CHEMICAL AND MATERIALS ENGINEERING

Major:

- Bachelor of Chemical Engineering (p. 1)

Concentration:

- Energy Systems-Chemical (p. 2)

Minors:

- Bioengineering (p. 3)
- Chemical Processing (p. 3)
- Composite Materials Engineering (p. 3)
- Energy Production Engineering (p. 3)
- Materials Engineering (p. 4)
- Polymer Materials (p. 4)

The Chemical and Materials Engineering Department offers an undergraduate program leading to a Bachelor of Chemical Engineering degree. Chemical engineering applies the principles of the physical sciences, economics, and human relations to research, design, build, and supervise facilities that convert raw materials into useful products and services.

The majority of chemical engineers are involved in the chemical process industries that produce many of the materials and items needed in everyday life. These include medicine, food, fertilizers, plastics, synthetic fibers, petroleum, petrochemicals, ceramics, and pulp and paper products. A chemical engineer may pursue a professional career in many other fields, such as energy conversion, pollution control, medical research, and materials development in aerospace and electronic industries. Chemical engineers are employed in research, development, design, production, sales, consulting, and management positions. They are also found in government and academia. Many use a chemical engineering education as a pathway to law, medicine, or corporate management.

The curriculum in chemical engineering serves as basic training for positions in these diverse areas of the manufacturing industry or for graduate study leading to advanced degrees. The first part of the chemical engineering curriculum provides a firm foundation in mathematics, physics, and chemistry. The chemistry background is stressed. The second part of the curriculum offers a balance between classroom and laboratory experience in stressing chemical engineering topics such as transport phenomena, thermodynamics, kinetics and reactor design, separation processes, fluid flow and heat transfer operations, process control, and process design. The development of design tools, communication, and interpersonal skills is integrated throughout the curriculum. The curriculum allows minors in emerging technologies such as bioengineering, environmental engineering, and materials engineering. Those interested in attending medical/dental school can pursue a premed preparation as part of their curriculum.

The educational objectives of chemical engineering program graduates:

- have successful careers in the chemical process industry with the skills necessary to have opportunities to work in non-traditional industries and positions
- be successful at prestigious graduate, medical, and law schools
- be committed to performing ethically while serving their professions, companies, and communities
- exhibit strong critical thinking skills from the breadth of their general education and the depth of their foundation in engineering principles, and engage in continuous intellectual and personal growth

Faculty
Charles E. Browning, Department Chairperson
Michael Elsass, Chemical Engineering Director
Professors Emeriti: Eylon, Flach, Lu, Snide
Professors: Browning, Lafdi, Lee, Myers, T. Saliba, Sandhu, Wilkens
Associate Professor: D. Comfort
Assistant Professors: K. Comfort, Vasquez
Senior Lecturer: Ciric
Lecturer: Elsass

Bachelor of Chemical Engineering (CME) minimum 137 hours

Common Academic Program (CAP)

*credit hours will vary depending on courses selected		
First-Year Humanities Commons [1]		12
HST 103	The West & the World	
REL 103	Introduction to Religious and Theological Studies	
PHL 103	Introduction to Philosophy	
ENG 100	Writing Seminar I [2]	
Second-Year Writing Seminar [3]		0-3
ENG 200	Writing Seminar II	
Oral Communication		3
CMM 100	Principles of Oral Communication	
Mathematics		3
Social Science		3
SSC 200	Social Science Integrated	
Arts		3
Natural Sciences [4]		7
Crossing Boundaries		variable credit
Faith Traditions		
Practical Ethical Action		
Inquiry		
Integrative		
Advanced Study		variable credit
Philosophy and/or Religious Studies		
Historical Studies [5]		
Diversity and Social Justice		3
Major Capstone		0-3

1 Completed with ASI 110 and ASI 120.
2 Or ENG 100A and ENG 100B, by placement.
3 Completed with ENG 114 or ENG 198 or ASI 120.
4 Must include two different disciplines and accompanying lab.
5 U.S. History AP credit will not satisfy this requirement.

Major Requirements

CHM 123	General Chemistry	3
CHM 123L	General Chemistry Laboratory	1
CHM 124	General Chemistry	3

CHM 124L	General Chemistry Laboratory	1
CHM 313	Organic Chemistry	3
CHM 313L	Organic Chemistry Laboratory	1
CHM 314	Organic Chemistry	3
CHM 314L	Organic Chemistry Laboratory	1
CME 101	Introduction to Chemical Engineering	0-1
CME 200	Professional Development Seminar	0-1
or COP 200	Introduction to Engineering Cooperative Education	
CME 203	Material & Energy Balances	3
CME 211	Introduction to Thermodynamics for Chemical Engineers	3
CME 281	Chemical Engineering Computations	3
CME 306	Chemical Reaction Kinetics & Engineering	3
CME 311	Chemical Engineering Thermodynamics	3
CME 324	Transport Phenomena I	3
CME 325	Transport Phenomena II	3
CME 326L	Transport Phenomena Laboratory	1-2
CME 365	Separation Techniques	3
CME 381	Advances Mathematics for Chemical Engineers	3
CME 408	Seminar (2 semesters)	0-1
CME 430	Chemical Engineering Design I	3
CME 431	Chemical Engineering Design II	3
CME 452	Process Control	3
CME 453L	Process Control Laboratory	2
CME 465	Fluid Flow & Heat Transfer Processes	3
CME 466L	Chemical Engineering Unit Operations Laboratory	2
CMM 100	Principles of Oral Communication	3
EGR 100	Enrichment Workshop (2 semesters)	0
EGR 102	Introduction to the University Experience for Engineers	0
EGR 103	Engineering Innovation	2
EGR 201	Engineering Mechanics	3
EGR 203	Electrical & Electronic Circuits	3
ENG 100 & ENG 200	Writing Seminar I and Writing Seminar II	3-6
or ENG 200H	Writing Seminar II	
HST 103	The West & the World	3
or HST 198	History Scholars' Seminar	
MTH 168	Analytic Geometry & Calculus I	4
MTH 169	Analytic Geometry & Calculus II	4
MTH 218	Analytic Geometry & Calculus III	4
MTH 219	Applied Differential Equations	3
PHL 103	Introduction to Philosophy	3
PHY 206	General Physics I - Mechanics	3
PHY 207	General Physics II - Electricity & Magnetism	3
REL 103	Introduction to Religious and Theological Studies	3
SSC 200	Social Science Integrated	3
Chemistry or Biology elective [1]		3
CME elective [1]		3
Elective [2]		3
Electives		12
Engineering/Science electives [6]		1
Total Hours		137

1 Must be selected from list approved by the Chemical and Materials Engineering Department.

2 Must be selected from approved list of PHL or REL ethics courses.

Concentration in Energy Systems-Chemical (CES)

This concentration is open to all engineering students. The Energy Systems Concentration provides an interdisciplinary concentration in energy systems and its social consequences. Students completing this concentration will be prepared for jobs in both industrial and building energy systems, a rapidly growing market.

ASI 320	Cities & Energy [1,2]	3
CME 203	Material & Energy Balances	3
CME 311	Chemical Engineering Thermodynamics	3
CME 324	Transport Phenomena I	3
CME 325	Transport Phenomena II	3
CME 326L	Transport Phenomena Laboratory	1-2
CME 430	Chemical Engineering Design I	3
CME 431	Chemical Engineering Design II	3
CME 465	Fluid Flow & Heat Transfer Processes	3
CME 466L	Chemical Engineering Unit Operations Laboratory	2
CME elective		
Select one course from:		3
CME 486	Introduction to Petroleum Engineering	
or CME 586	Introduction to Petroleum Engineering	
CME 524	Electrochemical Power	
or MEE 575	Fracture & Fatigue of Metals & Alloys I	
CME 565	Fundamentals of Combustion	
CME 574	Fundamentals of Air Pollution I	
Select two courses from:		6
Select any CME elective course above [3]		
AEE 560	Propulsion Systems	
or MEE 560	Propulsion Systems	
CME 507	Advanced Thermodynamics	
or MEE 511	Advanced Thermodynamics	
CME 579	Materials for Advanced Energy Applications	
or MAT 579	Materials for Advanced Energy Applications	
MEE 413	Propulsion	
or MEE 513	Propulsion	
MEE 420	Energy Efficient Buildings	
or MEE 569	Energy Efficient Buildings	
MEE 471	Design of Thermal Systems	
or MEE 571	Design of Thermal Systems	
MEE 473	Renewable Energy Systems	
or MEE 573	Renewable Energy Systems	
MEE 478	Energy Efficient Manufacturing	
or MEE 578	Energy Efficient Manufacturing	
Total Hours		36-3

1 Or another approved humanities elective related to Energy Systems.

2 Satisfies History requirement.

[3] Course cannot have already been chosen as CME elective.

Minor in Bioengineering (BIE)

This minor is open to chemical, civil, computer, electrical, and mechanical engineering majors. The program is designed to expose the student to the use of engineering principles in biological systems and applications.

BIO 151	Concepts of Biology I: Cellular & Molecular Biology	3
or BIO 152	Concepts of Biology II: Evolution & Ecology	
CME 490/590	Introduction to Bioengineering	3
Select one course from:		3
CME 491/591	Biomedical Engineering I	
MEE 430/530	Biomechanical Engineering	
Select one course from: [1]		3
BIE 503	Principles of Biology for Bioengineers	
BIE 507	Bioengineering Experimentation Techniques	
BIE 511	Biomaterials	
BIE 595	Special Problems in Bioengineering	
BIO 151	Concepts of Biology I: Cellular & Molecular Biology	
BIO 152	Concepts of Biology II: Evolution & Ecology	
BIO 312	General Genetics	
BIO 403	Physiology I	
BIO 411	General Microbiology	
BIO 440	Cell Biology	
CHM 420	Biochemistry	
CHM 451	General Biochemistry I	
CHM 452	General Biochemistry II	
CME 491/591	Biomedical Engineering I	
CME 492	Chemical Sensors & Biosensors	
CME 523/ BIE 551	Transport Phenomena in Biological Systems	
CME/MAT 530	Biomaterials	
CME 533	Biofuel	
CME/CEE/BIE 560	Biological Processing of Wastewater	
MEE 430	Biomechanical Engineering	
or MEE 530	Biomechanical Engineering	
Total Hours		12

[1] Course cannot have already been chosen above.

Minor in Chemical Processing (CHP)

This minor is open to civil, computer, electrical, and mechanical engineering majors. The program is designed to acquaint the student with industrial operations in the chemical process industries such as heat exchange, distillation, extraction, humidification, etc. The elective courses cover a wide range of topics to accommodate the student's special interests.

CME 203	Material & Energy Balances	3
CME 324	Transport Phenomena I	3
CME 365	Separation Techniques	3
Select one course from:		3
CME 306	Chemical Reaction Kinetics & Engineering	
CME 430	Chemical Engineering Design I	
CME 452	Process Control	
CME 465	Fluid Flow & Heat Transfer Processes	
CME 499	Special Problems in Chemical Engineering	
Total Hours		12

Minor in Composite Materials Engineering (CMA)

This minor is open to chemical, civil, and mechanical engineering majors. The program is designed to expose the student to the design, processing, and characterization of composite materials and their various applications in industry.

CME 510	High Performance Thermoset Polymers	3
or MAT 510	High Performance Thermoset Polymers	
CME 512	Advanced Composites	3
or MAT 542	Advanced Composites	
Select two courses from:		6
CEE 540	Composites Design	
or MAT 540	Composite Design	
CEE 543	Analytical Mechanics Composite Materials	
or MAT 543	Analytical Mechanics of Composite Materials	
CEE 546	Finite Element Analysis I	
or MEE 546	Finite Element Analysis I	
CME 509	Introduction to Polymer Science - Thermoplastics	
or MAT 509	Introduction to Polymer Science-Thermoplastics	
CME 527	Methods of Polymer Analysis	
or MAT 527	Methods of Polymer Analysis	
CME 528	Chemical Behavior of Materials	
or MAT 528	Chemical Behavior of Materials	
CME 580	Polymer Decomposition, Degradation & Durability	
or MAT 580	Polymer Durability	
Total Hours		12

Minor in Energy Production Engineering (EPE)

This minor is open to all engineering majors. A selection of courses covering the production of energy:

Select four courses from:		12
BIE/CME/RCL 533	Biofuel	
CME 486/586	Introduction to Petroleum Engineering	
CME/MEE/RCL 524	Electrochemical Power	
CHM/GEO 234	Energy Resources	
ECE 316	Introduction to Electrical Energy Systems	
ECE 583	Advanced Photovoltaics	
MAT 579	Materials for Advanced Energy Applications	
MEE 473/573/ RCL 573	Renewable Energy Systems	
RCL 590	Special Problems in Renewable & Clean Energy [1]	
RCL 590	Special Problems in Renewable & Clean Energy [2]	

RCL 590	Special Problems in Renewable & Clean Energy [3]	
Total Hours		12

1 Must be Thermal Systems Analysis.
2 Must be Solar Energy Engineering.
3 Must be Wind Energy Engineering.

Minor in Materials Engineering (MAT)

This minor is open to all engineering majors. A general overview of materials with choice courses in polymers, composites, nanomaterials, and material characterization.

MAT 501	Principles of Materials I	3
MAT 502	Principles of Materials II	3
Select two courses from:		6
CME 509	Introduction to Polymer Science - Thermoplastics	
or MAT 509	Introduction to Polymer Science-Thermoplastics	
CME 510	High Performance Thermoset Polymers	
or MAT 510	High Performance Thermoset Polymers	
CME 511	Principles of Corrosion	
or MAT 511	Principles of Corrosion	
CME 512	Advanced Composites	
or MAT 542	Advanced Composites	
CME 527	Methods of Polymer Analysis	
or MAT 527	Methods of Polymer Analysis	
CME 528	Chemical Behavior of Materials	
or MAT 528	Chemical Behavior of Materials	
CME 579	Materials for Advanced Energy Applications	
or MAT 579	Materials for Advanced Energy Applications	
CME 580	Polymer Decomposition, Degradation & Durability	
or MAT 580	Polymer Durability	
MAT 504	Techniques of Materials Analysis	
MAT 506	Mechanical Behavior of Materials	
MAT 507	Introduction to Ceramic Materials	
MAT 508	Principles of Material Selection	
MAT 521	NDE/SHM	
MAT 535	High Temperature Materials	
MAT 541	Experimental Mechanics of Composite Materials	
MAT 543	Analytical Mechanics of Composite Materials	
MAT 544	Mechanics of Composite Materials	
MAT 575	Fracture & Fatigue of Metals & Alloys I	
MAT 577	Light Structural Metals	
MAT 590	Selected Readings in Materials Engineering	
MAT 595	Special Problems in Materials Engineering	
MAT 601	Surface Chemistry of Solids	
MAT 604	Nanostructured Materials	
MEE 312	Engineering Materials I	
Total Hours		12

Minor in Polymer Materials (PME)

This minor is open to all engineering majors. Coverage of polymers including thermosets and thermoplastics, and composite materials in which polymers are used as constituents. Methods of polymer processing and polymer characterization are also included.

CME 509	Introduction to Polymer Science - Thermoplastics	3
or MAT 509	Introduction to Polymer Science-Thermoplastics	
CME 510	High Performance Thermoset Polymers	3
or MAT 510	High Performance Thermoset Polymers	
Select two courses from:		6
CME 512	Advanced Composites	
or MAT 542	Advanced Composites	
CME 527	Methods of Polymer Analysis	
or MAT 527	Methods of Polymer Analysis	
CME 528	Chemical Behavior of Materials	
or MAT 528	Chemical Behavior of Materials	
CME 580	Polymer Decomposition, Degradation & Durability	
or MAT 580	Polymer Durability	
MAT 540	Composite Design	
MAT 543	Analytical Mechanics of Composite Materials	
Total Hours		12

First Year

Fall	Hours	Spring	Hours
ENG 100 (Satisfies CAP Writing Seminar Requirement)	3,4	HST 103 (Satisfies CAP First Year Humanities Common	3
PHL 103 (Satisfies CAP First Year Humanities Common)	3	REL 103 (Satisfies CAP First Year Humanities Common	3
CHM 123	3-4	CHM 124	3
CHM 123L	1	CHM 124L	1
MTH 168 (Satisfies CAP Math Requirement)	4	MTH 169	4
EGR 103	2	PHY 206 (Satisfies CAP Natural Science)	3
EGR 102	0	CME 101	0-1
EGR 100	0	EGR 100	0
	16-18		17-18

Second Year

Fall	Hours	Spring	Hours
ENG 200 (Satisfies CAP Second Year Writing Seminar)	3-4	CMM 100 (Satisfies CAP Communication)	3
CME 203	3	CME 281	3
CME 211	3	CME 311	3
CHM 313	3	CHM 314	3
CHM 313L	1	CHM 314L	1
MTH 218	4	MTH 219	3
CME 200 (or COP 200)	1/0		
	17-19		16

Third Year

Fall	Hours	Spring	Hours
CAP-Art Study	3	CAP- PHL Ethics	3
CME 324	3	CME 306	3
CME 381	3	CME 365	3
PHY 207	3	CME 325	3
SSC 200	3	CME 326L	2

EGR 201	3	EGR 203	3
	18		17

Fourth Year

Fall	Hours	Spring	Hours
CAP-HST	3	Advanced HST (Satisfies CAP Crossing Boundaries)	3
CME 430	3	CME 431	3
CME 465	3	CME 453L	2
CME 466L (Satisfies CAP Capstone Requirement)	2	CME Advanced Elective	3
CME 452	3	CME 408	0-1
CME 408	0-1	EGR/SCI EL	6
CHM/BIO Elective	3		
	17-18		17-18

Total credit hours: 135-142

Courses

CME 101. Introduction to Chemical Engineering. 0-1 Hours
Introduction to the chemical engineering faculty, facilities, and curriculum; survey of career opportunities in chemical engineering. Introduction to the University first-year experience.

CME 198. Research & Innovation Laboratory. 1-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analysing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming and evalutating engineering solutions and engineering designs. Proposals from terams of students will be considered.

CME 200. Professional Development Seminar. 0-1 Hours
Presentations on contemporary and professional engineering subjects by students, faculty, and engineers in active practice. The seminar addresses topics in key areas that complement traditional courses and prepare distinctive graduates, ready for life and work. Registration required for all sophomore students.

CME 203. Material & Energy Balances. 3 Hours
Introductory course on the application of mass and energy conservation laws to solve problems typically encountered in chemical process industries. Prerequisite(s): CHM 123; MTH 168. Corequisite(s): CME 211.

CME 211. Introduction to Thermodynamics for Chemical Engineers. 3 Hours
First law of thermodynamics, states of matter, equations of state, open and closed system energy balances, reactive energy balances, entropy, 2nd law of thermodynamics, introduction to power cycles and refrigeration. Prerequisite(s): PHY 206, CHM 123, MTH 168.

CME 281. Chemical Engineering Computations. 3 Hours
Development of computational skills with an emphasis on algorithm development and problem solving. Computational skills are applied to typical problems in chemical engineering, engineering data analysis and statistics. Corequisite(s): CME 203, MTH 169.

CME 298. Research & Innovation Laboratory. 1-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

CME 306. Chemical Reaction Kinetics & Engineering. 3 Hours
Chemical reaction kinetics, ideal reactor analysis and design, multiple reactor/reaction systems, and heterogeneous catalysis. Prerequisite(s): CME 311. Corequisite(s): CME 324.

CME 311. Chemical Engineering Thermodynamics. 3 Hours
Development and application of the fundamental principles of chemical thermodynamics: Vapor/liquid equilibrium, solution thermodynamics, chemical reaction equilibria, and thermodynamic analysis of chemical engineering processes. Prerequisite(s): CME 203; CME 211; MTH 218.

CME 324. Transport Phenomena I. 3 Hours
Viscosity, shell momentum balances, isothermal equations of change, thermal conductivity, shell energy balances, non-isothermal equations of change, mass diffusivity, shell species mass balances, equations of change for multicomponent systems. Prerequisite(s): CME 203, CME 281; MTH 219. Corequisite(s): CME 381.

CME 325. Transport Phenomena II. 3 Hours
Multidimensional momentum, energy, and mass transport, dimensionless parameters, turbulence and numerical solution methods. Prerequisite(s): CME 324, CME 381.

CME 326L. Transport Phenomena Laboratory. 1-2 Hours
Viscosity, conductivity, diffusion coefficient measurements, velocity, temperature, concentration profiles, engineering instrumentation, and experimental error analysis. Prerequisite(s): CHM 124L; CME 324. Corequisite(s): CME 325.

CME 365. Separation Techniques. 3 Hours
Equilibrium staged separations: distillation, extraction and absorption, with an emphasis on distillation. Prerequisite(s): CME 311, CME 324.

CME 381. Advances Mathematics for Chemical Engineers. 3 Hours
Study of analytical and numerical techniques to support upper-level chemical engineering classes. Vector analysis, matrices, differential equations, numerical integration and differentiation, root finding, and curve fitting ordinary and partial differential equations. Prerequisite(s): CME 281; MTH 219.

CME 398. Research & Innovation Laboratory. 1-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

CME 408. Seminar. 0-1 Hours
Presentation of lectures on contemporary chemical engineering subjects by students, faculty, and engineers in active practice. Registration required of senior students only. Corequisite(s): CME 430.

CME 409. Introduction to Polymer Science - Thermoplastics. 3 Hours
Broad technical overview of the nature of synthetic macromolecules, including the formation of polymers and their structure, structure-property relationships, polymer characterization and processing, and applications of polymers. Fundmental topics such as viscoelasticity, the glassy state, time-temperature superposition, polymer transitions, and free volume will also be reviewed. The course focuses on thermoplastic polymers. Prerequisite(s): CHM 313, PHY 206, MTH 219.

CME 410. High Performance Thermoset Polymers. 3 Hours
Survey of high performance thermoset resins, focusing on chemistry, processing and properties of six general resin families; vinyl ester, epoxy, phenolic, cyanate ester, bismaleimide, and polyimides. The course will include fundamental discussions of polymerization mechanisms, network structure development, rheology and time-temperature transformation, resin toughening, and structure-processing-property relationships. Characterization techniques will also be reviewed. Prerequisite(s): CHM 313.

CME 412. Advanced Composites. 3 Hours
Materials and processing. Comprehensive introduction to advanced fiber reinforced polymeric matrix composites. Constituent materials and composite processing will be emphasized with special emphasis placed on structure-property relationships, the role of matrix in composite processing, mechanical behavior, and laminate processing. Specific topics will include starting materials, material forms, processing, quality assurance, test, methods, and mechanical behavior. Prerequisite(s): (CME 409 or CME 509 or MAT 501) or permission of instructor.

CME 429. Computational Chemistry. 3 Hours
Introduction to computational chemistry including a discussion of ab initio, semiempical, and DFT methods and an overview of molecular mechanics and molecular simulation methods. Lectures are supplemented by simulation exercises using commercial programs such a Gaussian and Molecular Studio. Prerequisite(s): CHM 124 or permission of instructor.

CME 430. Chemical Engineering Design I. 3 Hours
Study of basic design concepts, safety and health issues, capital cost estimation, manufacturing cost estimation, basic economics and profitability analysis, materials of construction, materials selection and process vessel design. Prerequisite(s): CME 203; CME 306. Corequisite(s): CME 465.

CME 431. Chemical Engineering Design II. 3 Hours
Project-based study of principles of process design and economics, use of process flowsheet simulators, short-cut design procedures, process optimization, and plant layout. Prerequisite(s): CME 306, CME 365, CME 430, CME 465.

CME 432. Chemical Product Design. 3 Hours
Application of the design process to products based on chemical technology. Coverage of the entire design process from initial identification of product needs, to the generation and selection of product ideas, and culminating in the manufacture of a new product.

CME 452. Process Control. 3 Hours
Mathematical models, Laplace transform techniques, and process dynamics. Feedback control systems, hardware, and instrumentation. Introduction to frequency response, advanced techniques, and digital control systems. Prerequisite(s): CME 381. Corequisite(s): CME 306.

CME 453L. Process Control Laboratory. 2 Hours
Team-based, project oriented study of process dynamics and digital control using computer-based data acquisition and control systems with a focus on real time process monitoring and control. Prerequisite(s): (CME 452, CME 466L) or permission of instructor.

CME 465. Fluid Flow & Heat Transfer Processes. 3 Hours
Fluid mechanics, transportation and metering of fluids, heat transfer and its applications. Prerequisite(s): CME 311, CME 324.

CME 466L. Chemical Engineering Unit Operations Laboratory. 2 Hours
Study of the equipment and utilization of various chemical engineering processes. Team based experimentation includes designing, and performing experiments on common chemical process unit operations apparatuses. After experimentation, students analyze data and compare with literature for experiment validation. Report writing and group presentations are emphasized. Prerequisite(s): CME 365. Corequisite(s): CME 465.

CME 486. Introduction to Petroleum Engineering. 3 Hours
Introduction to the fundamental concepts in petroleum engineering. Petroleum topics include overviews of areas such as petroleum geology, petroleum fluids and thermodynamics, drilling and completion, and production and multiphase flow. In addition this course will cover refinery operations.

CME 489. Principles of Biology for Bioengineers. 3 Hours
This course is designed for students with undergraduate majors in engineering or non-biological sciences. The focus of the course is to provide a common broad base of basic knowledge and terminology in the biological sciences required for coursework in the bioengineering emphasis tracts. Prerequisite(s): (BIO 151, BIO 152) or permission of instructor.

CME 490. Introduction to Bioengineering. 3 Hours
This class provides an introduction to bioengineering - a branch of engineering focusing on biological systems, biomaterials, engineering applications in living systems, and many other areas. By the end of this course, students will be able to understand bioengineering applications and processes, and properly apply engineering fundamentals, including transport phenomena and reaction kinetics, to these systems. Prerequisite(s): ((BIO 151 or BIO 152); (CME 324 or MEE 308)) or permission of instructor.

CME 491. Biomedical Engineering I. 3 Hours
Introduction to the fundamental concepts in biomedical engineering with a special focus on chemical engineering applications. Biomedical topics include overviews of areas such as biomaterials, tissue engineering, biosensors and biomedical engineering technology. Prerequisite(s): ((BIO 151 or BIO 152); CME 324) or permission of instructor.

CME 492. Chemical Sensors & Biosensors. 3 Hours
Analysis performed with chemical sensors complement laboratory analyses and offer the potential for more rapid and on-line analyses in complex sample matrices. The demand for new chemical sensors, biosensors, and sensing concepts is rapidly increasing and associated with the growing need to understand and/or control complex chemical and biochemical processes or detect the presence of toxic chemical or biological agents. Prerequisite(s): Permission of instructor.

CME 493. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program.

CME 494. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program. Prerequisite(s): CME 493.

CME 498. Research & Innovation Laboratory. 1-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

CME 499. Special Problems in Chemical Engineering. 1-6 Hours
Particular assignments to be arranged and approved by chairperson of the department.