Chemical Engineering B.S.

Contact Information

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Faculty

Professors Bang, Dixon, Puszynski, and Winter; Associate Professor Gilcrease; Assistant Professors Benjamin, Hower, Menkhaus, Sani, and Shende; Instructor Coble.

Emeritus and Other Faculty

Emeritus professors Bauer, Munro, and Sandvig; Professor and 2010 Center Director Christopher.

Staff

Chemical and Biological Engineering Secretary, Linda Embrock. Chemical and Instrumentation Specialist, Ivan Filipov.

Chemical and Biological Engineering (CBE)

Chemical engineers with a B.S. degree from the School of Mines acquire a solid foundation in the sciences of biology, chemistry, and physics in mathematics; and in applied engineering and technology. This broad foundation allows graduating chemical engineers to discover new ideas required to solve the problems challenging the people of the world, while constantly pursuing the efficient and safe use of the world's resources. These needs or problems might be related to the environment, electronics, energy, food, fibers, biotechnology, petroleum, pharmaceuticals, and new engineering materials (nano-materials, ceramics, and polymer composites). To learn more about a career in chemical engineering, visit our webpage: <http://cbe.sdsmt.edu> and the student web page of the American Institute of Chemical Engineers, AIChE <http://www.aiche.org/Students/Careers/index.aspx>

The 21st century brings with it many exciting opportunities and careers for chemical engineers. Chemical engineers are involved in all aspects of many projects, serving as the connection between engineering, science, and business disciplines. Their broad knowledge base allows them to be found throughout the entire structure of industry and commerce, and they are often considered the "universal" engineer. As such, the profession offers many interesting and challenging opportunities in areas such as research and development, manufacturing, production, plant or process design, technical sales or service, and management. Combining the scientific, math and problem-solving skills acquired as part of the core chemical engineering degree with an emphasis in biology, advanced materials, or environmental

issues offered at the School of Mines provides students additional opportunities to explore. The chemical engineering degree prepares students to pursue graduate study in medicine, materials science, patent or environmental law, or even business administration, in addition to chemical, biochemical, materials, or nanoengineering.

Chemical engineers, in their effort to solve real world problems for the betterment of society, use their knowledge and skills to control chemical and physical changes of raw materials to create high-value products, while minimizing pollution to the environment. Some specific examples:

Chemical and food process industry: Design processes using catalytic and multi-phase reactions to convert petroleum and agricultural feed stocks into much needed chemicals, fuels, and foods, and to subsequently purify the products. Reactor design and development of separations such as distillation, extraction, crystallization, evaporation, filtration, gas absorption, industrial waste reduction, and absorption are commonly used to make products such as plastics, paints, cosmetics, candies, cereals, chocolate, beverages, gasoline, paper, and countless other products.

Biotechnology industry: Design and operate bioreactors where conditions must be optimized for the growth of specialized microbes to produce desired metabolites, such as penicillin, human insulin, pharmaceutical proteins, fuel ethanol, food additives/sweeteners, and biopolymers. Develop special separation techniques to isolate these high-value biological materials. Use genetic engineering and recombinant DNA techniques to create new and improved agricultural products and microbes over-expressing biopharmaceuticals. Discover and produce new polymers for delivery of drugs or development of artificial organs.

Advanced materials and electronics: Develop new hurricane resistant windows made from recycled glass and polymers; produce intermetallic nano-powders created to store hydrogen more safely for fuel cell applications, or novel ion-conducting polymers for improved fuel cell efficiency; design and produce the next generation of protective combat gear, solar cells, or aeronautics equipment. Manufacture microchips and intricate circuitry for a variety of electronics applications. Synthesis and processing of nanopowders and nanostructures.

Environmental applications: Protection of human health and the environment is of vital concern to the process industries. Additionally, many sites have been previously contaminated and must be remediated. Design and development of in-situ and ex-situ technologies for the remediation or biological destruction of hazardous wastes such as polycyclic aromatic hydrocarbons, halogenated solvents, chlorinated aliphatic compounds, and toxic metals, such as uranium, arsenic, chromium and lead.

The chemical engineering program is challenging, but rewarding. It is designed to prepare students to become practicing chemical engineers, ready to enter the workforce and make immediate contributions or ready to enter graduate education to pursue additional career opportunities. Critical analysis of chemical processes, both as an entire process and individual components, is the core of the program. In addition to becoming proficient in using computers and process simulation software to solve chemical engineering problems, students will also learn to become effective communicators that can work and learn independently as well as within a successful team. As a part of the program, students will be expected to conduct themselves with the highest ethical standards and learn to appreciate the societal responsibilities of being a professional chemical engineer.

Safety and Chemical Education (SACHE) Certificate Program

The AIChE Chemical Engineering professional is a founder in the Safety and Chemical Education (SACHE) Safety Certificate Program, which School of Mines chemical engineering students may earn. This online program was developed by chemical safety experts to provide safety education. It also gives ChE students and graduates an edge over other job candidates, by allowing companies to hire School of Mines graduates who are prepared to improve safety in industrial facilities and laboratories. SACHE and AICHE present a Certificate of Completion to every student who

successfully completes the program and demonstrates proficiency in process safety.

Professional Development and Scholarship Opportunities

Students in the School of Mines Chemical Engineering Program have many chances to enrich their formal engineering education. The department has an active student professional organization, the American Institute of Chemical Engineers Student Chapter, which is associated with the national AIChE professional organization <www.aiche.org>. In this chapter, students learn more about their chosen profession, conduct community service, and participate in regional and national meetings.

At the regional and national AIChE meetings, chemical engineering students from the School of Mines compete against chemical engineering students from other universities in contests such as research paper presentations, process designs, and a Chem-E Car Competition. School of Mines students compete in and win several of these competitions. For example, in 2003, the fuel cell powered "ChemE-Car" car they designed won first place in the AIChE Rocky Mountain Regional competition, beating teams from Colorado, Utah, New Mexico, and Arizona. At the 2008 Annual AIChE meeting in Philadelphia, School of Mines ChE students were recognized for many honors. For example, one student received one of 15 national AIChE scholarships, and the SDSM&T Student Chapter was recognized as one of 15 Outstanding Student Chapters. In 2007, a School of Mines AIChE student was one of 11 engineering students from throughout the United States who participated as a Washington Internships for Students of Engineering intern in Washington, DC. <www.wise-intern.org> Highlights of the AIChE student chapter activities may be found at <http://aiche.sdsmt.edu>.

Numerous scholarship opportunities are available to students through the university and the Department of Chemical and Biological Engineering. Funding sources come from foundations, industry, and individual sponsors. The dollar amount and number of scholarships available fluctuate from year to year. In 2008-09, approximately 75 percent of the sophomore, junior, and senior ChE students received a scholarship. The total amount of scholarships given to all ChE students in 2008-09 exceeded $153,000.

Laboratories and New Initiatives

The chemical engineering program has laboratory facilities that are used extensively to enhance the theory and skills presented in the classroom and provide students hands-on experience in operating chemical process equipment. These facilities include the main laboratory that houses mini-plant equipment such as a distillation column, evaporators, heat exchangers, and gas absorbers. Other laboratories include a process dynamics laboratory, which is used to study the dynamics and control of process variables such as temperature, pressure, flow rate, and liquid level; a bioChE laboratory for students to use for addressing the solution and study of bioprocessing; and several research laboratories.

During the 2009-2010 calendar year, construction and renovation will begin on a new two-story wing and the mini-plant laboratory in the in the Chemistry/Chemical Engineering Building. While this will take a few years to complete, the new wing will provide integrated education and research opportunities for future generations of chemical/biological engineering and chemistry undergraduate and graduate students. As an essential teaching and learning environment, it will enrich the education of all School of Mines students in science and engineering. It will enhance recruitment and retention of the best students and faculty, promote multidisciplinary and global collaboration, foster new generations of innovators and leaders, and advance the resources of the State of South Dakota.

The Ph.D. program in Chemical and Biological Engineering has been growing over the past two years. This Ph.D. program complements nicely the B.S. undergraduate program. Three new faculty members have joined the department, thus providing enhanced opportunities for undergraduate students to experience the diverse perspectives that different faculty members bring

to the classroom, as well as increased undergraduate research experiences.

The department has been awarded substantial grants from industrial foundations and companies to enhance the laboratory facilities as well as the biochemical engineering area. The **Dow Corning Foundation Enhanced Materials, Automation, Processing, and Simulation (M.A.P.S.) Laboratory** is the foundation for an applied open-ended laboratory experience. Students are exposed to the challenge of effectively applying process design skills in a pilot plant environment. This is coupled to advanced process simulation using AspenPlus and state-of-the-art Opto-22 process controllers. The chemical engineering program is continuing to expand in the growth area of biochemical engineering and biology. Generous donations by the **Cargill Corporation and Foundation** have made the development of this program very successful. Students may develop an emphasis in biochemical engineering through elective courses in biochemistry, microbiology, and biochemical engineering. Additional biochemical engineering topics are integrated into the core chemical engineering courses. Students can gain practical experiences in our modern **Cargill Biochemical Engineering Laboratory**, which is substantially funded by **Cargill**. Check out the latest developments at <http://cbe.sdsmt.edu/bioche.html>.

Co-op and Research Opportunities

The chemical engineering curriculum is designed to allow students to prepare themselves to enter the workforce within the traditional four-year period. Opportunities also exist for students to participate in on-the-job training in the form of cooperative education (co-ops), summer internships and research. These employment opportunities may be included as an integral part of the student's studies. Students who participate in these opportunities demonstrate the high level of their educational knowledge and learn more about the profession of chemical engineering.

A number of industrial partners offer cooperative education opportunities for students majoring in chemical engineering. Students are encouraged to apply for these opportunities as they provide valuable exposure to the practice of chemical engineering. For each semester or summer term spent in a co-op position, students register for 2 credits of a Cooperative Education (CP) course. These credits can be used to fulfill the chemical engineering curriculum requirements. Students wishing to register for a co-op course should visit with their advisor prior to accepting a co-op position to ensure that departmental procedures are followed and to optimize the sequencing of co-op courses with other required courses.

The chemical and biological engineering faculty is actively engaged in research and development and welcomes the participation of undergraduates in these efforts. Additionally, students are encouraged to apply to Research Experience for Undergraduates (REU) sites at other institutions. For example, during the past few summers, School of Mines students have conducted summer research on fuel cells at the University of Houston, bioprocessing at Colorado State University, biomedical engineering at the University of Minnesota, synthesis of pharmaceutical building blocks at Aachen University of Technology in Aachen, Germany, and cellulosic biomass conversion at Iowa State University. Individual School of Mines CBE faculty member research projects and areas of interest may be found from their web pages that are linked from <http://cbe.sdsmt.edu/personel.html>.

Chemical Engineering Curriculum/Checklist

The courses listed in the curriculum have been chosen to develop a well-rounded education, beginning with the foundations of mathematics, physics, biology, and chemistry, and culminating with a capstone process design course at the senior level. Along the way, students develop competencies in fluid dynamics, heat transfer, mass transfer, computer solutions to complex engineering problems, process control, kinetics, and reactor design, all while developing their critical thinking and general problem solving skills.

Although a minor in chemical engineering is not available, one can obtain a special emphasis in

emerging areas such as biochemical engineering, environmental engineering, or advanced materials by tailoring their elective courses.

Students in the School of Mines B.S. environmental engineering program may elect chemical engineering as their specialty emphasis. With the increased national emphasis on the environment, the opportunity exists at School of Mines for one to earn dual degrees in chemical engineering and environmental engineering, thus coupling a focus on the environment with complementary chemical processing and design skills.

The chemical engineering faculty at the School of Mines strives to keep the curriculum current and dynamic. As a part of this evolution, the faculty continues to develop innovative approaches to teaching chemical engineering lectures and laboratories. An example of this is the integration of process design and simulation throughout the chemical engineering laboratory experiences. Sophisticated process design simulators (such as the commercial software, AspenPlus and COMSOL), are being co-integrated with process design projects. Major funding for the development came from the National Science Foundation and from industrial sponsors. The chemical engineering faculty is also involved in the university's tablet PC program, which has been used to explore new ways to deliver courses and integrate sophisticated process software. In addition, the School of Mines offers the opportunity for students and professors to interact in small groups and individual sessions.

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

First Semester

MATH 123	Calculus I	4
CHEM 112	General Chemistry I	3
CHEM 112L	General Chemistry I Lab	1
GE 130	Introduction to Engr.	2
ENGL 101	Composition I	3
Humanities or Social Sciences Elective(s)		5
TOTAL		**18**

Second Semester

MATH 125	Calculus II	4
CHEM 114	General Chemistry II	3
CHEM 114L	General Chemistry II Lab	1
PHYS 211	University Physics I	3
CBE 111	Intro. Engr. Modeling	1
CBE 117	Prof. Pract. in Chem. Engr.	2
Humanities or Social Sciences Elective(s)		4
TOTAL		**18**

Sophomore Year

First Semester

CBE 217	Chemical Engineering I	3
MATH 225	Calculus III	4
ENGL 279	Technical Comm. I	3
CHEM 326	Organic Chemistry I	3
CHEM 220L	Exp. Organic Chem. IA	1
PHYS 213	University Physics II	3
TOTAL		**17**

Second Semester

CBE 218	Chemical Engineering II	3
CBE 222	Chem. Engr. Thermo. I	3
CBE 250	Comp. App. in Chem. Engr.	2
CHEM 328	Organic Chemistry II	3
MATH 321	Differential Equations	4
Humanities or Social Sciences Elective(s)		3
TOTAL		**18**

Junior Year

First Semester

CBE 317	Chemical Engr. III	3
CBE 321	Chemical Engr. Thermo. II	3
CBE 333	Process Measure and Control	1
CBE 361	Chemical Engr. Lab II	2
CHEM 230	Analytical Chem. for Engr.	2
CHEM 332L	Analytical Chem. Lab	1
CHEM 341	Physical Chem. for Engr. I	2
ENGL 289	Technical Comm. II	3
TOTAL		**17**

Second Semester

CBE 318	Chemical Engineering IV	3
CBE 362	Chemical Engr Lab III	1
CBE 343	Chem Kinetics/Reactor Des	3
CHEM 343	Physical Chem. for Engr II	2
CHEM 345L	Physical Chem. I and II Lab	1
Engineering Elective		3
Department Approved Elective		3

TOTAL		**16**

Senior Year

First Semester

CBE 417	Chemical Engineering V	2
CBE 461	Chemical Engineering Lab IV	1
CBE 464	Chemical Engr. Design I	4
Chemical Engineering Elective		3
Biology Elective		3
Hum/SS 300 Level or Higher Elective(s)		3
TOTAL		**16**

Second Semester

CBE 433	Process Control	3
CBE 465	Chemical Engr Design II	3
CBE 487	Global and Contemporary Issues in Chemical Engineering	1
Chemical Engineering Elective		2
Chemical Engineering Lab Elective		1
Department Approved Elective		4
PE	Physical Education/MUEN	2
TOTAL		**16**

136 credits required for graduation

Curriculum Notes

Board of Regents General Education Requirements: Students working in conjunction with their advisor need to ensure General Education Requirements are completed in the required timeframe. Hum/SS electives require 6 cr hr each from Humanities and Social Sciences. Additionally, 3 cr hr of advanced (300 level or higher) of either Hum or SS is required.

Optional emphases in ChE: The academic advisor recommends and approves courses to take if students are interested in an emphasis in one of these areas: biochemical engineering, environmental engineering, or advanced materials (nano materials, polymers, ceramics, materials processing, corrosion, or solid state/semi-conductors).

BIOL Elective (3 cr hr): Select from BIOL 341, 231, or other approved by advisor.

CHE Elective (5 cr hr): Select 5 credits from CBE 434/434L, 444, 450, 455, 474, 474L, 476, 484, 484L, 488, 491, 492, 498 or others approved by advisor.

CHE Lab Elective (1 cr hr): Select 1 credit from CBE 434L, 474L, 484L, 498 or other approved by advisor.

Engineering Elective (3): Select 3 credits from engineering courses other than CBE prefix; requires advisor approval. These courses are typically at a 200 level or higher.

Department Approved Elective (7): Select from the following: CBE, Chem, or other approved courses to fulfill emphasis electives. These courses are typically at a 150 level or higher. May include up to 3 credits of advanced military science and up to 6 credits of cooperative education (CP 297, CP 397, or CP 497).