DEPARTMENT OF BIOMEDICAL ENGINEERING AND CHEMICAL ENGINEERING

The Department of Biomedical Engineering and Chemical Engineering offers a Bachelor of Science degree in Biomedical Engineering (BME) and a Bachelor of Science degree in Chemical Engineering (CME). The BME degree is currently accredited by the Accreditation Board for Engineering and Technology (ABET, http://www.abet.org).

The BME degree is an interdisciplinary program that combines engineering principles, approaches, and methodologies with biological, chemical and physical sciences in order to define and solve problems in medicine. Individuals enrolled in the BME degree program are given opportunities to develop a strong background in the engineering, technology and physical and biological sciences to learn the analysis, design, and synthesis tools necessary to function successfully as active participants in new and emerging areas of biosciences, medical devices and healthcare technologies. The Biomedical Engineering and Chemical Engineering department continues to be recognized locally and nationally for the quality of its undergraduate program. BME graduates continue to find positions in industry and are accepted into graduate schools and professional training programs (medicine and dentistry) nationwide. Students are trained in the fundamentals of science and engineering and expected to apply this knowledge to investigate fundamental biomedical engineering questions associated with complex living systems as well as with the diagnosis and treatment of human diseases. A broad understanding of sciences and engineering principles is provided in the first two years of the program. Students develop a degree of depth by selecting courses in three areas of concentration: 1) Biomechanics; 2) Biomaterials and Tissue Engineering; and 3) Biomedical Imaging and Nanotechnology. Critical thinking and innovative design skills are integrated throughout the program to aid students in developing solutions and in solving biomedical engineering-related problems. Design projects throughout the program and Senior BME Design courses provide students the opportunity to integrate their design, critical thinking and communication skills with the scientific and engineering knowledge they acquired throughout the Biomedical Engineering program.

The Chemical Engineering (CME) degree program provides high-quality education and training in chemical engineering through rigorous coursework and hands on experience in state-of-the-art laboratories. Students are requited to take two technical electives from any of the following study areas of Chemical Engineering: 1) Petroleum and Energy Systems, the sector with burgeoning industry demand for well-trained individuals; 2) Materials Engineering, the enabling technical field for microelectronics, energy conversion, and process control; 3) Bioengineering, the emerging area that biology and chemistry interface with bio-systems and healthcare; and 4) Environmental Engineering, the strategic growth area finding resources and environmental solutions for manufacturers and consumers. Evidence-based curricular pedagogies are utilized in the CME courses to ensure that our students develop critical thinking, problem-solving, teamwork and excellent communication skills.

Admission to an Engineering Program

Direct Admission Criteria

Applicants entering UTSA as Freshmen or Freshmen Transfers (fewer than 12 transferable semester credit hours) will be directly admitted to the Biomedical Engineering (BME) or Chemical Engineering (CME) program if they:

- meet all UTSA undergraduate admission requirements,
- qualify for enrollment in MAT 1214 Calculus I , or a higher level mathematics course, and
- are ranked in the top 10 percent of their high school class (no minimum SAT or ACT scores required), *or*
- are ranked below the top 10 percent of their high school class and have a minimum 1200 SAT* or 25 ACT score.

Applicants with SAT scores below 1200 or ACT scores below 25 may undergo admission by committee review.

Transfer requirements for direct admission to the Biomedical Engineering (BME) or Chemical Engineering (CME) program for students who have earned 12 or more transferable semester credit hours:

- meet all UTSA undergraduate transfer admission requirements, and
- have completed MAT 1214 Calculus I and WRC 1013 Freshman Composition I , or the equivalents, with grades of "C-" or better, and
- meet grade point average requirements:
- applicants with a transfer grade point average of 3.00 or higher may be granted direct admission to the College, or
- applicants with a transfer grade point average below 3.00 may be granted admission to the College by committee review. Contact bme@utsa.edu or cme@utsa.edu for information regarding the committee review process.

Applicants who do not meet the Biomedical Engineering and Chemical Engineering department admission requirements will be admitted to the Engineering, Math, and Sciences Studies in the University College. Students have three semesters to complete Calculus I with a grade of "C-" or better and meet the BME or CME Transfer Requirements.

"C-" Grade Rule

A grade of "C-" or better in any science, engineering, or mathematics course required for an engineering degree or any other course that is a prerequisite to a required Biomedical Engineering (BME), Chemical Engineering (CME), or Engineering (EGR) course indicates satisfactory preparation for further engineering education. Any course assigned a grade below a "C-" must be repeated before enrolling in any course for which it is a prerequisite. This requirement is subject to both the Gateway Course and Three-Attempt Limit rules.

Good Academic Standing in BME and CME

All students must be in good academic standing in order to remain in the Biomedical Engineering or Chemical Engineering programs. The minimum requirements that a student must satisfy in order to remain in good standing as a Biomedical Engineering or Chemical Engineering major are stated below:

- A cumulative grade point average (GPA) of at least 3.0 for all coursework (cumulative GPA will be calculated for all courses, including previously attempted or repeated courses).

- An average GPA of at least 3.0 for all science, mathematics and engineering coursework (GPA will be calculated for all courses, including previously attempted or repeated courses).

Students who fail to meet the above requirements but have a minimum cumulative GPA of 2.5 or above will be issued a warning. Students whose GPA falls below 2.5 will be placed on a programmatic probation the following semester. Students who fail to maintain a good academic standing after a semester of programmatic probation will be deemed to not be in good academic standing as a Biomedical Engineering or Chemical Engineering major and will be removed from the programs.

- B.S. degree in Biomedical Engineering (p. 2)
- B.S. degree in Chemical Engineering (p. 5)

Bachelor of Science Degree in Biomedical Engineering

A Bachelor of Science (B.S.) degree in Biomedical Engineering (BME) at UTSA is an interdisciplinary program that combines engineering principles, approaches, and methodologies with biological, chemical and physical sciences in order to define and solve problems in medicine. Students will be trained in the fundamentals of science and engineering and are expected to be able to apply this knowledge to investigate fundamental biomedical engineering questions associated with complex living systems as well as with the diagnosis and treatment of human diseases. A broad understanding of sciences and engineering principles is provided in the first two years of the program, with students having the option to choose one concentration as an in-depth focus area of study in the last two years of the program. Critical thinking and innovative design skills are integrated throughout the program to aid students in developing solutions and in solving biomedical engineering-related problems. Design projects throughout the program and Senior BME Design courses provide students the opportunity to integrate their design, critical thinking and communication skills with the scientific and engineering knowledge they acquired throughout the Biomedical Engineering program. The regulations for this degree comply with the general University regulations (refer to Bachelor's Degree Regulations (http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/)).

Students enrolled in the BME degree program are given opportunities to develop a strong background in the engineering, technology and physical and biological sciences to learn the analysis, design, and synthesis tools necessary to function successfully as active participants in new and emerging areas of biosciences, medical devices and healthcare technologies. The Biomedical Engineering and Chemical Engineering department continues to be recognized locally and nationally for the quality of its undergraduate program. BME graduates continue to find positions in industry and are accepted into graduate schools and professional training programs (medicine and dentistry) nationwide.

Good Academic Standing Requirements for a Biomedical Engineering Major

All students must be in good academic standing in order to remain in the Biomedical Engineering program. The minimum requirements that a student must satisfy in order to remain in good standing as a biomedical engineering major are stated below:

- A cumulative grade point average (GPA) of at least 3.0 for all coursework (cumulative GPA will be calculated on all courses, including previously attempted or repeated courses).
- An average GPA of at least 3.0 for all science, mathematics and engineering coursework (GPA will be calculated on all courses, including previously attempted or repeated courses).

Students who fail to meet the above requirements but have a minimum cumulative GPA of 2.5 or above will be issued a warning at the beginning of the following semester. Students who fail to maintain a cumulative GPA of 2.5 or above will be placed on a programmatic probation at the beginning of the following semester. Students who do not keep a good academic standing after a semester of programmatic probation or who have a cumulative GPA below 2.5 will be deemed to not be in good academic standing as a Biomedical Engineering major and will be removed from the program. These students will have the option to remain in the Klesse College of Engineering and Integrated Design. Students can apply again to be readmitted into the BME program if cumulative UTSA GPA improves above 2.5.

Education Objectives

The objectives of this program are founded on the belief that engineering principles and understanding of biological and physical sciences are critical to the investigation of fundamental bioengineering questions associated with complex living systems as well as with the diagnosis and treatment of human diseases. As such, the program educational objectives of the UTSA Biomedical Engineering program are to prepare graduates who will be able to:

1. Become professionals with careers in industry, government, healthcare, and/or pursue advanced graduate or professional degrees.
2. Continue their professional development as required for their career advancement.
3. Contribute to the socio-economic development of Texas, the nation and the world through the professional and ethical practice of engineering.
4. Assume leadership positions in their chosen field with a commitment to diversity, inclusion, and equity.

The minimum number of semester credit hours required for this degree is 125, at least 39 of which must be at the upper-division level. All candidates for this degree must fulfill the Core Curriculum requirements, the General Engineering requirements, and the degree requirements, listed below.

Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. degree in Biomedical Engineering must fulfill the University Core Curriculum requirements in the same manner as other students. The courses listed below satisfy both major requirements and Core Curriculum requirements; however, if these courses are taken to satisfy both requirements, then students may need to take additional courses in order to meet the minimum number of semester credit hours required for the degree.

MAT 1214 may be used to satisfy the core requirement in Mathematics, as well as one of the General Engineering Requirements. BIO 1203, BIO 1201 and PHY 1943 may be used to satisfy the core requirement in Life and Physical Sciences, as well as one of the General Engineering Requirements.

Core Curriculum Component Area Requirements (http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/)	
First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3
Component Area Option	3
Total Credit Hours	**42**

General Engineering Requirements

All degree-seeking candidates in engineering must complete the following 22 semester credit hours, as well as the Core Curriculum requirements and major requirements:

Code	Title	Credit Hours
CHE 1103	General Chemistry I	3
EGR 2323	Applied Engineering Analysis I	3
MAT 1214	Calculus I	4
MAT 1224	Calculus II	4
or EGR 1324	Calculus II for Engineers	
PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	4
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	4
Total Credit Hours		**22**

Gateway Courses

Students pursuing the B.S. degree in Biomedical Engineering must successfully complete the following Gateway Courses with a grade of "C-" or better in no more than two attempts. A student who is unable to successfully complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change his or her major.

Code	Title	Credit Hours
EGR 2323	Applied Engineering Analysis I	
MAT 1214	Calculus I	

Biomedical Engineering Requirements

Code	Title	Credit Hours
A. Core Biomedical Engineering Requirements		
All students majoring in Biomedical Engineering are required to complete 39 semester credit hours in the following Core Biomedical Engineering courses.		
BME 1002	Introduction to Biomedical Engineering	2
BME 2103	Physiology for Biomedical Engineering	3
BME 2203	Biomechanics I	3
BME 3003	Biomaterials I	3
BME 3013	Clinical Internship in Biomedical Engineering	3
BME 3023	Biomedical Engineering Technology and Product Development	3
BME 3113	Cellular Biology for Biomedical Engineering	3
BME 3121	Cellular Biology for Biomedical Engineering Laboratory	1
BME 3211	Biomedical Engineering Laboratory I	1
BME 3303	Bioinstrumentation	3
BME 3311	Biomedical Engineering Laboratory II	1
BME 3373	Modeling and Simulation Using MATLAB	3
BME 3703	Biotransport Phenomena	3
BME 3711	Biomedical Engineering Laboratory III	1
BME 4903	Senior BME Design I	3
BME 4913	Senior BME Design II	3
B. Other Required Courses		
All students majoring in Biomedical Engineering are required to complete 6 semester credit hours in the following:		
CHE 1113	General Chemistry II	3
STA 1403	Probability and Statistics for the Biosciences	3
or STA 2303	Applied Probability and Statistics for Engineers	
C. Biomedical Engineering Electives		
A minimum of 12 semester credit hours is required to fulfill this requirement. 9 semester credit hours of Biomedical Engineering elective courses must be selected from one of the following three concentrations. The remaining semester credit hours must be selected from other biomedical engineering concentrations to satisfy the Biomedical Engineering electives. Up to 6 semester credit hours of graduate-level biomedical engineering courses may be used to satisfy the Biomedical Engineering electives, with the approval of the advisor, instructor, Graduate Program Director, and Department Chair.		12
Biomechanics Concentration		
BME 3033	Biomedical Engineering Internship	
BME 3041	Biomedical Engineering Research	
BME 3042	Biomedical Engineering Research	
BME 3043	Biomedical Engineering Research	
BME 3203	Biomechanics II: Cardiovascular	
BME 4203	Biomechanics III	
BME 4213	Tissue Mechanics	
BME 4233	Computational Biomechanics	
BME 4293	Topics in Biomechanics	
BME 4803	Biomedical Data Science	
Biomaterials, Cellular, and Tissue Engineering Concentration		
BME 3033	Biomedical Engineering Internship	
BME 3041	Biomedical Engineering Research	
BME 3042	Biomedical Engineering Research	
BME 3043	Biomedical Engineering Research	
BME 3413	Biocompatibility of Materials: Tissue-Biomaterial Interaction	
BME 3503	Nanomaterials and Nanobiotechnology	
BME 4213	Tissue Mechanics	

BME 4423	Tissue Engineering	
BME 4433	Soft Materials	
BME 4443	Stem Cell Engineering	
BME 4483	Topics in Biomaterials	
BME 4493	Topics in Tissue Engineering	
BME 4713	Cellular Engineering	
BME 4793	Topics in Cellular Engineering	
BME 4803	Biomedical Data Science	
Biomedical Imaging and Nanobiotechnology Concentration		
BME 3033	Biomedical Engineering Internship	
BME 3041	Biomedical Engineering Research	
BME 3042	Biomedical Engineering Research	
BME 3043	Biomedical Engineering Research	
BME 3503	Nanomaterials and Nanobiotechnology	
BME 4503	Biosensors	
BME 4603	Biophotonics	
BME 4613	Biomedical Imaging	
BME 4623	Biomedical Optics	
BME 4803	Biomedical Data Science	
D. Technical Electives		
A minimum of 9 semester credit hours of Technical Electives must be completed by all students, with at least 6 semester credit hours chosen from one of the three engineering tracks and the remaining 3 semester credit hours chosen from any of the engineering tracks or from the list of science courses below.		9
Engineering Track 1		
EE 2213	Electric Circuits and Electronics	
EGR 3323	Applied Engineering Analysis II	
EGR 4993	Honors Research	
Engineering Track 2		
EGR 2103	Statics	
EGR 4993	Honors Research	
ME 3293	Thermodynamics I	
ME 3813	Mechanics of Solids	
Engineering Track 3		
EGR 2213	Statics and Dynamics	
EGR 3323	Applied Engineering Analysis II	
EGR 3713	Engineering Economic Analysis	
EGR 4993	Honors Research	
Science Courses		
BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors	
BIO 2313	Genetics	
BIO 3913	Molecular Biology	
CHE 2603	Organic Chemistry I	
CHE 2612	Organic Chemistry I Laboratory	
CHE 3643	Organic Chemistry II	
CHE 3303	Essentials of Biochemistry	
CHE 3313	Biochemistry I	
MAT 2214	Calculus III	
Total Credit Hours		**66**

B.S. in Biomedical Engineering – Recommended Four-Year Academic Plan

First Year

Fall		**Credit Hours**
AIS 1203	Academic Inquiry and Scholarship (core)	3
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors	4
CHE 1103	General Chemistry I	3
MAT 1214	Calculus I (core and major)	4
WRC 1013	Freshman Composition I (core)	3
	Credit Hours	**17**
Spring		
BME 1002	Introduction to Biomedical Engineering	2
CHE 1113	General Chemistry II	3
MAT 1224	Calculus II	4
PHY 1943	Physics for Scientists and Engineers I (core and major)	3
PHY 1951	Physics for Scientists and Engineers I Laboratory	1
WRC 1023	Freshman Composition II (core)	3
	Credit Hours	**16**

Second Year

Fall		
BME 2103	Physiology for Biomedical Engineering	3
EGR 2323	Applied Engineering Analysis I	3
STA 1403 or STA 2303	Probability and Statistics for the Biosciences or Applied Probability and Statistics for Engineers	3
PHY 1963	Physics for Scientists and Engineers II (core and major)	3
PHY 1971	Physics for Scientists and Engineers II Laboratory	1
Technical elective		3
	Credit Hours	**16**
Spring		
BME 2203	Biomechanics I	3
BME 3003	Biomaterials I	3
BME 3113	Cellular Biology for Biomedical Engineering	3
BME 3121	Cellular Biology for Biomedical Engineering Laboratory	1
BME 3211	Biomedical Engineering Laboratory I	1
Technical elective		3
	Credit Hours	**14**
Summer		
BME 3013	Clinical Internship in Biomedical Engineering	3
	Credit Hours	**3**

Third Year		
Fall		
BME 3303	Bioinstrumentation	3
BME 3311	Biomedical Engineering Laboratory II	1
Government-Political Science (core)		3
BME 3373	Modeling and Simulation Using MATLAB	3
Technical elective		3
	Credit Hours	**13**
Spring		
BME 3023	Biomedical Engineering Technology and Product Development	3
BME 3703	Biotransport Phenomena	3
BME 3711	Biomedical Engineering Laboratory III	1
Government-Political Science (core)		3
Upper-division BME elective		3
	Credit Hours	**13**
Summer		
BME 3033	Biomedical Engineering Internship (BME Elective)	3
	Credit Hours	**3**
Fourth Year		
Fall		
BME 4903	Senior BME Design I	3
Upper-division BME elective		3
Upper-division BME elective		3
American History (core)		3
Creative Arts (core)		3
	Credit Hours	**15**
Spring		
BME 4913	Senior BME Design II	3
American History (core)		3
Component Area Option (core)		3
Language, Philosophy and Culture (core)		3
Social and Behavioral Sciences (core)		3
	Credit Hours	**15**
	Total Credit Hours	**125**

Bachelor of Science Degree in Chemical Engineering

A Bachelor of Science (B.S.) degree in Chemical Engineering (CME) is the newest addition to the Klesse College of Engineering and Integrated Design at The University of Texas at San Antonio. The program began welcoming incoming freshman students in the fall of 2017, and provides an exceptional learning environment and opportunities for discovery at UTSA.

Chemical engineering is unique, as it educates students to use chemistry, physics, biology and mathematics to solve engineering problems related to production, transformation, and utilization of chemicals, materials and energy.

The Chemical Engineering program provides high-quality education and training in chemical engineering through structured coursework and hands-on experience in state-of-the-art laboratory facilities. Students are also required to take two technical electives from any of the four following study areas of Chemical Engineering: 1) Petroleum/Energy Engineering, the sector with burgeoning industry demand for well-trained individuals; 2) Materials Engineering, the enabling technical field for microelectronics, energy conversion, and process control; 3) Bioengineering, the emerging area where biology and chemistry interface with bio-systems and healthcare; and 4) Environmental Engineering, the strategic growth area finding resources and environmental solutions for manufacturers and consumers.

The chemical engineering program prepares graduates with the knowledge and skill sets to capture career opportunities – together, our goal is to make the industry more efficient and our world cleaner and healthier.

Study Areas

- Petroleum/Energy Engineering
- Materials Engineering
- Bioengineering
- Environmental Engineering

The regulations for this degree comply with the general regulations of the University (refer to Bachelor's Degree Regulations (http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/)).

Good Academic Standing Requirements for a Chemical Engineering Major

All students must be in good academic standing in order to remain in the Chemical Engineering program. The minimum requirements that a student must satisfy in order to remain in good standing as a chemical engineering major are stated below:

- A cumulative grade point average (GPA) of at least 3.0 for all coursework (cumulative GPA will be calculated for all courses, including previously attempted or repeated courses).
- An average GPA of at least 3.0 for all science, mathematics and engineering coursework (GPA will be calculated for all courses, including previously attempted or repeated courses).

Students who fail to meet the above requirements but have a minimum cumulative GPA of 2.5 or above will be issued a warning at the beginning of the following semester. Students who fail to maintain a cumulative GPA of 2.5 or above will be placed on a programmatic probation at the beginning of the following semester. Students who do not keep a good academic standing after a semester of programmatic probation or who have a cumulative GPA below 2.5 will be deemed to not be in good academic standing as a chemical engineering major and will be removed from the program. These students will have the option to remain in the Klesse College of Engineering and Integrated Design. Students can apply again to be readmitted into CME if cumulative UTSA GPA was improved to above 2.5.

Education Objectives

The Chemical Engineering program is preparing graduates to achieve the following Educational Objectives:

1. Succeed in the practice of chemical engineering through chosen careers in industry, government, or in advanced graduate and/or professional studies.

2. Demonstrate leadership in their chosen field with a commitment to diversity, inclusion, and equity in their chosen profession.
3. Contribute to the socio-economic development of Texas, the nation and the world through the ethical practice of engineering.
4. Embrace life-long learning for professional development and career advancement.

The minimum number of semester credit hours required for this degree is 128, at least 39 of which must be at the upper-division level. All candidates for this degree must fulfill the Core Curriculum requirements, the General Engineering requirements, and the Chemical Engineering requirements, which are listed below.

Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. degree in Chemical Engineering must fulfill the University Core Curriculum requirements in the same manner as other students. The courses listed below satisfy both major requirements and Core Curriculum requirements; however, if these courses are taken to satisfy both requirements, then students may need to take additional courses in order to meet the minimum number of semester credit hours required for the degree.

MAT 1214 may be used to satisfy the core requirement in Mathematics, as well as one of the General Engineering Requirements. PHY 1943 and PHY 1963 may be used to satisfy the core requirement in Life and Physical Sciences, as well as one of the General Engineering Requirements. ECO 2023 may be used to satisfy the core requirement in Social and Behavioral Sciences. EGR 1343 may be used to satisfy the Component Area Option requirement.

Core Curriculum Component Area Requirements (http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/)	
First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3
Component Area Option	3
Total Credit Hours	**42**

General Engineering Requirements

All degree-seeking candidates in engineering must complete the following 22 semester credit hours, as well as the Core Curriculum requirements and major requirements:

Code	Title	Credit Hours
CHE 1103	General Chemistry I	3
EGR 2323	Applied Engineering Analysis I	3
MAT 1214	Calculus I	4
MAT 1224	Calculus II	4
or EGR 1324	Calculus II for Engineers	
PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	4
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	4
Total Credit Hours		**22**

Gateway Courses

Students pursuing the B.S. degree in Chemical Engineering must successfully complete the following Gateway Courses with a grade of "C-" or better in no more than two attempts per course. A student who is unable to successfully complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change his or her major.

Code	Title	Credit Hours
EGR 2323	Applied Engineering Analysis I	
MAT 1214	Calculus I	

Degree Requirements

Students seeking the B.S. degree in Chemical Engineering must complete the following semester credit hours, as well as the Core Curriculum requirements and General Engineering requirements:

Code	Title	Credit Hours
A. Required Chemical Engineering courses (45 semester credit hours)		
CME 1202	Introduction to Chemical Engineering	2
CME 2103	Chemical Process Principles	3
CME 2303	Transport Phenomena I	3
CME 2403	Introduction to Programming for Engineers	3
CME 2503	Thermodynamics I	3
CME 3003	Introduction to Materials Science and Engineering	3
CME 3123	Computational Methods in Chemical Engineering	3
CME 3203	Thermodynamics II	3
CME 3302	Chemical Process Safety and Risk Management	2
CME 3403	Separation Processes	3
CME 3503	Kinetics and Reactor Design	3
CME 3601	Chemical Engineering Laboratory I	1
CME 3703	Transport Phenomena II	3
CME 4103	Process Dynamics and Control	3
CME 4163	Chemical Engineering Design Fundamentals	3
CME 4201	Chemical Engineering Laboratory II	1
CME 4263	Plant Design	3
B. Other required courses (25 semester credit hours)		
CHE 1103 & CHE 1121	General Chemistry I and General Chemistry I Laboratory (CHE 1103 also satisfies a General Engineering Requirement)	4

CHE 1113 & CHE 1131	General Chemistry II and General Chemistry II Laboratory	4
CHE 2603 & CHE 2612	Organic Chemistry I and Organic Chemistry I Laboratory	5
EGR 3323	Applied Engineering Analysis II	3
CHE 3643	Organic Chemistry II	3
EGR 3713	Engineering Economic Analysis	3
STA 2303	Applied Probability and Statistics for Engineers	3
C. Prescribed electives (6 semester credit hours)		
A minimum of 6 semester credit hours must be selected from any of the following areas of study (based on availability):		6
Bioengineering		
CME 2113	Physiology for Chemical Engineering	
CME 2803	Biomechanics I	
BIO 3513	Biochemistry	
CME 3113	Cellular Biology for Chemical Engineering	
CME 3413	Biocompatibility of Materials: Tissue-Biomaterial Interaction	
CME 3803	Biomechanics II	
CME 3903	Bioinstrumentation	
CME 4513	Selected Topics in Bioengineering	
Environmental Engineering		
CE 2633	Environmental Engineering	
CHE 3464	Descriptive Inorganic Chemistry	
CME 4543	Selected Topics in Environmental Engineering	
CE 4603	Water Resources Engineering	
CE 4633	Water and Wastewater Treatment	
ES 6103	Environmental Assessment (with approval)	
Materials Engineering		
CME 2803	Biomechanics I	
EE 2423	Network Theory	
EGR 2103	Statics	
PHY 2103	Modern Physics	
CME 3433	Crystal Chemistry of Structure and Properties	
CME 3903	Bioinstrumentation	
EE 3213	Electromagnetic Engineering	
EE 3323	Electronic Devices	
or PHY 3313	Materials Physics	
ME 3243	Materials Engineering	
ME 3813	Mechanics of Solids	
CME 4533	Selected Topics in Materials Science and Engineering	
EE 4323	Dielectric and Optoelectronic Engineering Laboratory	
EE 4523	Introduction to Nanoelectronics	
Petroleum/Energy Engineering		
EGR 2213	Statics and Dynamics	
PHY 2103	Modern Physics	
CME 4423	Rheology	
CME 4433	Process Optimization	
CME 4523	Selected Topics in Petroleum/Energy Engineering	
Common Electives		
No more than 3 semester credit hours of Independent Study, Research, or Internship courses may count towards electives.		
CME 4701	Chemical Engineering Research	
CME 4702	Chemical Engineering Research	
CME 4703	Chemical Engineering Research	
CME 4803	Chemical Engineering Internship	
CME 4911	Independent Study	
CME 4912	Independent Study	
CME 4913	Independent Study	
Total Credit Hours		**76**

B.S. in Chemical Engineering – Recommended Four-Year Academic Plan

First Year		
Fall		**Credit Hours**
AIS 1243	AIS: Engineering, Mathematics, and Sciences (core)	3
CHE 1103	General Chemistry I	3
CHE 1121	General Chemistry I Laboratory	1
EGR 1343	The Impact of Modern Technologies on Society (core)	3
MAT 1214	Calculus I (core and major)	4
WRC 1013	Freshman Composition I (core)	3
	Credit Hours	**17**
Spring		
CHE 1113	General Chemistry II	3
CHE 1131	General Chemistry II Laboratory	1
CME 1202	Introduction to Chemical Engineering	2
MAT 1224	Calculus II	4
PHY 1943	Physics for Scientists and Engineers I (core and major)	3
PHY 1951	Physics for Scientists and Engineers I Laboratory	1
WRC 1023	Freshman Composition II (core)	3
	Credit Hours	**17**
Second Year		
Fall		
CHE 2603	Organic Chemistry I	3
CHE 2612	Organic Chemistry I Laboratory	2
CME 2103	Chemical Process Principles	3
EGR 2323	Applied Engineering Analysis I	3
PHY 1963	Physics for Scientists and Engineers II (core and major)	3
PHY 1971	Physics for Scientists and Engineers II Laboratory	1
	Credit Hours	**15**
Spring		
CHE 3643	Organic Chemistry II	3
EGR 3323	Applied Engineering Analysis II	3

STA 2303	Applied Probability and Statistics for Engineers	3
CME 2303	Transport Phenomena I	3
CME 2403	Introduction to Programming for Engineers	3
CME 2503	Thermodynamics I	3
	Credit Hours	**18**
Third Year		
Fall		
Creative Arts (core)		3
CME 3003	Introduction to Materials Science and Engineering	3
CME 3123	Computational Methods in Chemical Engineering	3
CME 3203	Thermodynamics II	3
CME 3703	Transport Phenomena II	3
	Credit Hours	**15**
Spring		
CME 3403	Separation Processes	3
CME 3503	Kinetics and Reactor Design	3
CME 3601	Chemical Engineering Laboratory I	1
American History (core)		3
ECO 2023	Introductory Microeconomics	3
CME 3302	Chemical Process Safety and Risk Management	2
	Credit Hours	**15**
Fourth Year		
Fall		
CME 4103	Process Dynamics and Control	3
CME 4163	Chemical Engineering Design Fundamentals	3
CME 4201	Chemical Engineering Laboratory II	1
Elective I		3
American History (core)		3
Government-Political Science (core)		3
	Credit Hours	**16**
Spring		
CME 4263	Plant Design	3
EGR 3713	Engineering Economic Analysis	3
Elective II		3
Government-Political Science (core)		3
Language, Philosophy and Culture (core)		3
	Credit Hours	**15**
	Total Credit Hours	**128**

Biomedical Engineering (BME) Courses

BME 1002. Introduction to Biomedical Engineering. (2-0) 2 Credit Hours. Prerequisites: A grade of "C-" or better, or concurrent enrollment in BIO 1203, BIO 1201, and MAT 1214. This course is an introduction to the interdisciplinary field of biomedical engineering. Topics covered include core biomedical engineering areas, fundamental concepts, ethics, professionalism, careers, and technical skills. Generally offered: Spring. Course Fees: LRE1 $20; STSE $25.

BME 2103. Physiology for Biomedical Engineering. (3-1) 3 Credit Hours. Prerequisites: Major in Biomedical Engineering and a grade of "C-" or better in BIO 1203, BIO 1201, MAT 1214, and BME 1002. Fundamental principles of general and organ systems physiology, including composition and concentration of cellular and other body fluids, types of transport (e.g., diffusion, membrane transporters), energy (e.g., thermodynamics, metabolism), enzymes, feedback control, and membrane potentials with engineering applications and mathematical modeling. This course includes a 3 hour lecture and a 1 hour recitation. (Same as CME 2113. Credit cannot be earned for both BME 2103 and CME 2113.) Generally offered: Fall. Course Fees: LRE1 $25; STSE $30.

BME 2203. Biomechanics I. (3-1) 3 Credit Hours. Prerequisites: MAT 1224 and PHY 1943. Corequisites: BME 3211, EGR 2323, and PHY 1963. Introduction to the fundamental engineering mechanics with focus on the human body. This course includes a 3 hour lecture and a 1 hour recitation. (Same as CME 2803. Credit cannot be earned for both BME 2203 and CME 2803.) Generally offered: Spring. Course Fees: LRE1 $25; STSE $30; DL01 $75.

BME 3003. Biomaterials I. (3-0) 3 Credit Hours. Prerequisites: A grade of "C-" or better in BME 1002 and CHE 1113. Introduction to the fundamental science of natural and synthetic biomaterials used for repairing human tissues and organs. Topics include crystal structures, phase diagrams, and properties of materials. (Formerly listed as BME 2403 in previous catalogs. Credit cannot be earned for both BME 3003 and CME 3003.) Differential Tuition: $165. Course fee: DL01 $75.

BME 3013. Clinical Internship in Biomedical Engineering. (0-0) 3 Credit Hours. Prerequisites: A grade of "C-" or better in BME 3003 and BME 3113 and BME 3121. This course will introduce students to the clinical environment, interacting with clinicians on current clinical problems, and engineering approaches. Generally offered: Summer. Differential Tuition: $165.

BME 3023. Biomedical Engineering Technology and Product Development. (3-0) 3 Credit Hours. Prerequisite: A grade of "C-" or better in BME 3013 and BME 3303. This course will introduce students to current biomedical technologies and product development. (Formerly BME 3022. Credit cannot be earned for both BME 3023 and BME 3022.) Differential Tuition: $165. Course fee: DL01 $75.

BME 3033. Biomedical Engineering Internship. (0-0) 3 Credit Hours. Prerequisite: A grade of "C-" or better in BME 3023. Internship with a biomedical industry. May be repeated for credit but no more than 3 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165.

BME 3041. Biomedical Engineering Research. (0-0) 1 Credit Hour. Prerequisite: Consent of instructor. Advanced laboratory practice and introduction to biomedical engineering research. This course may be counted as one of the courses to satisfy one of the BME tracks. May be repeated for credit but no more than 3 semester credit hours will apply towards a bachelor's degree in Biomedical Engineering. Differential Tuition: $55.

BME 3042. Biomedical Engineering Research. (0-0) 2 Credit Hours. Prerequisite: Consent of instructor. Advanced laboratory practice and introduction to biomedical engineering research. This course may be counted as one of the courses to satisfy one of the BME tracks. May be repeated for credit but no more than 3 semester credit hours will apply towards a bachelor's degree in Biomedical Engineering. Differential Tuition: $110.

BME 3043. Biomedical Engineering Research. (0-0) 3 Credit Hours.
Prerequisite: Consent of instructor. Advanced laboratory practice and introduction to biomedical engineering research. This course may be counted as one of the courses to satisfy one of the BME tracks. May be repeated for credit but no more than 3 semester credit hours will apply towards a bachelor's degree in Biomedical Engineering. Differential Tuition: $165.

BME 3113. Cellular Biology for Biomedical Engineering. (3-0) 3 Credit Hours.
Prerequisites: Major in Biomedical Engineering and a grade of "C-" or better in BME 2103. Introduction to concepts and principles in cell and molecular biology. Topics include the structure and function of biomolecules, the fundamentals of DNA synthesis and repair, gene expression, cell metabolism, cell signaling, the cytoskeleton, and the cell cycle. (Formerly BME 3114. Same as CME 3113. Credit can only be earned for one of the following: BME 3113, BME 3114, and CME 3113.) Differential Tuition: $165.

BME 3121. Cellular Biology for Biomedical Engineering Laboratory. (0-3) 1 Credit Hour.
Prerequisites: Major in Biomedical Engineering and a grade of "C-" or better in BME 2103. Corequisite: BME 3113 (Formerly BME 3114). This laboratory course is designed to reinforce concepts from BME 3113 (Formerly BME 3114) and provide students with the ability to use techniques and procedures commonly used in cell and molecular biology with biomedical engineering applications. Differential Tuition: $55.

BME 3203. Biomechanics II: Cardiovascular. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in BME 2203 and BME 3211. Continuation of fundamental biomechanics to include elasticity, viscoelasticity, deformation, stress analysis, blood flow in the systemic and pulmonary circulation, and fluid-structure interaction. (Same as CME 3803. Credit cannot be earned for both BME 3203 and CME 3803.) Generally offered: Fall. Differential Tuition: $165. Course fee: DL01 $75.

BME 3211. Biomedical Engineering Laboratory I. (0-4) 1 Credit Hour.
Prerequisite: A grade of "C-" or better in BME 1002. Corequisites: BME 2203, BME 3003, and either STA 1403 or STA 2303. A biomedical engineering lab in biomechanics and biomaterials. This lab-based course will emphasize the synthesis and characterization of mechanical properties as well as physical and chemical properties of biomaterials. (Formerly listed as BME 2211 in previous catalogs. Credit cannot be earned for both BME 3211 and BME 2211.) Differential Tuition: $55.

BME 3303. Bioinstrumentation. (3-1) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in BME 2203. Corequisite: BME 3311. Fundamental principles of bioinstrumentation used in clinical and research measurements will be covered. Topics include: principles of transducer operation, amplifiers and signal processing, recording and display. This course includes a 3 hour lecture and a 1 hour recitation. (Same as CME 3903. Credit cannot be earned for both BME 3303 and CME 3903.) Generally offered: Fall. Differential Tuition: $165. Course fee: DL01 $75.

BME 3311. Biomedical Engineering Laboratory II. (0-4) 1 Credit Hour.
Corequisite: BME 3303. A biomedical engineering lab in bioinstrumentation. This course will involve the design and testing of hardware and software for acquiring and analyzing biological signals. Generally offered: Fall. Differential Tuition: $55.

BME 3373. Modeling and Simulation Using MATLAB. (3-0) 3 Credit Hours.
Prerequisites: Junior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 2103, BME 2203, and BME 3211, or permission by instructor. Corequisite: BME 3311. Introduction to programming using MATLAB. Topics may include modeling biomedical phenomena including neuronal action potentials, muscles, the heart and circulatory system, and problem solving in biomechanics. Differential Tuition: $165.

BME 3413. Biocompatibility of Materials: Tissue-Biomaterial Interaction. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in BME 3003, BME 3113, and BME 3121. This course is an introduction to the interactions of cells and tissues with biomaterials. Blood composition and blood-material interactions, responses of the inflammatory and immune systems to biomaterials, the process of wound healing, protein structure and interactions with material surfaces, the mechanisms of cell interactions with extracellular matrix components, and cell/tissue responses to implant materials are reviewed in detail. Case studies of cardiovascular and orthopedic implants are discussed to illustrate that judicious selection of materials is a key aspect of implant design and a crucial choice for the success of various biomedical applications (e.g., in tissue engineering and biotechnology) which require regeneration of tissues. (Same as CME 3413. Credit can only be earned for one of the following: BME 3413, BME 4423, or CME 3413). Generally offered: Fall. Differential Tuition: $165. Course fee: DL01 $75.

BME 3503. Nanomaterials and Nanobiotechnology. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in BME 3003. This course will introduce an overview of nanomaterials and nanotechnology development. Topics may include biocompatible nanomaterials, microfabrication, microfluidics, lab-on-a-chip, and applications in biomedical engineering. (Formerly titled "Fundamentals of Nanobiotechnology.") (Same as CME 3513. Credit cannot be earned for both BME 3503 and CME 3513.) Generally offered: Spring. Differential Tuition: $165. Course fee: $75.

BME 3703. Biotransport Phenomena. (3-1) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in BME 3703 and BME 3373. Corequisite: BME 3711. This course introduces the concepts of quantitative modeling of biological systems with respect to mass, momentum, and energy transport. We will study the use of conservation laws to model cardiopulmonary, renal, and thermal systems of the human physiology, and apply these principles to design artificial and extracorporeal devices and drug delivery systems for pharmacokinetic analysis. This course includes a 3 hour lecture and a 1 hour recitation. Generally offered: Spring. Differential Tuition: $165.

BME 3711. Biomedical Engineering Laboratory III. (0-4) 1 Credit Hour.
Corequisite: BME 3703. A biomedical engineering lab in biotransport phenomena. Experiments related to mass, momentum, and energy conservation in biological systems such as measurements of apparent viscosity in microcirculation, oxygen diffusivity and thermal conductivity. Generally offered: Spring. Differential Tuition: $55.

BME 4203. Biomechanics III. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in BME 2203. Topics may include elasticity, viscoelasticity, deformation, stress and strain analysis, stress and strain in tissue and organs, and problem solving and design in biomechanics using statics, mechanics of materials, kinematics, and/or dynamics concepts. Differential Tuition: $165.

BME 4213. Tissue Mechanics. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in BME 2203. Topics may include biomechanics characterization, modeling, and properties of regenerating tissues ranging from bone, cartilage, tendons, ligaments, skin, adipose tissue, nerves, bladder, eye, and pulmonary and cardiovascular tissues. Differential Tuition: $165.

BME 4233. Computational Biomechanics. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in BME 2203 or consent from the instructor. This course will provide students with practical knowledge and tools to perform biomechanical analysis through computational modeling. The course applies fundamentals of mechanics of material and the methods of computational modeling such as the finite element method (FEM) to model biological systems and biomechanical components and simulate biomedical phenomena. Examples and problems may be solved analytically and with the use of commercially available FEM software. Some basic knowledge of computer programming is recommended. Differential Tuition: $165.

BME 4283. Impact Biomechanics. (3-0) 3 Credit Hours.
Prerequisites: Senior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 2203 or consent from the instructor. This course will cover the response of the human organism to impact loading. Topics will include dynamics, kinetics, injury mechanisms of the head, spine, thorax, abdomen, and extremities, human tolerance to impact, anthropomorphic test devices, mathematical models, and human subject testing. Impact scenarios covered will include automotive, aerospace, combat, and sports. Maybe repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165.

BME 4293. Topics in Biomechanics. (3-0) 3 Credit Hours.
Prerequisites: Senior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 2203. Specific topics in biomechanics. May be repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165. Course fee: DL01 $75.

BME 4423. Tissue Engineering. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in BME 3003, BME 3113, and BME 3121. This course is an introduction to the current status of practice and advances in tissue engineering. Tissue engineering is the biomedical engineering discipline that applies science and technology to develop replacements for damaged and/or diseased tissues of the body. The course focuses on fundamental aspects of new tissue formation, specifically cells, biomaterials, biochemical cues and biophysical stimuli, which are part of the physiological milieu. Applications of the latest advances in current knowledge of the aforementioned aspects in designing and formulating cell-containing constructs composed of natural and/or synthetic biomaterial scaffolds is necessary for successful outcomes in tissue engineering. Examples of applications in bone, cartilage, skin, and vascular tissues are reviewed in detail. Strategies which are used to address current challenges, pursue emerging opportunities, and explore new scientific directions are discussed. (Same as BME 3413 and CME 3413. Credit can only be earned for one of the following: BME 3413, BME 4423, or CME 3413). Differential Tuition: $165. Course fee: DL01 $75.

BME 4433. Soft Materials. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in BME 3003 or CME 3003 and a junior or senior status in the program. A review of specific topics in soft biomaterials with an emphasis on the use of polymer matrices. Aspects of material synthesis and characterization will be addressed, along with their applications in nano- and micro-technologies, drug delivery, biosensing, and tissue engineering. Differential Tuition: $165.

BME 4443. Stem Cell Engineering. (3-0) 3 Credit Hours.
Prerequisites: BME 3003 or CME 3003, BME 3113 (BME 3114 in previous catalogs), BME 3121, and senior status in the program. A review of special topics and recent advancements in stem cell engineering. Differential Tuition: $165.

BME 4483. Topics in Biomaterials. (3-0) 3 Credit Hours.
Prerequisites: Senior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 3003. Specific topics in biomaterials. May be repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165. Course fee: $75.

BME 4493. Topics in Tissue Engineering. (3-0) 3 Credit Hours.
Prerequisites: Senior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 3003, BME 3113 (BME 3114 in previous catalogs), and BME 3121. Specific topics in tissue engineering. May be repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165.

BME 4503. Biosensors. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in BME 3303. Basics to biological detection and in-depth view of device design and performance analyses. Topics may include optical, electrochemical, acoustic, piezoelectric, and nanobiosensors. Differential Tuition: $165.

BME 4603. Biophotonics. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in EGR 2323. This course will introduce the fundamental principles of biophotonics and will focus on their applications to address critical issues in the frontier of biomedical science and technology. Topics may include fundamentals of light interactions with molecules, cells, and tissues, optical imaging, optical biosensing, flow cytometry, photodynamic therapy, laser tweezers and laser surgery, and nanobiotechnology. Generally offered: Fall. Differential Tuition: $165. Course fee: DL01 $75.

BME 4613. Biomedical Imaging. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in EGR 2323. This course will examine, from a systems perspective, the techniques used in a variety of medical imaging modalities, which include x-ray imaging, computed tomography, magnetic resonance imaging, nuclear medicine, ultrasound imaging, and photoacoustic imaging. The fundamental principles and engineering underlying each imaging modality will be discussed and a performance analysis of each system will be examined. Differential Tuition: $165. Course fee: DL01 $75.

BME 4623. Biomedical Optics. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in EGR 2323. This course will introduce the fundamental principles of modern and classical optics and their applications for biomedical research. State-of-the-art topics on cutting-edge research in the area of optics and lasers in medicine and biology will be covered. Differential Tuition: $165.

BME 4713. Cellular Engineering. (3-0) 3 Credit Hours.
Prerequisites: BME 3113 and BME 3121. This course focuses on the engineering of cell function for applications in biomedical engineering. Topics include cell conditioning, genetic engineering and gene therapy, basic principles of stem cell engineering, and translational applications of cell engineering. Differential Tuition: $165. Course fee: $75.

BME 4793. Topics in Cellular Engineering. (3-0) 3 Credit Hours.
Prerequisites: Senior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 3113 (BME 3114 in previous catalogs), BME 3121, and EGR 2323. Specific topics in cellular engineering. May be repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165. Course fee: DL01 $75.

BME 4803. Biomedical Data Science. (3-0) 3 Credit Hours.
Prerequisites: Major in Biomedical Engineering and a grade of "C-" or better in BME 1002 and EGR 2323, or permission from instructor. This course will introduce students to computational methods to understand and analyze biological data. Topics covered include analysis of molecular, clinical, and epidemiology data, network modeling, image analysis, and emerging methods in artificial intelligence. Differential Tuition: $165.

BME 4903. Senior BME Design I. (3-0) 3 Credit Hours.
Prerequisites: Senior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 3023 and BME 3703. Development of project proposals and presentation of conceptual designs. Industrial collaboration and/or faculty sponsorship of these projects is encouraged. Differential Tuition: $165.

BME 4913. Senior BME Design II. (3-0) 3 Credit Hours.
Prerequisite: Senior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 4903. Continuation of the development of an instructor-approved design project, testing of the design project, and presentation of the findings. Industrial cooperation or faculty sponsorship of projects is encouraged. Differential Tuition: $165.

BME 4923. Orthopaedic Device Design. (3-0) 3 Credit Hours.
Prerequisites: Senior status with a major in Biomedical Engineering and a grade of "C-" or better in BME 2203, or consent from the instructor. This course will educate students about current biomedical technologies and product development. Topics covered will include ideation, concept development, design methodologies, business plan basics, regulatory concepts for medical devices and intellectual property management. Maybe repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165.

Chemical Engineering (CME) Courses

CME 1202. Introduction to Chemical Engineering. (2-0) 2 Credit Hours.
A broad survey of the practice of chemical engineering, intended to expose students to various areas of chemical engineering and potential career paths (e.g., bioengineering, environmental engineering, materials engineering, and petroleum/energy engineering) through discussions and guest lectures. Students will review ethics and safety, and practice technical communication through oral presentations and written assignments. Course fees: LRE1 $25; STSE $20.

CME 2103. Chemical Process Principles. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in CHE 1113, CME 1202, and MAT 1214. Students will first learn basic principles of chemical engineering, including temperature, pressure, pressure head, mass, moles, volume, concentration, density, time-dependent variables, and buoyancy. They will apply techniques such as interpolation, linearization, statistical analysis, and Gauss-Jordan elimination. Students will define system boundaries for closed and open systems to apply material and energy balances to single units and multiple unit processes; processes containing recycle loops; non-reactive and reactive processes; processes with ideal and nonideal gases; and processes with liquid-liquid equilibrium, solid-vapor equilibrium, and single and multi-component vapor liquid equilibrium. Students will learn the first law of thermodynamics to derive and apply the general energy balance, mechanical energy balance, and Bernoulli equation. Students will learn the differences between extensive versus intensive variables, and state functions versus path functions. Students will develop an understanding of system and stream energies (enthalpy, internal energy, potential energy, and kinetic energy) versus energy transfer terms (heat and work) and apply them to non-reactive and reactive chemical processes. Course Fees: LRE1 $25; STSE $30; DL01 $75.

CME 2113. Physiology for Chemical Engineering. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" of better in BIO 1203 and MAT 1214. Fundamental principles of general and organs physiology, including composition and concentration of cellular and other body fluids, types of transport (e.g., diffusion, membrane transporters), energy (thermodynamics, metabolism), enzymes, feedback control, and membrane potentials with engineering applications and mathematical modeling. (Same as BME 2103. Credit cannot be earned for both CME 2113 and BME 2103.) Course Fees: LRE1 $25; STSE $30.

CME 2301. Chemical Process Safety and Risk Management. (1-0) 1 Credit Hour.
(This course is for students in catalogs prior to 2022-2024.) Application of chemical process safety, risk assessment and management, including hazardous waste disposal and remediation. (Same as CME 3302 and CME 4001. Credit cannot be earned for more than one of the following: CME 2301, CME 3302, and CME 4001.) Course Fees: LRE1 $25; STSE $10.

CME 2303. Transport Phenomena I. (3-1) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2103. This course covers the fundamentals of momentum transport, fluid mechanics, and fluid unit operations. Topics discussed include fluid statics, fluid properties and fluid flow, overall mass, energy and momentum balances, incompressible and compressible flow in pipes, flow in packed and fluidized beds, pumps, compressors, agitators and nozzles, differential equations of fluid flow, non-Newtonian fluids, potential and creeping flow, and boundary layer and turbulent flow. This course includes a 3-hour lecture and a 1-hour recitation per week. (Credit cannot be earned for both CME 2303 and CME 3303). Course Fees: LRE1 $25; STSE $30.

CME 2403. Introduction to Programming for Engineers. (3-0) 3 Credit Hours.
This course is designed to provide a foundation in programming. Topics include data types, the use of variables for storing data, arrays and strings, mathematical and logical expressions, loops, intro to data structures, structured program design, file input and output, plotting 2-D and 3-D data, and application to solving engineering problems. Course fees: LRE1 $25; STSE $30.

CME 2503. Thermodynamics I. (3-1) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2103. Thermodynamic analysis and modeling of pure component and constant concentration systems. Topics include basic thermodynamic variables, introductory equations of state, first and second laws of thermodynamics (close and open systems), reversible and irreversible processes, thermodynamic cycles, thermodynamic potentials, Maxwell relations, phase change properties and introduction to statistical thermodynamics. (Credit cannot be earned for both CME 2503 and CME 3103 or ME 3293.) This course includes a 3-hour lecture and a 1-hour recitation per week. Course Fees: LRE1 $25; STSE $30.

CME 2803. Biomechanics I. (3-1) 3 Credit Hours.
Prerequisites: A grade of "C-" of better in EGR 2323 and PHY 1963. Introduction to fundamental engineering mechanics with focus on the human body. (Same as BME 2203. Credit cannot be earned for both CME 2803 and BME 2203.) Course Fees: LRE1 $25; STSE $30; DL01 $75.

CME 3003. Introduction to Materials Science and Engineering. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 1202. Foundation for understanding the structure and properties of engineering materials such as ceramics, glass, polymers, composites, biomaterials, metals and alloys. An integrated introduction of materials' microstructure, thermodynamic properties, and corresponding mechanical, electrical, optical, and magnetic properties. (Same as BME 3003. Credit cannot be earned for both CME 3003 and BME 3003.) Differential Tuition: $165. Course fee: DL01 $75.

CME 3103. Thermodynamics I. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in CME 2103 and completion of or concurrent enrollment in CHE 3804. This course is intended for students in catalogs prior to the 2022-2024 edition. Heat, work, equations of state, thermodynamic systems, control volume, first and second laws of thermodynamics, applications of the laws of thermodynamics, reversible and irreversible processes, introduction to basic thermodynamic cycles, vapor-liquid equilibria, and non-ideal solutions. One hour of problem solving recitation per week. (Credit cannot be earned for more than one of the following: CME 2503, CME 3103, CME 3203, and ME 3293). Differential Tuition: $165.

CME 3113. Cellular Biology for Chemical Engineering. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2103. Introduction to concepts and principles in cell and molecular biology. Topics include the structure and function of biomolecules, the fundamentals of DNA synthesis and repair, gene expression, cell metabolism, cell signaling, the cytoskeleton, and the cell cycle. This class consists of a 3-hour lecture. (Same as BME 3114 and BME 3113. Credit can only be earned for one of the following: CME 3113, BME 3114, or BME 3113.) Differential Tuition: $165. Course fee: DL01 $75.

CME 3123. Computational Methods in Chemical Engineering. (3-1) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2403; completion of or concurrent enrollment in EGR 3323. Introduction to numerical techniques and computational tools essential for chemical engineering, including the use of data acquisition and processing, numerical analysis of linear, non-linear, and differential equations. Students will learn to use computer software to aid in their analysis (e.g., Matlab). This course includes a 3-hour lecture and a 1-hour recitation per week. Differential Tuition: $165.

CME 3203. Thermodynamics II. (3-1) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 3603 (CME 2203 in previous catalogs). Thermodynamic analysis and modeling of pure and multicomponent mixtures with variable concentration. This course focuses mainly on phase and chemical equilibria. Topics covered include thermodynamic properties estimation, equations of state, fugacity, activity coefficient models, chemical reactions and equilibrium, and intermolecular forces. (Credit cannot be earned for both CME 3203 and CME 3103 or ME 3293.) This course includes a 3-hour lecture and a 1-hour recitation per week. Differential Tuition: $165.

CME 3302. Chemical Process Safety and Risk Management. (2-0) 2 Credit Hours.
Application of process safety and risk assessment and management in the petrochemical and related industries. The Risk Based Process Safety (RBPS) framework is used. Process safety design strategies are incorporated in a team project to complete a Hazard Identification and Risk Analysis (HIRA) for a given petrochemical process. Impact on employees, community, and the environment are addressed. The course includes lectures, guest speakers from industry, and investigation of case studies involving significant process safety events. (Same as CME 2301 and CME 4001. Credit cannot be earned for more than one of the following: CME 2301, CME 3302, and CME 4001.) Differential Tuition: $110.

CME 3303. Transport Phenomena I. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2103. This course is intended for students in catalogs prior to the 2022-2024 edition. This course covers the fundamental of momentum transport, fluid mechanics and fluid unit operations. Topics discussed include fluid statics, fluid properties and fluid flow, overall mass, energy and momentum balances, incompressible and compressible flow in pipes, flow in packed and fluidized beds, pumps, compressors, agitators and nozzles, differential equations of fluid flow, non-Newtonian fluids, potential and creeping flow and boundary layer and turbulent flow. (Credit cannot be earned for both CME 3303 and CME 2303.) Differential Tuition: $165. Course fee: DL01 $75.

CME 3403. Separation Processes. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2303 (Formerly CME 3303). This course covers unit operations associated with mass transfer. Topics covered include absorption and stripping, humidification processes, filtration and membrane separations, distillation, liquid-liquid extraction, adsorption and ion exchange, settling, evaporation and drying. Differential Tuition: $165.

CME 3413. Biocompatibility of Materials: Tissue-Biomaterial Interaction. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in CME 3003 and CME 3113. This course is an introduction to the interactions of cells and tissues with biomaterials. Blood composition and blood-material interactions, responses of the inflammatory and immune systems to biomaterials, the process of wound healing, protein structure and interactions with material surfaces, and the mechanisms of cell interactions with extracellular matrix components as well as cell/tissue responses to implant materials are reviewed in detail. Case studies of cardiovascular and orthopedic implants are discussed to illustrate that judicious selection of materials is a key aspect of implant design and a crucial choice for the success of various biomedical applications (e.g., in tissue engineering and biotechnology) which require regeneration of tissues. (Same as BME 3413. Credit cannot be earned for both CME 3413 and BME 3413.) Differential Tuition: $165.

CME 3433. Crystal Chemistry of Structure and Properties. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 3003. Principles of crystal chemistry applied to the relationships of crystallographic structures, compositions, and engineering properties of materials. Differential Tuition: $165.

CME 3503. Kinetics and Reactor Design. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in CHE 3804 and CME 2303 (Formerly CME 3303). Fundamental principles to the design and analysis of batch, continuously stirred tank, and fixed bed chemical reactors; steady and unsteady state operations; effects of pressure and temperature; heterogeneous catalysis; analysis of transport processes in catalysis; special topics may include enzyme catalysis; fluid bed reactors; membrane reactors; and microscale reactors. Differential Tuition: $165. Course fee: DL01 $75.

CME 3513. Nanomaterials and Nanobiotechnology. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 3003. This course will introduce an overview of nanomaterials and nanotechnology development. Topics may include biocompatible nanomaterials, microfabrication, microfluidics, lab-on-a-chip, and applications in biomedical engineering. (Same as BME 3503. Credit cannot be earned for both CME 3513 and BME 3503.) Differential Tuition: $165.

CME 3601. Chemical Engineering Laboratory I. (0-3) 1 Credit Hour.
Prerequisite: Completion of or concurrent enrollment in CME 3503. Basic principles and statistical design of experiments using software tools; experiments demonstrating key unit operations with emphasis on fluid flow and heat transfer. Written reports and oral presentations required. Differential Tuition: $55.

CME 3603. Computational Methods in Chemical Engineering. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2403. Introduction to numerical techniques and computational tools essential for chemical engineering, including the use of data acquisition and processing, numerical analysis of linear, non-linear, and differential equations. Students will learn to use computer software to aid in their analysis (e.g., Matlab). This course includes a 3-hour lecture and a 1-hour recitation per week. (Formerly CME 2203. Credit cannot be earned for both CME 3603 and CME 2203.) Differential Tuition: $165.

CME 3703. Transport Phenomena II. (3-1) 3 Credit Hours.
Prerequisite: CME 2303 (CME 3303 in previous catalogs) or instructor approval. This course focuses on the fundamentals and applications associated with heat and mass transfer. Topics discussed steady state conduction, principles of unsteady state heat transfer, convection, heat transfer coefficients, heat exchangers, radiation, steady state mass transfer, diffusions, convection, mass transfer coefficients, and unsteady state mass transfer. This course includes a 3-hour lecture and a 1-hour recitation per week. Differential Tuition: $165. Course fee: DL01 $75.

CME 3803. Biomechanics II. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2803. Continuation of fundamental biomechanics to include elasticity, viscoelasticity, deformation, stress analysis, blood flow in the systemic and pulmonary circulation, and fluid-structure interaction. (Same as BME 3203. Credit cannot be earned for both CME 3803 and BME 3203.) Differential Tuition: $165. Course fee: DL01 $75.

CME 3903. Bioinstrumentation. (3-1) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 2803. Topics include: principles of transducer operation, amplifiers and signal processing, recording and display. This course includes a 3 hour lecture and a 1 hour recitation per week. (Same as BME 3303. Credit cannot be earned for both CME 3903 and BME 3303.) Differential Tuition: $165.

CME 4103. Process Dynamics and Control. (3-1) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 3403. Modeling of dynamic processes; response of uncontrolled systems; transfer functions; response and stability of controlled systems; frequency response; design of feedback controllers; cascade, feed forward and multivariable control systems; process Instrumentation; use of simulators to design feedback controllers. One hour of problem solving recitation per week. Differential Tuition: $165. Course fee: DL01 $75.

CME 4163. Chemical Engineering Design Fundamentals. (3-0) 3 Credit Hours.
Prerequisites: A grade of "C-" or better in CME 3203 and CME 3403. Application of design and economic principles to chemical engineering systems; analysis of costs of equipment, feedstocks, utilities, and risk assessment; optimization of equipment design using simulation tools. Students will be assembled in teams to perform materials and energy balances on their capstone design projects. (Formerly titled Thermodynamics II.) Differential Tuition: $165. Course fee: DL01 $75.

CME 4201. Chemical Engineering Laboratory II. (0-3) 1 Credit Hour.
Prerequisite: Completion of or concurrent enrollment in CME 4103. Experiments demonstrating key unit operations with emphasis on mass transfer with and without reactions; hands on experience with process control. Written and oral reports required. Differential Tuition: $55.

CME 4263. Plant Design. (3-0) 3 Credit Hours.
Prerequisite: A grade of "C-" or better in CME 4163 and CME 3302. Strategic application of technical and economic constraints in the design of a chemical processing plant including most aspects of typical industrial design, integration of process safety, and environmental impact factors. Students will work in small groups and submit a plant design project report that has a comprehensive design of all equipment included in the plant. Students will present the results of their design in a College of Engineering and Integrated Design-wide symposium. Differential Tuition: $165.

CME 4423. Rheology. (3-0) 3 Credit Hours.
Prerequisites: To be determined by the instructor. This course covers the fundamentals of rheology as they apply to the oil and gas industry. Topics covered include crude oil flow rheology, drilling fluids, fluids in completion, crude oil pipelining, and fractal characterization of wax. Differential Tuition: $165.

CME 4433. Process Optimization. (3-0) 3 Credit Hours.
Modern optimization theory, algorithms, and applications for large scale chemical engineering real-world problems. Topics included in the course and prerequisites required for the course will be decided upon by the instructor who teaches the course. Differential tuition: $165.

CME 4513. Selected Topics in Bioengineering. (3-0) 3 Credit Hours.
Prerequisites: May vary with the topic (refer to the course syllabus on Bluebook or contact the instructor). An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. May be repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165. Course fee: DL01 $75.

CME 4523. Selected Topics in Petroleum/Energy Engineering. (3-0) 3 Credit Hours.
Prerequisites: May vary with the topic (refer to the course syllabus on Bluebook or contact the instructor). An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. May be repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165. Course fee: DL01 $75.

CME 4533. Selected Topics in Materials Science and Engineering. (3-0) 3 Credit Hours.
Prerequisites: May vary with the topic (refer to the course syllabus on Bluebook or contact the instructor). An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. May be repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Differential Tuition: $165. Course fee: DL01 $75.

CME 4543. Selected Topics in Environmental Engineering. (3-0) 3 Credit Hours.
Prerequisites: May vary with the topic (refer to the course syllabus on Bluebook or contact the instructor). An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. May be repeated for credit when topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree. Course Fees: LRE1 $25; STSE $30. Differential Tuition: $165. Course fee: DL01 $75.

CME 4701. Chemical Engineering Research. (0-0) 1 Credit Hour.
Prerequisite: Permission in writing (form online) from the instructor, the student's advisor, and the Department Chair. Advanced laboratory practice and introduction to chemical engineering research. This course may be used to satisfy one of the electives for the CME tracks. May be repeated for credit but no more than 3 semester credit hours will apply towards the bachelor's degree in Chemical Engineering. This course cannot be taken if 3 semester credit hours in CME 4913 or CME 4803 have already been earned. Differential Tuition: $55.

CME 4702. Chemical Engineering Research. (0-0) 2 Credit Hours.
Prerequisite: Permission in writing (form online) from the instructor, the student's advisor, and the Department Chair. Advanced laboratory practice and introduction to chemical engineering research. This course may be used to satisfy one of the electives for the CME tracks. May be repeated for credit but no more than 3 semester credit hours will apply towards the bachelor's degree in Chemical Engineering. This course cannot be taken if 3 semester credit hours in CME 4913 or CME 4803 have already been earned. Differential Tuition: $110.

CME 4703. Chemical Engineering Research. (0-0) 3 Credit Hours.
Prerequisite: Permission in writing (form online) from the instructor, the student's advisor, and the Department Chair. Advanced laboratory practice and introduction to chemical engineering research. This course may be used to satisfy one of the electives for the CME tracks. May be repeated for credit but no more than 3 semester credit hours will apply towards the bachelor's degree in Chemical Engineering. This course cannot be taken if 3 semester credit hours in CME 4913 or CME 4803 have already been earned. Differential Tuition: $165.

CME 4803. Chemical Engineering Internship. (0-0) 3 Credit Hours.
Prerequisite: Permission in writing (form online) from the instructor, the student's advisor, and the Department Chair. Internship in the chemical engineering industry. No more than 3 semester credit hours will apply to the bachelor's degree in Chemical Engineering. This course cannot be taken if 3 semester credit hours in CME 4913 or CME 4703 have already been earned. Differential Tuition: $165.

CME 4911. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Permission in writing (Independent Study Form available online) from the instructor and the Department Chair. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 3 semester credit hours of independent study will apply to a bachelor's degree in Chemical Engineering. This course cannot be taken if 3 semester credit hours in CME 4703 or CME 4803 have already been earned. (Formerly CME 4601. Credit cannot be earned for both CME 4601 and CME 4911.) Differential Tuition: $55.

CME 4912. Independent Study. (0-0) 2 Credit Hours.
Prerequisites: Permission in writing (Independent Study Form available online) from the instructor and the Department Chair. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 3 semester credit hours of independent study will apply to a bachelor's degree in Chemical Engineering. This course cannot be taken if 3 semester credit hours in CME 4703 or CME 4803 have already been earned. Formerly CME 4602. Differential Tuition: $110.

CME 4913. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Permission in writing (Independent Study Form available online) from the instructor and the Department Chair. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 3 semester credit hours of independent study will apply to a bachelor's degree in Chemical Engineering. This course cannot be taken if 3 semester credit hours in CME 4703 or CME 4803 have already been earned. Formerly CME 4603. Credit cannot be earned for both CME 4603 and CME 4913. Differential Tuition: $165.