CHEMICAL & MATERIALS ENGINEERING

Mission
The New Mexico State University Chemical & Materials Engineering Department strives to prepare Chemical Engineering Bachelor of Science graduates to successfully and safely practice the chemical engineering profession, to engage in life-long personal and professional development, and to contribute to the betterment of their community and society.

Undergraduate Program Information
Chemical engineers solve problems by combining the fundamentals of physical sciences (chemistry and physics) and life sciences (biology, microbiology, biochemistry) with the principles of engineering analysis, mathematics, and economics. The curriculum of study leading to the BSCHE continuously builds on prerequisite knowledge. The capstone course requires completion of a series of seven prerequisite courses, each having its own prerequisites. In this manner, the BSCHE produces graduates with highly developed problem-solving capabilities, strong communication and interpersonal skills, and an ability to seek out and assimilate knowledge beyond the classroom. Graduates apply these competencies to solve problems across a wide range of industries in the private and public sectors.

The work of a chemical engineer typically leads to the development of processes that convert raw materials (chemicals) into more useful or valuable products. Chemical engineers are pioneers of modern materials processes that convert raw materials (chemicals) into more useful or valuable products. Chemical engineers solve problems by combining the fundamentals of physical sciences (chemistry and physics) and life sciences (biology, microbiology, biochemistry) with the principles of engineering analysis, mathematics, and economics. The curriculum of study leading to the BSCHE continuously builds on prerequisite knowledge. The capstone course requires completion of a series of seven prerequisite courses, each having its own prerequisites. In this manner, the BSCHE produces graduates with highly developed problem-solving capabilities, strong communication and interpersonal skills, and an ability to seek out and assimilate knowledge beyond the classroom. Graduates apply these competencies to solve problems across a wide range of industries in the private and public sectors.

The New Mexico State University Chemical & Materials Engineering Department strives to produce undergraduates who will:

1. apply their problem-solving and communication skills to chemical engineering industries, government research labs, academia, and related fields;
2. implement safety practices in their work;
3. be on the path to leadership; and
4. build new skills sets through continuing education and professional development.

These Program Educational Objectives (PEOs), which are modified based on input from our constituencies, are consistent with the missions of NMSU, the College of Engineering and the Department of Chemical & Materials Engineering.

Graduate Program Information
The Department of Chemical and Materials Engineering offers graduate study leading to the M.E., M.S. and Ph.D. degrees with an emphasis in chemical engineering. Admission to the program is in accord with the general regulations of the Graduate School. The Graduate Record Examination (GRE) General Test is required for all applicants. All graduate students are required to pass all graduate engineering courses with a minimum grade of B-.

All graduate students must select a thesis or dissertation advisor by the end of their first year in the chemical engineering graduate program. Thesis/dissertation may be pursued in absentia at various industrial sites by special arrangement.

Graduate teaching and research assistantships, fellowships and traineeships are available. For consideration for financial assistance, completed applicants must be received by March 1. All support is contingent upon availability, eligibility and satisfactory progress toward the degree.

Each student admitted to the CHME grad program who has an undergraduate degree in a discipline other than chemical engineering must schedule a meeting with the CHME Department Head to identify undergraduate course deficiencies that the student must take to obtain a graduate degree in chemical engineering.

Graduate Program Educational Objectives
Chemical & Materials Engineering graduate students must:

1. demonstrate skills in the (1) design of experiments or simulations, (2) collection of experimental/simulated data, (3) development of appropriate models, and (4) make appropriate use of those models;
2. complete an independent research project, resulting in at least a thesis/dissertation and peer-reviewed journal article(s);
3. defend original research in front of a panel of peers and experts;
4. be knowledgeable of the contemporary issues that are relevant to their chosen area of research.

Degrees for the Department
Bachelor Degree(s)
Chemical Engineering - Bachelor of Science in Chemical Engineering

Master Degree(s)
Chemical Engineering - Master of Engineering in Chemical Process Industry
Chemical Engineering - Master of Science in Chemical Engineering

Doctoral Degree(s)
Engineering (Chemical Engineering) - Doctor of Philosophy
Minors for the Department

Undergraduate
- Biomedical Engineering - Undergraduate Minor
- Brewery Engineering - Undergraduate Minor
- Computational Engineering - Undergraduate Minor
- Materials Engineering - Undergraduate Minor
- Nuclear Chemical Engineering - Undergraduate Minor
- Pre-Law in Intellectual Property - Undergraduate Minor
- Pre-Medicine Studies - Undergraduate Minor

Graduate
- Materials Engineering - Graduate Minor

Department Head: David A. Rockstraw

Associate Department Head: Martha C. Mitchell

Professors: Garcia, Luo, Mitchell, Rockstraw

Associate Professors: Andersen, Brewer, Foudazi, Houston, Manz

Assistant Professors: Zhou

Emeritus Professors: Bhada, Ghassemi, Johnson, Patton

Research Interests:
- P.K. Andersen (Ph.D., University of California, Berkeley) physicochemical hydrodynamics, nuclear chemical engineering, modeling and simulation, education and training.
- C.E. Brewer (Ph.D., Iowa State) biomass thermochemical processing, sustainable agriculture, biorenewable resources, brewery engineering.
- R. Foudazi (Ph.D., Cape Peninsula University of Technology, South Africa) soft matter, membranes, rheology of complex fluids, colloid and interface science, adsorption.
- A.A. Garcia (Ph.D., University of California, Berkeley) drug delivery, diagnostic devices, nanobiotechnology, bioprocessing.
- J. Houston (Ph.D., Texas A&M) biomedical engineering, biophotonics, flow cytometry.
- H. Luo (Ph.D., Tulane) nanostructured materials, thin films, photovoltaics, batteries, electrocatalysts, photocatalysts.
- T.A. Manz (Ph.D., Purdue) quantum chemistry simulations of materials, catalysis, and space physics.
- M.C. Mitchell (Ph.D., Minnesota) computer modeling and simulation of molecular-level phenomena, thermodynamic characterization of aerospace fuels, statistical mechanics, engineering education, diversity and inclusion in STEM.
- D.A. Rockstraw (Ph.D., Oklahoma) chemical process design, analysis & simulation, catalysis and reaction kinetics, activated carbon, trade secret and intellectual property litigation.
- M. Zhou (Ph.D., New Mexico State) gas adsorption and separation, energy storage devices, capacitive deionization.

Chemical Engineering Courses

CHME 101. Introduction to Chemical Engineering Calculations
2 Credits (2)
Introduction to the discipline of chemical engineering, including: an overview of the curriculum; career opportunities; units and conversions; process variables; basic data treatments; and computing techniques including computer programming and use of spreadsheets.
Prerequisite(s)/Corequisite(s): MATH 1250G.

CHME 102. Material Balances
2 Credits (2)
Perform material balances in single- and multi-phase, reacting and non-reacting systems under isothermal conditions.
Prerequisite(s)/Corequisite(s): CHEM 1215G or CHEM 1265.
Prerequisite(s): MATH 1250G, CHME 101.

CHME 201. Energy Balances & Basic Thermodynamics
3 Credits (3)
Chemical Engineering energy balances; combined energy and material balances including those with chemical reaction, purge and recycle; thermochemistry; application to unit operations. Introduction to the first and second laws of thermodynamics and their applications. May be repeated up to 3 credits.
Prerequisite(s): CHME 102, CHEM 1216 or CHEM 1215G, and MATH 1521G or MATH 1521H.

CHME 294. Communicating in Chemical Engineering
2 Credits (2)
Students will master the fundamentals of communicating as an engineer, with focus on both written and oral communication, both independently and collaboratively, including development of the skills of gathering information and making decisions.
Corequisite(s): ENGL 1110G, COMM 1115G.

CHME 303. Chemical Engineering Thermodynamics
4 Credits (4)
Applications of the First and Second Law to chemical process systems, especially phase and chemical equilibria and the behavior of real fluids. Development of fundamental thermodynamic property relations and complete energy and entropy balances. Modeling of physical properties for use in energy and entropy balances, heat and mass transfer, separations, reactor design, and process control.
Prerequisite(s)/Corequisite(s): MATH 392. Prerequisite(s): CHME 201, MATH 2530G.

CHME 305. Transport Operations I: Fluid Flow
3 Credits (3)
Theory of momentum transport. Unified treatment via equations of change. Shell balance solution to 1-D problems in viscous flow. Analysis of chemical engineering unit operations involving fluid flow. General design and operation of fluid flow equipment and piping networks. May be repeated up to 3 credits.
Prerequisite(s)/Corequisite(s): MATH 392. Prerequisite(s): CHME 201, PHYS 1310G, MATH 2530G. Restricted to: CH E,CHME,CMEG majors.

4 Credits (4)
Prerequisite(s)/Corequisite(s): CHME 392. Prerequisite(s): CHME 305 and MATH 392. Restricted to: CH E, CHME, CMEG, EPCHE majors.
3 Credits (3)  
Theory of mass transport. Mass transfer coefficients. Analysis of chemical engineering unit operations involving mass transfer and separations. Equilibrium stage concept. General design and operation of mass-transfer equipment and separation sequences. May be repeated up to 3 credits. Restricted to: CHME, CMEG, CH E majors.  
Prerequisite(s): CHME 303, CHME 306.

CHME 311. Engineering Data Analysis  
3 Credits (3)  
Methodology and techniques associated with analyzing engineering data. Extensive spreadsheet use to analyze data and develop statistically significant conclusions based on the data. Data sets range from single variable experiments to multifactor regression analysis.  
Prerequisite(s): MATH 1521G or MATH 1521H.

CHME 323 L. Transport Operations and Instrumentation Laboratory I  
1 Credit (3P)  
Laboratory experiments demonstrate the principles of process measurement and instrumentation through the determination of thermodynamic properties, transport phenomena properties, heat transfer, and material physical properties. Treatment of data includes regression techniques, analysis of error, and statistical analysis. May be repeated up to 1 credits.  
Prerequisite(s)/Corequisite(s): CHME 306. Prerequisite(s): I E 311. Restricted to: CH E, CHME, CMEG majors.

CHME 324 L. Transport Operations and Instrumentation Laboratory II  
1 Credit (3P)  
Continuation of CHME 323L. Restricted to: CHME majors.  
Prerequisite(s): CHME 323L.

CHME 352 L. Simulation of Unit Operations  
1 Credit (1P)  
Definition, specification, and convergence of basic unit operations in a process simulator. Course will cover pipe networks, pressure changers, heat exchangers, distillation columns, and chemical reactors.  
Prerequisite(s)/Corequisite(s): CHME 307, CHME 441. Restricted to: CHME majors.

CHME 361. Engineering Materials  
3 Credits (3)  
Prerequisite(s): CHEM 1215G or CHEM 1216) and MATH 1250G.

CHME 391. Industrial Employment  
1-2 Credits  
Employment in chemical, petroleum, food, biotechnology, materials, environmental, pharmaceutical, or other industry relevant to the discipline, with opportunity for professional experience and training in chemical engineering. Requires written report covering work period approved by employer. May be repeated up to 6 credits. Consent of Instructor required. Restricted to: CHME, CH E majors.  
Prerequisite(s): Consent of department head.

CHME 392. Numerical Methods in Engineering  
3 Credits (3)  
Study and application of numerical methods in solving problems commonly encountered in engineering. The numerical methods are motivated by engineering problems rather than by mathematics. However, sufficient mathematical theory will be provided so that students can appreciate the insight into the techniques and their shortcomings of different methods. MATLAB will be used as the working environment for implementing and performing the numerical methods in computers. This course is an engineering elective open to all engineering majors.  
Prerequisite(s)/Corequisite(s): MATH 392.

CHME 395V. Brewing Science and Society  
3 Credits (3)  
An overview of the science of brewing and the interrelationships between society, technology, business, and the evolution of the current beer market. Topics covered are history of brewing and the interrelationships between societal attitudes, technology, and cultural preferences; beer styles and evaluation techniques; production and characteristics of ingredients used in brewing; brewing unit operations; biochemistry of malting, mashing, and fermentation; engineering in the brewery; homebrewing; and societal and health issues related to beer and alcohol. Students must be at least 21 years of age by the first day of instruction of the semester to enroll in this course.

CHME 412. Process Dynamics and Control  
3 Credits (3)  
Prerequisite(s): CHME 441.

CHME 423 L. Unit Operations Laboratory I  
1 Credit (3P)  
Experiments with chemical engineering unit operations including the use of computer data acquisition. Covers control system instrumentation and development of empirical models from process data. Includes written and oral reports. Restricted to: CHME majors.  
Prerequisite(s): CHME 307, CHME 441, CHME 324L.

CHME 424 L. Process Control Laboratory  
1 Credit (3P)  
Experiments with chemical engineering process control including the use of computer data acquisition and closed-loop process control. Covers control system instrumentation. Includes written and oral reports. Restricted to: CHME majors.  
Prerequisite(s): CHME 412, CHME 423L.

CHME 441. Chemical Kinetics and Reactor Engineering  
3 Credits (3)  
Analysis and interpretation of kinetic data and catalytic phenomena. Applied reaction kinetics; ideal reactor modeling; non-ideal flow models. Mass transfer accompanied by chemical reaction. Application of basic engineering principles to design, operation, and analysis of industrial reactors. May be repeated up to 3 credits.  
Prerequisite(s)/Corequisite(s): CHME 307. Prerequisite(s): CHEM 313, CHME 303. Restricted to: CHME, CMEG, CH E majors.
CHME 448. Industrial Safety
3 Credits (3)
An introduction to the fundamentals of chemical process safety, including toxicology, industrial hygiene, source models, fires and explosions, relief systems, hazard identification, risk assessment, environmental fate and transport, hazardous waste generation, pollution prevention, and regulatory requirements.
Prerequisite(s): CHEM 1216 or CHEM 1215G.

CHME 449. Intellectual Property for Engineers and Scientists
3 Credits (3)
An overview of intellectual property with an emphasis on patents. Terminology, patentability requirements, invention disclosures, inventorship, scope of claims, patent application content and the patent prosecution process, and post-allowance matters including infringement and enforcement. Taught with CHME 549.
Prerequisite(s): CHEM 1120G, CHEM 1215G, or CHEM 1216; and senior standing in engineering or a fundamental science major; or consent of instructor.

CHME 452. Chemical Process Design & Economic Evaluation
3 Credits (3)
Concepts in chemical engineering process design, including: capital and manufacture cost estimation; discounted cash flows; interest; taxes; depreciation; profitability analysis; project specifications. Restricted to: CHME,CHE E majors.
Prerequisite(s): CHME 307, CHME 441.

CHME 452 L. Chemical Process Simulation
1 Credit (1P)
Construction and convergence of chemical processes in a process simulator. Students will understand how to access variables, define and converge design specifications and converge tear/recycle streams.
Prerequisite(s)/Corequisite(s): CHME 452. Prerequisite(s): CHME 352L. Restricted to: CHME majors.

CHME 455. Chemical Plant Design
3 Credits (3)
Design and analysis of integrated process plants. Consideration given to optimizing performance, operability, reliability, safety, control, energy integration, and cost effectiveness. Requires written report covering solution of a capstone design problem. Restricted to: CHME majors.
Prerequisite(s): CHME 452.

CHME 455 L. Chemical Plant Simulation
1 Credit (1P)
Construction, convergence, and optimization of chemical processes in a process simulator. Dynamic process simulation and control.
Prerequisite(s)/Corequisite(s): CHME 455. Prerequisite(s): CHME 412, CHME 452L. Restricted to: CHME majors.

CHME 461. Calculation of Material and Molecular Properties
3 Credits (3)
The aim is to describe and apply techniques for computing common properties of materials and molecules: optimized geometries, transition states, vibrational spectra, energies (electronic, internal energy, enthalpy, and Gibbs free energy), heat capacities, net atomic charges, atomic spin moments, and effective bond orders. These techniques allow one to estimate the thermodynamic properties of a chemical, as well as to compute the mechanisms and energy barriers for chemical reactions and catalytic processes, and to quantify the electronic, magnetic, and chemical ordering in materials. The theory behind these techniques will be described and students will perform hands-on computer exercises using common computational chemistry programs. Taught with CHME 561.
Prerequisite(s): CHEM 1226, MATH 1521G or MATH 1521H, (PHYS 2140 or PHYS 1320G).

CHME 463. Soft Matter
3 Credits (3)
Prerequisite(s): CHME 303, CHME 305, CHME 361.

CHME 464. Polymer Science & Engineering
3 Credits (3)
This course covers concepts in science and engineering of macromolecules, such as synthesis and chemistry, characterization of molecular weight, morphology, rheology, and mechanical behavior; structure and property relationships, and polymer processing. Taught with CHME 564. May be repeated up to 3 credits.
Prerequisite(s): CHEM 314.

CHME 465. Rheology and Viscoelasticity
3 Credits (3)
Navier-Stokes equation; non-Newtonian fluids; flow fields; rheometry; viscoelastic models; non-linear viscoelasticity; material functions; complex fluids, including emulsions, suspensions and nanocomposites. Taught with CHME 565. Consent of Instructor required.
Prerequisite(s): CHME 306.
CHME 467. Nanoscience and Nanotechnology
3 Credits (3)
This is a lecture/laboratory course designed to present the basic concepts, the techniques and the tools to synthesize and characterize nanometer scale materials, and the latest achievements in current and future nanotechnology applications in engineering, materials, physics, chemistry, biology, electronics and energy. It is intended for a multidisciplinary audience with a variety of backgrounds. This course should be suitable for graduate students as well as advanced undergraduates. Topics covered will include: nanoscience and nanotechnology, nanofabrication, self-assembly, colloidal chemistry, sol-gel, carbon nanotubes, graphene, thin film, lithography, physical vapor deposition, chemical vapor deposition, quantum dots, lithium batteries, X-ray diffraction, scanning electron microscopy, transmission electron microscopy, nanoelectronics, nanophotonics and nanomagnetics, etc. Taught with PHYS 520 and CH E 567. Crosslisted with: PHYS 520 and PHYS 467.
Prerequisite(s): (CHEM 116 or CHEM 112G), (PHYS 211G or PHYS 215G), (EH&S Safety training to include the courses: (1) Employee & Hazard Communication Safety (HazCom); (2) Hazardous Waste Management; and (3) Laboratory Standard).

CHME 470. Introduction to Nuclear Energy
3 Credits (3)
Atomic and nuclear structure, nuclear stability and radioactivity, nuclear reactions, detection and measurement of radiation, interaction of radiation with matter, radiation doses and hazard assessment, principles of nuclear reactors, and applications of nuclear technology.
Prerequisite(s): CHEM 1215G, MATH 1521G or MATH 1521H.

CHME 471. Health Physics
3 Credits (3)
Introduction to radiation protection, radiation radioactivity, radioactive decay/fission, interactions of radiation and matter; biological effects of radiation, radiation measurement and statistics, sampling for radiation protection, radiation dosimetry, environmental transport, radiation protection guidance, external and internal radiation protection, and hazards analysis.
Prerequisite(s): MATH 1521G or MATH 1521H, CHME 470.

CHME 476. Nuclear Fuel Cycles
3 Credits (3)
Physical and chemical processes in the conventional nuclear fuel cycle: uranium mining and milling, conversion, enrichment, fuel fabrication, reactor operations, interim storage, reprocessing and recycling, waste treatment and disposal. Alternative fuel cycles and future prospects. Consent of Instructor required.
Prerequisite(s): CHME 470.

CHME 479. Corrosion and Degradation of Materials
3 Credits (3)
Failure of engineering materials in aggressive environments. Chemical and electrochemical mechanisms of corrosion. Influence of chemical composition and microstructure on corrosion behavior. Types of corrosion and chemical attack, including uniform corrosion, galvanic corrosion, pitting and other forms of localized corrosion, stress corrosion cracking, and corrosion fatigue. Methods of corrosion mitigation including cathodic protection, coatings, passivation, and corrosion inhibitors. Corrosion in nuclear reactors and nuclear waste repositories.
Prerequisite(s): CHME 361.

CHME 481. Biomedical Engineering and Engineering Healthcare
3 Credits (3)
Orientation to solving human and world health issues with biological engineering systems, tools, and analysis methods. Introduces general concepts including applied biology for engineers, biophotonics, biosensing, bioinstrumentation, tissue and biomaterials engineering, biomedical engineering research practices, and physical bioanalytical methods. Taught with CHME 581. Restricted to: CHME, CH E majors.
Prerequisite(s): CHEM 1226, CHME 201.

CHME 485. Materials from Biorenewable Resources
3 Credits (3)
Types, sources, composition and properties of biomass. Production, processing, and applications of biomass materials with energy, water, cost, sustainability, and waste management considerations. Taught with CHME 585. Crosslisted with: AGRO 485 and HORT 486.
Prerequisite(s): CHEM 2115 or CHEM 313 or permission of instructor.

CHME 486. Biofuels
3 Credits (3)
Introduction to the fundamentals and applications of biofuels and bioenergy production; biomass resources and their composition; types of biofuels; conversion technologies (thermochemical and biochemical conversion processes); biodiesel production, algae to biofuels; economic and environmental assessments; term paper of selected topics relevant to biofuels. May be repeated up to 3 credits. Consent of Instructor required.
Prerequisite(s): CHME 201.

CHME 490. Senior Seminar
1 Credit (1)
Research seminar attended by graduate students is open to CHME undergraduates who are research active. May be repeated up to 2 credits. Students must be in Senior Standing to enroll in this course.
Prerequisite(s)/Corequisite(s): CHME 498. Restricted to: CHME, CH E majors.

CHME 491. Special Topics
3 Credits (3)
Lecture and/or laboratory instruction on special topics in chemical engineering. May be repeated up to 6 credits. Consent of Instructor required.
Prerequisite(s): Consent of instructor.

CHME 495. Brewing Science & Engineering
3 Credits (3)
Details of beer production, fermentation science, brewery operation, and process design & economics. Engineering considerations including process safety, fermentation kinetics, unit operations, and economies of scale. Beer styles, recipe formulation, product quantification for tax purposes, and brew analytical methods will also be discussed. Crosslisted with: FSTE 430. Restricted to: CH E, CHME, CMEG majors.
Prerequisite(s): CHME 395V, CHME 441, CHME 452.

CHME 495 L. Brewing Science & Technology Lab
1 Credit (3P)
Brewing and brewing operations in a one-barrel brewery. Topics addressed will include brewery safety, characteristics and handling of brewing ingredients, recipe formulation, water treatment, wort preparation, fermentation, waste disposal, and packaging. Corequisite(s): CHME 495.
CHME 498. Undergraduate Research
1-3 Credits (1-3P)
Provides an opportunity for undergraduate students to work in research or areas of special interest such as design problems and economic studies under the direction of a faculty member. Written report covering work required. May be repeated up to 6 credits. Consent of Instructor required. Restricted to: CHME,CH E majors.
Prerequisite(s): Consent of instructor and department head.

CHME 501. Graduate Thermodynamics for Chemical Engineers
3 Credits (3)
Advanced applications of the first and second law to chemical process systems. The calculus of thermodynamics, equilibrium and stability criteria. Properties relationships for real fluids, both pure materials and mixtures. An introduction to molecular thermodynamics and statistical mechanics. Restricted to: CHME,CH E majors.

CHME 506. Graduate Transport Phenomena(s)
3 Credits (3)

CHME 516. Graduate Numerical Methods in Chemical Engineering
3 Credits (3)
Survey of numerical methods for solving problems commonly encountered in heat and mass transfer, fluid mechanics, and chemical reaction engineering.

CHME 542. Graduate Reactor Analysis and Design (s)
3 Credits (3)
Application and analysis of equations of continuity to multicomponent reaction systems. Introduction to homogeneous and heterogeneous catalysis, single-phase combustion, and shock reaction systems.

CHME 548. Industrial Safety
3 Credits (3)
Same as CHME 448 with graduate-level projects.
Prerequisite(s): CHEM 1216 or CHEM 1215G.

CHME 563. Soft Matter
3 Credits (3)
The physiochemistry of soft materials including gels, polymers and colloids, self-assembly, intermolecular forces, and colloidal forces. Taught with CHME 463. May be repeated up to 3 credits.
Prerequisite(s): CHME 302, CHME 305, CHME 361.

CHME 564. Polymer Science & Engineering
3 Credits (3)
Synthesis, structure, property relationships of synthetic polymers. Taught with CHME 464. May be repeated up to 3 credits.
Prerequisite(s): CHME 201, CHEM 314.

CHME 565. Rheology and Viscoelasticity
3 Credits (3)
This course is an introduction to rheology and viscoelasticity. In particular, the flow behavior of Non-Newtonian Fluids and Viscoelastic Fluids will be covered. Rheometry, the technique for characterization of fluids, will be discussed. Most of the course is quantitative and uses mathematical modeling. Taught with CHME 465.
Prerequisite(s): CHME 306.

CHME 567. Nanoscience and Nanotechnology
3 Credits (3)
This is a lecture/laboratory course designed to present the basic concepts, the techniques and the tools to synthesize and characterize nanometer scale materials, and the latest achievements in current and future nanotechnology applications in engineering, materials, physics, chemistry, biology, electronics and energy. It is intended for a multidisciplinary audience with a variety of backgrounds. This course should be suitable for graduate students as well as advanced undergraduates. Topics covered will include: nanoscience and nanotechnology, nanofabrication, self-assembly, colloidal chemistry, sol-gel, carbon nanotubes, graphene, thin film, lithography, physical vapor deposition, chemical vapor deposition, quantum dots, lithium batteries, X-ray diffraction, scanning electron microscopy, transmission electron microscopy, nanoelectronics, nanophotonics and nanomagnetics, etc. Taught with CHME 467.
Prerequisite(s): CHEM 1225G or CHEM 1226 and PHYS 1230G or PHYS 1310G.

CHME 579. Corrosion and Degradation of Materials
3 Credits (3)
Failure of engineering materials in aggressive environments. Chemical and electrochemical mechanisms of corrosion. Influence of chemical composition and microstructure on corrosion behavior. Types of corrosion and chemical attack, including uniform corrosion, galvanic corrosion, pitting and other forms of localized corrosion, stress corrosion cracking, and corrosion fatigue. Methods of corrosion mitigation including cathodic protection, coatings, passivation, and corrosion inhibitors. Corrosion in nuclear reactors and nuclear waste repositories. Taught with CHME 479.
Prerequisite(s): CHME 361.

CHME 585. Materials from Biorenewable Resources
3 Credits (3)
Types, sources, composition and properties of biomass. Production, processing and applications of biomass materials to fulfill food, feed, fiber, fuel and chemical feedstock needs with energy, water, cost, sustainability, and waste management considerations. Taught with CHME 485.
Prerequisite(s): CHEM 2115 or 313 or consent of instructor.

CHME 586. Biofuels
3 Credits (3)
Introduction to the fundamentals and applications of biofuels and bioenergy production; biomass resources and their composition; types of biofuels; conversion technologies (thermochemical and biochemical conversion processes); biodiesel production, algae to biofuels; economic and environmental assessments; term paper of selected topics relevant to biofuels. May be repeated up to 3 credits. Restricted to: CHME/CH E majors.
Prerequisite(s): CHME 201.

CHME 590. Graduate Seminar
1 Credit (1)
Presentations on topics of professional interest in chemical engineering. Includes seminars by faculty, graduate students, and invited speakers from academia, government, and industry. May be repeated up to 6 credits. Restricted to: CHME majors.
CHME 594. Professional Communication in Chemical Engineering
2 Credits (2)
Connections between interpersonal relationships and the effective communication of information. Strategies for formal and informal written and verbal communication in the context of presentations, interviews, reports and publications. Factors affecting non-verbal communication. Special focus will be given to understanding and adapting to the audience's perspective. 2 credits. Open to chemical engineering graduate students or by permission of instructor. This class will prepare you to communicate technical information effectively within a variety of contexts and to a variety of audiences. Class assignments will be partially based on current student needs such as preparing presentations for professional conferences, giving research progress reports, and writing research manuscripts. Restricted to: CHME majors.
Prerequisite(s): CHME graduate student standing.

CHME 595. Chemical Process Design and Business Analysis
3 Credits (3)
Graduate chemical process design principles, emphasizing literature review, patent search, heuristics application, process simulation assistance to process creation, synthesis of reactor and separator trains, second-law analysis, heat and power integration, process equipment mechanical design specifications, process design optimization, cost accounting and capital estimation, annual costs, earnings, and profitability analysis.
Prerequisite(s)/Corequisite(s): CHME 506, CHME 516, CHME 542.
Prerequisite(s): CHME 452, CHME 455 L or equivalent.

CHME 596. Chemical Process Industries Research
1 Credit (1)
Independent graduate-level chemical process design project development, literature search, and proposal/defense.
Prerequisite(s): CHME 595.

CHME 597. Advanced Chemical Process Industry Analysis
2 Credits (2)
In-depth analysis and defense of a timely commercially-relevant chemical process design.
Prerequisite(s): CHME 596.

CHME 598. Ph.D. Research - Level I
1-9 Credits (1-9)
Individual investigations either analytical or experimental. May be repeated up to 6 credits.

CHME 599. Master's Thesis
1-15 Credits (1-15)
Thesis.

CHME 690. Graduate Seminar
1 Credit (1)
Presentations on topics of professional interest in chemical engineering. Includes seminars by faculty, graduate students, and invited speakers from academia, government, and industry. Required each semester for every Ph.D. student. All candidates for graduate degrees required to give seminar. May be repeated up to 8 credits. Restricted to: CHME majors.

CHME 698. Ph.D. Research - Level II
1-9 Credits (1-9P)
Advanced topics for current research. Course subtitled in the Schedule of Classes. May be repeated up to 99 credits. Consent of Instructor required.
Prerequisite(s): successful completion of Ph D qualifying exam.

CHME 700. Doctoral Dissertation
1-9 Credits (1-9)
Individual research in selected topics of current interest in chemical engineering. May be repeated up to 88 credits. Thesis/Dissertation Grading.
Prerequisite(s): CHME 698 (9 credits) and successful completion of comprehensive exam.

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