab	3		Adv. Technical Elective	3
	Core Curriculum	3		Core Curriculum	3
				Total Credits	**128**

Chemical Engineering Suggested 4 Year Curriculum University of Notre Dame

(Entering FA23, Pre-med curriculum, no AP/transfer credit, Gap year)

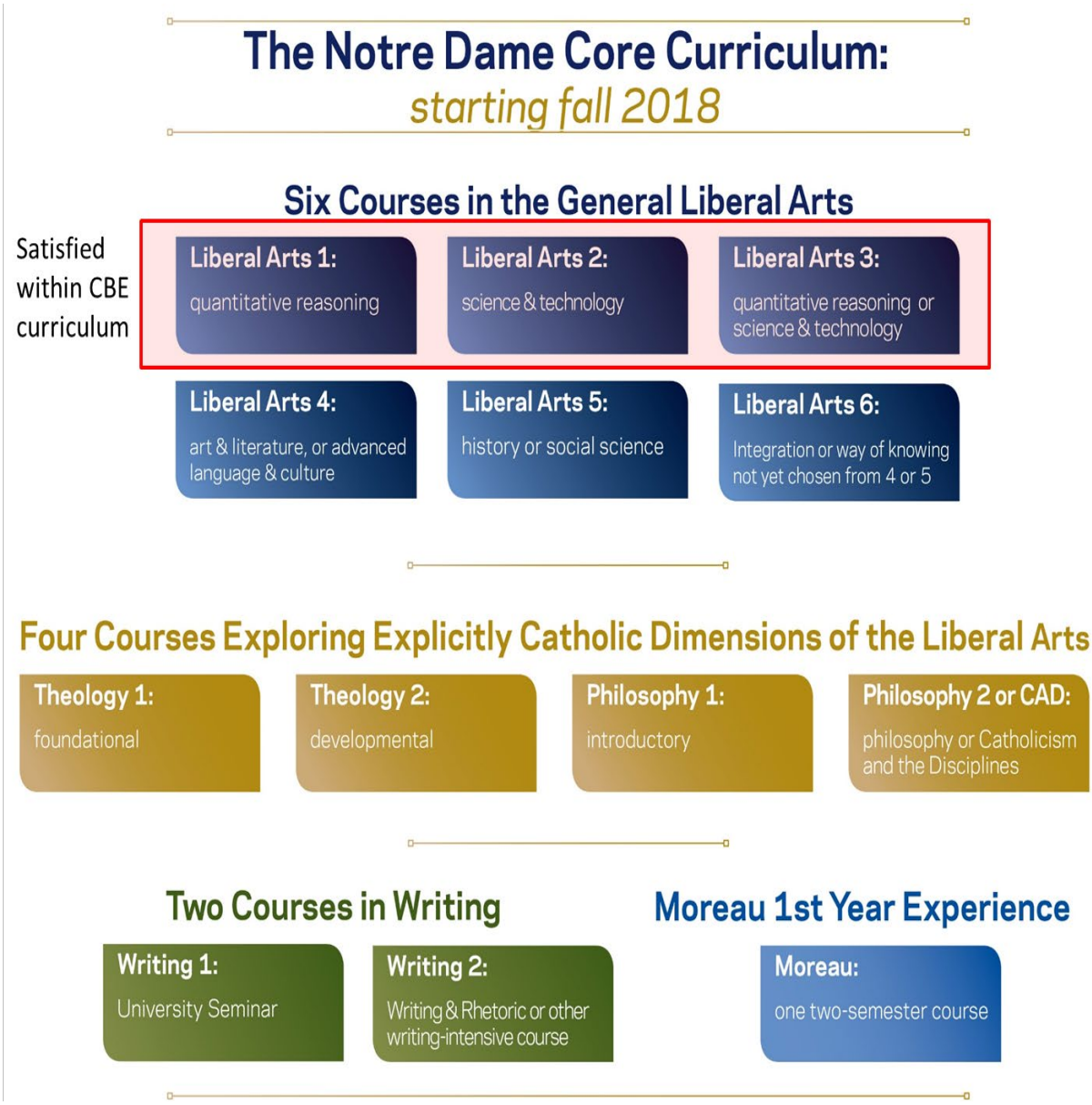


+Professional Enrichment course. Options include: CBE 20290 (careers course), CBE 28901/48901 (UG research), CBE 28980 (ChemE Car), SCPP 40001 (Applying to Health Professions), other courses by petition to DUS.

Last updated: 10/2023 tjv

2.5 The Notre Dame Core Curriculum

Central to undergraduate education at the University of Notre Dame is the core curriculum, a set of requirements that apply to all students, regardless of major. While the approach to the core will necessarily evolve over time, the goal is always the same: to provide students with a common foundation in learning that will make a unique contribution to their intellectual and personal development as well as their lives after Notre Dame. See full description at https://corecurriculum.nd.edu/



Six Courses in the General Liberal Arts

- Liberal Arts 1: Quantitative Reasoning

- Liberal Arts 2: Science & Technology
- Liberal Arts 3: Quantitative Reasoning or Science & Technology
- Liberal Arts 4: Art & Literature, or Advanced Language & Culture (WKAL or WKLC)
- Liberal Arts 5: History or Social Science (WKHS or WKSS)
- Liberal Arts 6: Integration or Way of Knowing not yet chosen from 4 or 5 (WKIN, WKHS or WKSS)

Four Courses Exploring Explicitly Catholic Dimensions of the Liberal Arts

- Theology 1: Foundational
- Theology 2: Developmental
- Philosophy 1: Introductory
- Philosophy 2 or CAD: Philosophy elective or Catholicism and the Disciplines

Two Courses in Writing

- Writing 1: University Seminar[1]
- Writing 2: Writing & Rhetoric or Other Writing-Intensive Course[2]

Moreau First Year Experience

- Moreau: One two-semester cours

3 CBE and Technical Electives

3.1 CBE Electives

A CBE elective includes any CBE 30000 level and above course with the exception of CBE 48901 and CBE 48903. To find these, go to class search (https://classsearch.nd.edu/) and select the subject *CBE – Chemical and Biomolecular Engineering.* Students should make sure to read through registration restrictions for each course including pre-requisites, enrollment level limitations, and special approvals by department or instructor.

3.2 Technical Electives

The program includes 3 technical elective and 6 advanced technical elective credits.

Technical Elective (3 credit hours)

[1] *Regardless of which core curriculum you fall under, a University Seminar (USEM) course may be double-counted to fulfill both the USEM requirement and one of the other university requirements.*

[2]

[2] *Students who have AP credit to test out of Writing and Rhetoric may have opportunities to double-count by choosing an approved writing-intensive course that also fulfills a university, college, or major requirement. Writing and Rhetoric does not count toward any other ways of knowing.*

The 3 credit hours of Technical Elective are satisfied by any graded 2XXXX+ or higher course in the College of Engineering or the College of Science that you have not otherwise taken to fulfill some other College or CHEG requirement. These hours can add up to 3 or be taken as a single 3-credit course.

Advanced Technical Elective (6 credit hours)
The 6 credit hours of Advanced Technical Electives are satisfied by any graded, 3-credit 3XXXX+ level courses in the College of Science or College of Engineering.

All technical electives taken must be intended for STEM majors. A maximum of 3 credits of approved undergraduate research (regardless of department) may count toward the 9 total Technical Elective credits required. For more information on undergraduate research click here Once Chemical Engineering Electives have been satisfied, additional Chemical Engineering courses taken will populate the Technical Elective requirement. Special requests for technical electives should be brought to the Director of Undergraduate Studies.

3.3 Medical School

Chemical Engineers pursuing a pre-health path should connect with specialized advising early and often.

The Center for Health Sciences Advising can provide you with advice on choosing courses as an engineering student planning to attend medical school. It is recommended that you schedule an appointment as early as possible with pre health advisor Dr. Susan Gursky (sgursky@nd.edu) and with the CBE Faculty Advisor Dr. Tanyel Kiziltepe Bilgicer (tkizilte@nd.edu).

Please reference the 4 year CHEG pre-med curriculum in you planning.

Most medical schools require applicants to have taken the MCAT (Medical College Admission Test), and to have completed:

- One year of Biology (Recommend BIOS 10171/11173: Biological Sciences I and lab, BIOS 10172/11174: Biological Sciences II and lab)
- Two years of Chemistry (10171, 10172, 20273, 30333 with labs)
- One year of Physics
- Biochemistry

Many schools recommend courses in:

- Writing intensive courses
- Psychology and Sociology/Anthropology

Note that some medical schools (e.g. Harvard) require the biology courses to be taken in college (not satisfied by AP credits). If you have AP credit, you must take higher level biology courses with lab components. There are similar restrictions on AP chemistry and physics. Other schools accept credits awarded through AP testing (at Notre Dame this usually requires a score of 5). If you are interested in a specific medical school you should verify their policy on AP credits early in the program.

Hence, in addition to the CBE degree requirements, students must take additional courses. In addition to the courses, the Notre Dame preprofessional programs generally require a 1 credit lab component with each course. Students with an interest in preparing for medical school should consult with personnel in the Center for Health Sciences Advising for curricular planning advice, as they have prepared course plans for engineering students interested in medical school.

3.4 ROTC

ROTC courses can count toward satisfying engineering degree requirements as follows:

Navy ROTC

A NSCI 40000 level course can be applied to satisfy a University core requirement where the course has the necessary attribute or has been approved to meet the requirement. For example, NSCI 40402 has the WKSP attribute assigned and so it may count as the second philosophy and a technical elective course. A second NSCI 40000 level course can be used to satisfy either the HISTORY or SOCIAL SCIENCE (not both) requirement.

Army ROTC

An MSL 40000 level course can be used to satisfy either the HISTORY or SOCIAL SCIENCE (not both) requirement. An MSL 40000 level course can be used to satisfy a technical elective requirement. For engineering majors with free electives, other MSL graded courses can be used to satisfy free electives.

Air Force ROTC

An AS 40000 level course can be used to satisfy either the HISTORY or SOCIAL SCIENCE (not both) requirement. An AS 40000 level course can be used to satisfy a technical elective requirement. For engineering majors with free electives, other AS graded courses can be used to satisfy free electives.

4 Study Abroad

Students who study abroad in the academic year generally do it during the fifth or sixth semester; a few go for the entire junior year. Below are the requirements to participate in the programs. Any student who is not behind in the program is eligible to participate. However, in certain cases students must register for the correct courses during their sophomore year to attend the program, and if they do not do so, then they are not eligible to attend.

4.1 Academic Year Program Locations

If a student needs to take CBE courses abroad, these locations may work for them:

- **Dublin (Ireland)** - UCD
- Hong Kong (China) - HKUST and HKU
- Perth (Australia)
- Singapore
- Alcoy (Spain) – students need to have the equivalent of 2 semesters of college-level Spanish (Beginning I/II) by the time they go abroad to Alcoy, or test out of that level via AP/SAT II/IB credit. If a student has not taken a Spanish class at Notre Dame, they can request a meeting with the DUS in the Spanish department who can submit the language reference on their behalf.
- Santiago- language requirement

If a student does not need to take a course in their major during their semester abroad, they are welcome to study in any program that interests them.

Students with program specific questions should schedule an appointment with the Notre Dame International Study Abroad Team. Each location has a specific program director, which you can find at https://studyabroad.nd.edu/programs/program-advising/

For additional information on a specific program, please speak with your adviser or the DUS and visit the Notre Dame International Study Abroad website: https://international.nd.edu/education-abroad/study-abroad/.

4.2 Summer Study Abroad Programs

International Programs offered by the College of Engineering feature courses taught by Notre Dame faculty, so you can enjoy time abroad and still graduate in four years. Most engineering students choose to go abroad the summer after their first or second year (leaving later years open for internships).

The **College of Engineering** offers summer programs in:

- CHEG Imperial (London)
- Alcoy (Spain)
- London (England)
- Dublin (Ireland)
- Shenzhen (China)
- Kitakyushu (Japan)
- Rome (Italy)
- Berlin (Germany)

Other summer programs offered through Notre Dame International Study Abroad

5 Minors

The College of Engineering offers six minors, open to all University students who have taken the appropriate prerequisite courses for upper-level engineering and science courses.

A student seeking an Engineering degree is allowed to count the same course to satisfy a university requirement, a college requirement, and a program requirement (major, supplementary major, minor). A multi-counted course can be used no more than once at each level (university, college, program). There is no limit to the number of multi counts a student may use in their degree. However, each program will require a specific number of credit hours to earn the degree - AP / IB / Credit by examination credits do count towards the total number of required credit hours.

Note: if a student multi counts a course (or courses) for their unique course of study (primary degree and secondary credential), they may be required to take additional courses in order to meet the minimum required courses needed to earn the degree. In such cases, the student should consult their advisor or Director of Undergraduate Studies to determine which additional courses are required.

The department who manages the minor should be consulted for the rules. Students in other colleges should consult their own program department for similar restrictions. Each minor has a director and should be consulted for the rules. Students in other colleges should consult their own program department for similar restrictions.

- Bioengineering
- Computational Engineering
- Energy Engineering
- Energy Studies
- Engineering Corporate Practice
- Environmental Earth Sciences
- Resiliency and Sustainability of Engineering Systems

5.1 Bioengineering (MBIE)

This minor, offered by the Department of Aerospace and Mechanical Engineering and the Department of Chemical and Biomolecular Engineering, comprises a six-course sequence that teaches students how to use the tools of engineering analysis with the fundamentals of the engineering and life sciences, to enliven the understanding of living organisms, medical treatments and biochemical pathways and to provide quantitative predictions and insight towards the design of medical and biological devices and processes.

Introduction requirement:
Students select one of five foundational courses that are suitable for students with interests in differing areas of bioengineering. Some of these courses are at the senior elective level, and may build on previous courses. Others at the sophomore level, and provide an introduction to a field. The Foundations course can be taken at any point in the undergraduate curriculum.

Concentration area requirements:
Students complete the minor requirements with any course in the college that has the BIOE attribute. Students are advised to pursue course sequences that are thematic, either from a single department or in a topic area that spans departments. However, there are no restrictions on specific course groupings.

Biological Sciences Requirements:

Students should complete the standard two semester introductory sequence in biology. These two courses are prerequisites for every biological science class offered at Notre Dame. They provide a solid grounding for students in biological sciences, covering the essential concepts of evolution, basic physiology, gene transcription and translation, proteins and signaling molecules, and progressing to ecosystems. The courses cover multi-organism systems, which is relevant for students interested in environmental engineering and epidemiology.

Non-engineering Majors:
The college council also approved awarding the minor to students in the college of science, and the demand from students in chemistry and biochemistry has been particularly strong. Students outside the college of engineering are expected to complete a minimum of two semesters of physics and three semesters of mathematics, including at least Calculus I and II. They must also meet the prerequisites for any engineering courses they plan to take as part of the minor, which generally includes a course in differential equations.
AP Credits and Double Counted Credits:
Credit for BIOS 10171 and BIOS 10172 could be satisfied for students who receive a 5 on the AP biology exam, consistent with Notre Dame Policy: https://firstyear.nd.edu/academics/advanced-placement-credit/ap-exam-credit/.

To see a list of courses for the minor please click here

5.2 Computational Engineering (MCOM)

This minor, offered by the Department of Aerospace and Mechanical Engineering, recognizes the importance of computational tools in all disciplines of engineering and gives students exposure to the fundamentals of programming and numerical methods, experience and skills in computer usage, and knowledge of applications from a range different areas. The Computational Engineering Minor will provide the students with a solid grounding in the application of computational methods to various engineering problems such as fluid mechanics, structural analysis, elasticity, optimization, etc. With a fundamental understanding of the problems being solved and the numerical methods used to determine solutions, students are prepared to properly interpret the results, recognize the limitations of the methods employed, etc.

The Minor requires completion of five courses, more fully described below.

One of the following courses must be taken to fulfill the requirements for the minor:

- AME 40532 Computational Fluid Dynamics
- AME 40541/60541 Finite Element Methods
- CE 60130 Finite Elements in Engineering

Any of the following courses may be taken in order to fulfill the requirements for the Computational Engineering Minor:

- ACMS 20210 Scientific Computing[3]
- ACMS 20220 Scientific Computing Python[3]
- ACMS 40212 Advanced Scientific Computing

[3] *Only one of these courses will be counted*

- ACMS 40390 Numerical Analysis [or Math 40390][4]
- ACMS 40395 Numerical Linear Algebra
- ACMS 40630 Nonlinear Dynamical Systems
- ACMS 40730 Mathematical/Computational Modeling
- ACMS 40760 Introduction to Stochastic Modeling
- ACMS 50550 Functional Analysis
- ACMS 50051 Numerical PDE Techniques for Scientists and Engineers I [or PHYS 50051]
- ACMS 50052 Numerical PDE Techniques for Scientists and Engineers II
- ACMS 60395 Numerical Linear Algebra
- ACMS 60612 Advanced Scientific Computing
- ACMS 60690 Numerical Analysis I[4]
- ACMS 60790 Numerical Analysis II
- AME 20214 Introduction to Engineering Computing[3]
- AME 20251 Computing Methods in AME
- AME 40510 Introduction to Numerical Methods[5]
- AME 40532 Computational Fluid Dynamics
- AME 40541/60541 Finite Element Methods
- AME 50559 Statistical Computing Methods for Scientists and Engineers
- AME 60614 Numerical Methods
- AME 60620 Multiscale Modeling
- AME 60627 Computational Mechanism Design
- AME 60649 Molecular Level Modeling for Engineering Applications
- CBE 20258 Computational Methods in Chemical Engineering[5]
- CBE 40455 Process Operations
- CE 30125 Computational Methods [or CSE 30125]
- CE 40140 Applied/Computational Probability for Engineers; Uncertainty Quantification and Propagation
- CE 60130 Finite Elements in Engineering [or CSE 60130, or ACMS 60590]
- CE 60263 Finite Element Methods in Structural Mechanics
- CSE 20189 Basic UNIX for Engineers
- CSE 20232 C/C++ Programming

[4] *Only one of these courses will be counted*

[5] *Only one of these courses will be counted*

- CSE 40113 Design/Analysis of Algorithms
- CSE 40166 Computer Graphics
- CSE 40171 Introduction to Artificial Intelligence
- CSE 40431 Programming Languages
- CSE 40755 Parallel Computing
- MATH 30720 Discrete Fourier and Wavelet Transforms
- MATH 50510 Computer Programming/ Problem Solving
- PHYS 30421 Scientific Programming

5.3 Energy Engineering (MENE)

This minor, offered by the Department of Aerospace and Mechanical Engineering, recognizes that Energy is an important subject of current interest that involves many engineering and non-engineering disciplines, and enables students to develop a stronger background in and to prepare better for professional jobs or higher studies in the area. This minor differs from the Energy Studies minor as described below in that it focuses on the technical aspects of energy and requires courses concentrated in engineering and science.

Energy is clearly of pressing national and international concern, the fact of which is evidenced by recognition by Notre Dame in the creation of the Center for Sustainable Energy. The factual details of the nature of the technological energy needs facing society and the manner in which academia, and Notre Dame in particular, are addressing them were the focus of a recent article in the Signatures Magazine and include the following subjects:

- Blackouts, the stability of the power grid and other reliability issues in energy distribution;
- Energy efficiency and policy;
- The politics of power;
- Sources of energy and the related environmental concerns;
- Carbon dioxide capture and storage;
- Nuclear energy and the associated difficulties;
- Clean coal technology, and;
- Biofuels

The Energy Engineering Minor parallels the institutional commitment reflected in the creation of the Center for Sustainable Energy at the undergraduate level by providing undergraduates with the educational background necessary to confront this important technological issue of the current time.

The Minor requires completion of five courses, more fully described below.

The following courses may be taken in order to fulfil the requirements for the Energy Engineering Minor:

- AME 20231 Thermodynamics
- AME 40401 Energy, Technology and Policy
- AME 40431 Gas Turbines and Propulsion
- AME 40472 Electrical and Hybrid Vehicles
- AME 40530 Wind Turbine Performance, Control and Design

- AME 47431 Special Studies: Designing Energy-Efficient Buildings
- AME 40532 Computational Fluid Dynamics
- AME 50535 Energy Systems
- AME 40634/60634 Intermediate Heat Transfer
- AME 60636 Fundamentals of Combustion
- AME 60638 Turbine Engine Components
- AME 60733 Solar Energy: Photovoltaic Systems
- CBE 20256 Chemical Engineering Thermodynamics
- CBE 40425 Energy, Economics, and Environment
- CBE 40435 Electrochemical Energy and Storage
- CBE 40498 Energy and Climate
- EE 30372 Electric Machinery and Power Systems
- EE 47010 Alternative Energy Devices and Materials
- EE 40472 Electrical and Hybrid Vehicles
- EE 47015 Electric Vehicles and the Power Grid
- PHYS 30461 Thermal Physics

Only one of these courses will be counted

5.4 Energy Studies (MENS)

The **Energy Studies Minor** is open to undergraduate students in all majors and colleges at the University of Notre Dame. This minor prepares students to become successful leaders who understand the complexities of the world's energy challenges, joining an energy network that extends far beyond campus. Students may draw from both technical and non-technical resources to learn how to help move our country and the world toward a more sustainable energy future.

For a list of courses for this minor please click here

The ESM Academic Advisor is Peter C. Burns, The Henry J. Massman Professor of Civil and Environmental Engineering and Earth Sciences and Director of ND Energy. If you have questions for Prof. Burns or would like more information about the ESM, contact Anne Berges Pillai, Education and Outreach Associate Program Director, at 574-631-9106 or apillai@nd.edu.

5.5 Engineering Corporate Practice (MECP)

The College of Engineering collaborates with the Mendoza College of Business and the College of Arts and Letters to offer this unique experience that prepares you for your future career while exploring topics at the intersection of engineering and business.

The Minor in Engineering Corporate Practice (MECP) is open to all engineering undergraduates.

For a list of required courses please click here

For additional questions, please contact:

Professor Mike Kitz (Michael.P.Kitz.1@nd.edu)

Professor Todd Taylor (Ttaylo24@nd.edu).

5.6 Environmental Earth Sciences (MEES)

This minor will provide you with an introduction to the disciplines of Earth and Environmental sciences. It provides a foundation in the physical sciences, with emphasis on processes that occur near or at the surface of Earth and the impact of human activity on such processes.

You'll explore the geochemical, mineralogical and hydrological properties of Earth's crust and develop an understanding of the interplay of natural processes such as mineral-water-rock-bacteria interactions, with anthropogenic issues such as transport of toxic heavy metals and safe disposal of nuclear waste.

For a list of courses please click here

5.7 Resiliency and Sustainability of Engineering Systems (MRSE)

The Resiliency and Sustainability of Engineering Systems minor is open to students from all disciplines (i.e., not just limited to students in the College of Engineering) who can satisfy the pre-requisites for CE10700 (see below). The minor includes two required courses, three elective courses, and a capstone experience. The two required courses are:

- CE10700 Sustainable Development in a Changing World (Required)
  Spans a broad range of topics on the environmental consequences of engineering systems in sustainable development.
- CE30720 Resiliency of Engineering Systems (Required)
  Focuses on engineering for mitigation and resiliency, also emphasizing communication skills so that graduates are equipped to work with city planners, policymakers and the public.

The three elective courses will be selected in collaboration with the Director of the Minor. Options to fulfill this requirement span multiple departments and include pre-approved courses from departments such as Political Science, Psychology, Philosophy, Laws, Economics, and Sociology. Courses will be from at least two different departments. At least two of the elective courses will be at the advanced undergraduate level (i.e., junior or senior). In addition, at least one of the three elective courses will be outside the College of Engineering.

In addition to coursework, students will be required to complete a 1-credit capstone experience. The goal is for the student to obtain hands-on experience with resiliency and sustainability issues focusing on implementation in a real-world setting, such as a related research position or an internship with a governmental body, regulatory agency, environmental advocacy group, or other organization. Proposed by the student, each capstone experience will be approved by the Director of the Minor. Projects will vary among students, and it is expected that each experience will allow the student to pursue a topic of particular interest to him/her in much more depth than a single course might allow. Each experience will be accompanied by a Capstone Thesis Report that will be due no later than the spring semester of the senior year.

6 Concentrations

The Department of Chemical and Biomolecular Engineering offers students the ability to concentrate their studies in one of three areas, Biomolecular Engineering, Energy, or Materials. A student is effectively narrowing the scope of their curricular choices and electives to concentrate on a particular area, taking 4 courses from a defined list. Each concentration can be completed without taking any “extra” courses beyond those required for degree completion. Some elective courses may require special permission or additional prerequisites. Upon a student's successful completion of a CBE program with a chosen Concentration, the Concentration will appear on the student's transcript.

6.1 Biomolecular Engineering Concentration

concentration code: CBIE

The Biomolecular Engineering Concentration is a helpful addition to your CBE degree if you are especially interested in pursuing a career in pharmaceutical industry, medical device industry, a PhD in any biologically related field, consulting in a pharmaceutical or medically related field, or going into medical/dental/veterinary school after graduation.

Four courses must be completed from the courses listed here

6.2 Materials

concentration code: CMTR

A significant fraction of Chemical Engineering graduates finds employment in companies that focus on materials production such as ExxonMobil, DuPont, Dow Chemicals and 3M, to list only a few. Many of our graduates also go on to pursue advanced degrees with research emphasis on materials science. Characterization, design and processing of polymers, ceramics, metals and alloys requires detailed knowledge of thermodynamics, reaction engineering and physical rate processes (heat and mass transfer), making Chemical Engineers particularly qualified for the job. While all CBE students will be exposed to these topics in their classes, those that select the materials concentration will use their electives to explore a set of material engineering topics in more detail than the baseline chemical engineering requirements.

Four courses must be completed from the courses listed here

6.3 Energy Concentration

concentration code: CENY

The Energy Concentration is designed for students interested in learning about the importance of energy in everyday life, the positive and negative impacts of anthropogenic activities related to energy, and alternative strategies for cleaner energy processes. The courses in this concentration are relevant to students who are interested in pursuing a career in oil and gas, bulk and/or fine chemicals, catalysis, catalyst manufacturing, renewable/alternative energy, or in pursuing a graduate degree in chemical engineering or a related field.

Four courses must be completed from the courses listed here

7 Undergraduate Research and Projects

7.1 Undergraduate Research and Engineering Projects

Most students benefit greatly from becoming involved in research projects and participating in the Department's research activities. CBE students may do research for either course credit or as a paid research aide. Please note: students cannot receive credit and be paid for the same research position.

Finding a Research Advisor

To find suitable supervisors and research topics, students should talk to their instructors and academic advisors to find out about on-going research in the Department.

Students can explore the departmental website and the faculty websites for more detailed information on their research. Individual faculty members should be contacted directly to see if they have openings for undergraduate research aides.

Research as a Paid Position

The supervising faculty member will determine if the research can be done as a paid position. Once this decision is made, the student should come the Department office and complete the necessary employment paperwork with CBE Undergraduate Academic Program Administrator.

Research and Projects for Credit

CBE 28901: Undergraduate Research
First and second-year students should sign up for this course as their first experience in research. This one-credit course involves a minimum commitment of 4-5 hours per week. This course is S/U, may be taken more than once, but does not satisfy chemical engineering degree requirements.

CBE 48901: Undergraduate Research
Students in their third year and beyond should sign up for this course as their first experience in research. This one-credit course involves a minimum commitment of 4-5 hours per week. This course is S/U, may be taken more than once, but does not satisfy chemical engineering degree requirements.

CBE 48902: Advanced Undergraduate Research
This is a three-credit course in which students should expect to spend 12-15 hours per week. Successful completion of CBE 48901 or another substantial research experience is a prerequisite for enrolling in this course, which can be counted as a technical elective.

Students in this course must produce a written research report, (3,000 – 5,000 words) at the end of the semester. This course is graded and may be repeated but may only count as a technical elective one time.

Some students choose to do a research course in another department. This can count as a technical elective if the course is science or engineering related research, 3 credit hours, graded, and requires a significant written report.

CBE 48903: Undergraduate Thesis
This 3-credit course is typically taken in the final semester of the program. Successful completion of CBE 48901, CBE 48902, or a substantial research experience in CBE is a prerequisite for enrolling. Students produce a substantial written document and defend it orally before a committee of CBE faculty. The ideal outcome of a successfully defended undergraduate thesis is a journal article. This course can be counted as a 3 credit CBE elective. The research can be conducted in any department but the defense committee must have at least one CBE faculty member.

Summer Research Experience for Undergrads (REUs)

Approximately 300 undergraduate students from around the world participate in research at Notre Dame in the summer. All students doing research in the summer must be registered for a course in the summer and complete the ND Roll Call process. Current Notre Dame students must get department approval in order to register through insideND. More info at https://summersession.nd.edu/programs/reu

8 Student Organizations and Activities

8.1 Professional and Honors Societies

8.1.1 American Institute of Chemical Engineers (AIChE)

The Notre Dame Chapter of the American Institute of Chemical Engineers is dedicated to supporting the professional development of our undergraduate chemical engineering students. We host industry lectures and field trips that expose our members to the variety of fields that chemical engineers can go into, beyond what can be learned in the classroom. There are also two conferences, a regional conference and a national conference, that we regularly attend. We send students who participate in ChemE Car (a popular competition judging a car that runs entirely off of chemical processes), ChemE Jeopardy (like regular Jeopardy, but focused on topics that undergraduate chemical engineering students learn), and poster presentations. All in all, our members gain industry connections, get exposure to many aspects of chemical engineering, and get to network with other chemical engineering students both at Notre Dame and across the country. More info contact aiche@nd.edu Faculty advisor Troy Vogal.

8.1.2 Engineering Leadership Council

The Engineering Leadership Council of Notre Dame exists as a student government body within the College of Engineering which supports all CoE clubs via working with the Dean's Office. ELC members are provided with excellent leadership development opportunities while serving the CoE student body with professional development and community outreach. More info contact elc@nd.edu or visit https://elc.nd.edu/

8.1.3 Society Women in Engineering

Notre Dame Women in Engineering encourages women to pursue engineering as an exciting and fulfilling educational and career choice. We bring together women at all levels — undergraduate, graduate, faculty, and alumni — to create a community of support and opportunities for women to thrive.

The Society of Women Engineers (SWE) gives support, guidance and recognition to women engineers and engineering students. Today, SWE is a nationally recognized professional, educational, non-profit, service organization. Its student section membership includes graduate and undergraduate female and male engineers. More info at https://engineering.nd.edu/student-experience/women-in-engineering/

8.1.4 ELITE Engineers

ELITE (Enhancing Leadership through Intentional and Transformational Experiences) engineers is a program designed to help students develop their identity as engineers and support their success inside and outside of the classroom. Programming offered through the program is centered around the pillars of career/professional development, academic excellence, community building, and wellness. Although open to anyone, this program may be of special interest to first gen and/or students from underrepresented backgrounds in STEM. Click here to join the mailing list.

8.1.5 Society of Hispanic Professional Engineers (SHPE)

The purpose of this student chapter is to: 1. Increase the number of underrepresented students in the fields of science, technology, engineering, and mathematics (STEM) at the University of Notre Dame. 2. Promote the advancement of underrepresented STEM students in employment and education. 3. Improve the retention of underrepresented students enrolled in STEM majors. 4. Provide a forum for the exchange of information pertinent to underrepresented STEM students enrolled at the University of Notre Dame. 5. Develop a working network with

local schools to encourage pre-college, underrepresented students to enter the STEM fields. 6. Promote professional advancement for underrepresented STEM students by fostering cooperation among industry, government, academic, and professional leaders to improve educational and employment opportunities. 7. Provide counseling and financial assistance to underrepresented students in STEM. For more information, please contact us at shpe@nd.edu

8.1.6 National Society of Black Engineers (NSBE)

Founded in 1975, The National Society of Black Engineers has strived to increase the number of culturally responsible Black Engineers who excel academically, succeed professionally, and positively impact the community. The objective of the National Society of Black Engineers shall be to stimulate and develop student interest in engineering; to strive to increase the number of students studying engineering at both the undergraduate and graduate levels; and to endeavor in the advancement of the ethnic minority engineer in professional industry. For more information, please contact nsbe@nd.edu

8.1.7 Tau Beta Pi

In 1960, the Indiana Gamma Chapter of Tau Beta Pi was installed at Notre Dame to foster a spirit of liberal culture in the engineering college and to recognize those who have conferred honor upon Notre Dame by distinguished scholarship and exemplary character as undergraduates in engineering or by their attainment as alumni in the field of engineering. Seniors in the top fifth of their class and juniors in the top eighth of their class are eligible for election under rigid standards of scholarship, character, leadership, and service. More info at https://sites.google.com/a/nd.edu/tbp/home

8.1.8 Engineers Without Borders (EWB)

Engineers Without Borders - Notre Dame strives to live out the mission of EWB-USA: "EWB-USA builds a better world through engineering projects that empower communities to meet their basic human needs." In accordance with the mission of Engineers Without Borders-USA, EWB-ND strives to bring necessary changes to international communities in order to improve the quality of living. EWB-ND works with the community to implement and maintain the given project. More info at https://ewbnotredame.weebly.com/the-team.html