# Chemical Engineering B.S.

## Contact Information

**Dr. David J. Dixon**
Department of Chemical and Biological Engineering
Chemistry/Chemical Engineering C220
(605) 394-2421
e-mail: David.Dixon@sdsmt.edu

## Faculty

Professor Dixon, Chair; Professors Bang, Puszynski, and Winter; Associate Professor Gilcrease; Assistant Professors BenjaminBenjamin, Menkhaus, Sani, and Shende.

## Emeritus and Other Faculty

Professors Bauer, Munro, and Sandvig; Professor and Center Director Christopher; Professor and Vice President of Research Pillay.

## 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 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 are:

- 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 high-producing microbes for 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 or aeronautics equipment. Manufacture microchips and intricate circuitry for a variety of electronics applications.

- 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, U, As, Cr, or Pb.

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 SDSM&T Chemical Engineering students may earn. This online program was developed by chemical safety experts to provide cutting edge safety education. It also will give ChE students and graduates an edge over other job candidates, by allowing companies to hire SDSM&T 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, do community service, and participate in regional and national meetings.

At the regional and national AIChE meetings, chemical engineering students from School of Mines compete against chemical engineering students from other universities in such things as research paper presentations, process designs, and a Chem-E Car Competition. School of Mines students compete, and win, 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 2006 Annual AIChE meeting in San Francisco, School of Mines ChE students were recognized for many honors. For example, one student received one of 15 national AIChE scholarships, a student design team from Tech was one of 5 teams to receive an award for their national design project (design safety award), and the ChE Car team placed in the top half during a competition that included many large universities. In Summer 2007, a School of Mines AIChE student will be one of 11 engineering students from throughout the USA who will participate as a Washington Internships for Students of Engineering (WISE) intern in Washington, DC. <www.wise-intern.org> Highlights of the AIChE student chapter activities may be found at: <http://aiche.sdsmt.edu>.

At the 2003 AIChE National Meeting, the student's ChemE-car received 4th place in the competition of the top 31 entries from around the U.S. This is but one example of many opportunities chemical engineering students have to take part in interdisciplinary team activities on campus. The Center for Advanced Manufacturing and Production (CAMP) sponsors several projects in addition to ChemE-car, such as design of a light-weight remote control airplane, and a full sized four wheel off-road vehicle (Mini-Baja car). Chemical engineers work on these projects providing expertise in processing and material usage.

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. While the dollar amount and number of scholarships available fluctuate from year to year, during the fall 2006/spring 2007 academic year approximately 60 percent of undergraduates enrolled in chemical engineering received financial support through a scholarship. In 2007-08 approximately 75 percent of the sophomore – senior ChE students will receive a scholarship. The total amount of scholarships given to all ChE students in 2007-08 was $192,000.

## Laboratories and New Initiatives

The chemical engineering program has laboratory facilities that are used extensively to supplement 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 personal computer laboratory for students to use for addressing the solution of laboratory and classroom problems, and several research laboratories.

A new Ph.D. program in chemical and biological engineering began in July 2007. This Ph.D. program complements nicely the B.S. undergraduate program. Three new faculty members are joining 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 university is actively pursuing a new building to replace the chemistry/chemical engineering building. While this will take a few years to complete, the state of the art building 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 / global collaboration, foster new generations of innovators and leaders, and advance the resources of the State of South Dakota.

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 the unique hands-on open-ended laboratory experience. Students are exposed to the real-world 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 Camile and Opto-22 process controllers. The chemical engineering program is continuing to expand in the growth area of biochemical engineering and biology. Students may develop an emphasis in biochemical engineering through elective courses in biochemistry, microbiology, physiology, and biochemical engineering. Additional biochemical engineering topics are integrated into the core chemical engineering courses. Students can gain hands-on experiences in our state-of-the-art biochemical engineering laboratory, which is substantially funded by the Cargill company. 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 time frame. 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 quality of their education 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 a valuable exposure to the practice of chemical engineering. For each semester or summer term spent in a co-op position, students register for two (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 are actively engaged in research and development and welcomes the participation of undergraduates in these efforts. Additionally, students are encouraged to apply to REU (Research Experience for Undergraduates) 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, bio-processing at Colorado State University, biomedical engineering at the University of Minnesota, and cellulosic biomass conversion at the 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 unique 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 and unique 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 Pipe-Flo), are being co-integrated with the process design project. 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 they have used to explore new ways to deliver courses and integrate sophisticate process software. In addition, School of Mines offers the unique opportunity for students and professors to interact in small groups and one-on-one sessions to focus the student learning to each individual.

It is the student's responsibility to check with his or her advisor 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 |
| CHE 111 | Intro. Eng. Modeling | 1 |
| CHE 117 | Prof. Pract. in Chem. Eng. | 2 |
| Humanities or Social Sciences Elective(s) | | 4 |
| **TOTAL** | | **18** |

### Sophomore Year

**First Semester**

| | | |
|---|---|---|
| CHE 217 | Chemical Engineering I | 3 |
| MATH 225 | Calculus III | 4 |
| ENGL 279 | Technical Communications 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**

| | | |
|---|---|---|
| CHE 218 | Chemical Engineering II | 3 |
| CHE 222 | Chem. Engr. Thermo I | 3 |
| CHE 250 | Comp. App. in Chem. Eng. | 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**

| | | |
|---|---|---|
| CHE 317 | Chemical Engr. III | 3 |
| CHE 321 | Chemical Engr. Thermo II | 3 |
| CHE 333 | Process Measure and Control | 1 |
| CHE 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**

| | | |
|---|---|---|
| CHE 318 | Chemical Engineering IV | 3 |
| CHE 362 | Chemical Engr Lab III | 1 |
| CHE 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**

| | | |
|---|---|---|
| CHE 417 | Chemical Engineering V | 2 |
| CHE 461 | Chemical Engineering Lab IV | 1 |
| CHE 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**

| | | |
|---|---|---|
| CHE 433 | Process Control | 3 |
| CHE 465 | Chemical Engr Design II | 3 |
| CHE 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.

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): Select from BIOL 341, 231, or other approved by advisor.
CHE Elective (5): Select 5 credits from CHE 434/434L, 444, 450, 455, 474, 474L, 484, 484L, 491, 492, 498 or others approved by advisor.

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

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

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