Department of Chemical and Biomedical Engineering

Degrees Offered

- Masters of Science, Biomedical Engineering (M.S.Bm.E.)
- Masters of Science, Chemical Engineering (M.S.Ch.E.)
- Masters of Science, Engineering (M.S.E.)
- Doctor of Philosophy, Chemical Engineering (Ph.D.)

The Department of Chemical and Biomedical Engineering has one of the oldest doctoral-granting programs in the university. From the initial doctoral degree in 1932, the graduate academic program has been based on advanced engineering fundamentals, while the research program has reflected a balance of fundamental research areas and their application to relevant technological areas such as decarbonization of energy systems, sustainability, precision medicine, flexible manufacturing, novel materials, modeling and computational tools.

Areas of Research

The Chemical and Biomedical Engineering faculty are presently involved in a broad spectrum of research areas that can be broadly classified into biomedical engineering, catalysis and reaction engineering, materials and interfacial phenomena, and process systems engineering. These research activities impact economic development, national security, the stability and sustainability of the energy supply, and many quality-of-life issues.

Faculty members possess a wide spectrum of industrial experience and are routinely in contact with their counterparts in industry. This contact with real engineering problems enables them to convey a practical experience to students while keeping in perspective many of the fundamental concepts involved in graduate study. The faculty is nationally and internationally recognized through the publication of text books, monograph series, and technical papers as well as presentations in national and international conferences.

FACULTY

CHAIR
- Srinivas Palanki - Ph.D. (University of Michigan)
  Process systems engineering, Chemical process control, Bioengineering

PROFESSORS
- Debangsu Bhattacharyya - Ph.D. (Clarkson University)
  GE Plastics Material Engineering Professor. Artificial intelligence and machine learning, Biomimetic and other advanced control Nonlinear state estimation, Condition monitoring, Sensor placement, Bayesian analysis, Multi-scale dynamic modeling, Fuel cells and electrolyzers, Carbon capture, H2 production, Biomass conversion and Energy systems
- Zoica Cerasela Dinu - Ph.D. (Max Planck Inst of Molecular Cell Biology & Genetics & Dresden University of Technology)
  Nanomaterials, Bionanotechnology, Biomimetics, Catalysis and Biocatalysis
- Pradeep Fulay - Ph.D. (University of Arizona)
  Advanced Electronics, Magnetic Materials and Devices, Flexible Electronics, Synthesis and Processing of Nanomaterials
- Rakesh Gupta - Ph.D. (University of Delaware)
  Berry Professor. Polymer processing, Rheology, Non-Newtonian fluid mechanics, Composite materials
- John (Jianli) Hu - Ph.D. (Tsinghua University)
  Statler Chair Professor. Catalysis and reaction engineering, Utilization of natural gas, CO2 and biomass
- David J. Klinke - Ph.D. (Northwestern University)
  Systems Biology, Kinetics, Cellular Signal Transduction Pathways, Immunology, Mathematical Modeling, Bioengineering

ASSOCIATE PROFESSOR
- Fernando V. Lima - Ph.D. (Tufts University)
  Process design and operability, Model-based control and Optimization, State estimation and process identification, Modular energy systems and sustainability

ASSISTANT PROFESSOR
- Jessica L. Allen - Ph.D. (University of Texas at Austin)
  Neuromuscular biomechanics; Aging, injury, and disease-related mobility impairments; Rehabilitation engineering; Musculoskeletal modeling and simulation
• Madelyn R. Ball - Ph.D. (University of Wisconsin - Madison)
  Heterogeneous catalysis, Metal nanoparticle development, Operando spectroscopic characterization, Reaction Kinetics, CO2 utilization, Hydrogenation chemistry
• Margaret F. Bennewitz - Ph.D. (Yale University)
  Biomedical imaging, Fluorescence intravital lung microscopy, MRI contrast agents, Nano drug delivery systems, Microfluidics, Tumor microenvironment, Cancer metastasis, Toxicology
• Stephen M. Cain - Ph.D. (University of Michigan)
  MEMS inertial sensor applications, Wearable sensor applications, Real-world biomechanics, Upper extremity biomechanics, Human gait, Sports biomechanics, Experimental methods, Bicycle dynamics, Medication adherence
• Moriah Katt - Ph.D. (Johns Hopkins University)
  Blood-brain barrier, Tissue engineering, Stroke, Drug delivery, Stem cells
• Wenyan Li - Ph.D. (West Virginia University)
  Solid state ionics, Solid oxide fuel/electrolysis cells, High temperature electrochemistry, Shale gas conversion and utilization, CO2 utilization
• Oishi Sanyal - Ph.D. (Michigan State University)
  Membrane for water treatment and desalination, Self-assembly based surface modification, Molecular sieving materials, Natural gas and Flue gas purification
• Soumya K. Srivastava - Ph.D. (Mississippi State University)
  Point-of-care (POC) medical diagnostic platforms and environmental bio-separations using electrokinetics, Transport phenomena, Fluid dynamics, and Dielectric spectroscopy
• Ruhe Tian - Ph.D. (Texas A&M University)
  Process systems engineering, Computer-aided process intensification, Process synthesis and optimization, Multi-scale sustainable energy systems, Hybrid mechanistic/data-driven modeling

TEACHING ASSOCIATE PROFESSOR
• Robin S. Hissam - Ph.D. (University of Delaware)
  Director of Undergraduate Education. Biomaterials, Polypeptides, Drug delivery, Bioengineering and materials science

TEACHING ASSISTANT PROFESSOR
• Jeremy S. Hardinger - Ph.D. (West Virginia University)

VISITING ASSISTANT PROFESSOR
• Nasagree Garapati - Ph.D. (West Virginia University)
  Carbon dioxide capture and storage (CCS) in various geologic media, utilizing carbon dioxide in gas hydrate reservoirs, petroleum reservoirs and geothermal reservoirs for enhanced gas, oil and heat recovery

PROFESSORS EMERITUS
• Eung H. Cho - Ph.D. (University of Utah)
  Mineral Processing, Leaching, Solvent Extraction, Environmental Science
• Eugene V. Cilento - Ph.D. (University of Cincinnati)
  Physiological Transport Phenomena, Biomedical Engineering, Image Analysis, Mathematical Modeling
• Dady B. Dadyburjor - Ph.D. (Delaware)
  Catalysis, Reaction Engineering
• Edwin L. Kugler - Ph.D. (Johns Hopkins)
  Catalysis, Adsorption, Coal Liquefaction
• Joseph A. Shaeiwitz - Ph.D. (Carnegie-Mellon University)
  Design, Design Education, Outcomes Assessment
• Alfred H. Stiller - Ph.D. (University of Cincinnati)
  Physical/Inorganic/Solution Chemistry, Coal Liquefaction, Carbon Science
• Charter D. Stinespring - Ph.D. (West Virginia University)
  Semiconductor Growth and Etching, Surface Kinetics, Thin Films, Electronic Materials
• Richard Turton - Ph.D. (Oregon State University)
  WVU Bolton Professor, P.E.; Process systems engineering, Particle and powder technology, Chemical process design
• Ray Y.K. Yang - Ph.D. (Princeton)
  Biochemical and Chemical Engineering, Nonlinear Dynamics
• John W. Zondlo - Ph.D. (Carnegie Mellon University)
  Coal Enhancement and Utilization, Carbon Science, Fuel Cells

For specific information on the following programs, please see the links to the right:
• Biomedical Engineering
• Chemical Engineering

BIOMEDICAL ENGINEERING COURSES

BMEG 501. Principles and Applications of Biomedical Engineering. 3 Hours.
PR: Consent. Introduction to the principles of biomedical engineering from cells to systems. Biomedical engineering concepts and applications as related to biomaterials, drug delivery, tissue engineering, biohybrid devices, bioinstrumentation, bioimaging, and other areas. Emphasis on critical thinking and development of original research ideas.

BMEG 593. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

BMEG 601. Numerical and Statistical Methods for Biomedical Engineering. 3 Hours.
PR: Consent. Introduces analysis methods for research in biomedical engineering. Topics include numerical analysis, simulation of dynamic systems, statistical inference test and applications in clinical trials, time-series data analysis, machine learning, bioimaging, and acquiring physiological data. Through homework projects, relevant examples and extensive case studies, this course will equip students with the tools to conduct research in biomedical engineering.

BMEG 602. Interfacial Phenomena in Living and Non-Living Systems. 3 Hours.
PR: Consent. Introduces concepts related to the interfacial phenomena in living and non-living systems. Specific topics covered include the free energy of interface formation, intermolecular and surface forces, energetic processes, thermodynamics, statistical mechanics, and interfacial phenomena that emphasize the chemical natures of living and non-living systems.

BMEG 695. Independent Study. 1-9 Hours.
BMEG 695. Independent Study. 1-9 hr. Faculty-supervised study, reading, or research.

CHEMICAL ENGINEERING COURSES

CHE 516. Oil & Gas Refining. 3 Hours.
PR: Graduate standing and instructor approval. The fundamental principles to analyze refining processes in modern petroleum refineries, chemistry and processes for the conversion of natural gas to products equivalent to those from petroleum.

CHE 531. Mathematical Methods in Chemical Engineering. 3 Hours.
PR: MATH 261 and consent. Classification and solution of mathematical problems important in chemical engineering. Treatment and interpretation of engineering data. Analytical methods for ordinary and partial differential equations, including orthogonal functions and integral transforms. Vector calculus. (3 hr. lec.).

CHE 565. Corrosion Engineering. 3 Hours.
PR: CHE 320 or CHEM 341 or equivalent. Basic mechanisms of various types of corrosion such as galvanic corrosion, pitting corrosion and stress corrosion cracking; methods of corrosion prevention such as cathodic and anodic prevention, by using coatings and inhibitors, and by selecting proper alloys. (3 hr. lec.).

CHE 566. Electronic Materials Processing. 3 Hours.
PR: Graduate standing in Engineering, Physics, Chemistry, or instructor consent. Design and application of thermal, plasma, and ion assisted processing methodologies; design and function of key process tools and components; vacuum technology; solid state, gas phase, surface, and plasma chemistry underpinnings; thin film nucleation, growth, and etching; effects of processing methods and conditions on materials properties.

CHE 580. Advanced Cellular Machinery. 3 Hours.
PR: Consent. Coverage and application of principles of cellular biology to enable the integration of cell components into biotechnological applications.

CHE 591. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

CHE 593. Special Topics. 1-6 Hours.
PR: Consent. A study of contemporary topics selected from recent developments in the field.

CHE 610. Fluidization Engineering. 3 Hours.
PR: Consent. Fundamentals of fluidization, two-phase flow theory and powder characteristics, structure and property of the emulsion phase and bubbles, mass and heat-transfer in fluidized beds with and without chemical reaction. (3 hr. lec.).
CHE 615. Transport Phenomena. 3 Hours.
PR: Consent. Introduction to equations of change (heat, mass, and momentum transfer) with a differential-balance approach. Use in Newtonian flow, turbulent flow, mass and energy transfer, radiation, convection. Estimation of transport coefficients. (3 hr. lec.).

CHE 620. Thermodynamics. 3 Hours.
PR: Consent. Logical development of thermodynamic principles. These are applied to selected topics including development and application of the phase rule, physical and chemical equilibria in complex systems, and nonideal solutions. Introduction to nonequilibrium thermodynamics. (3 hr. lec.).

CHE 625. Chemical Reaction Engineering. 3 Hours.
PR: Consent. Homogeneous and heterogeneous reaction systems, batch and flow ideal reactors, macro- and micro-mixing, non-ideal reactors, diffusion and reaction in porous catalysts, reactor stability analysis, special topics. (3 hr. lec.).

CHE 693. Special Topics. 6 Hours.
A study of contemporary topics selected from recent developments in the field.

CHE 694. Seminar. 1-6 Hours.
Seminars on current research by visitors and graduate students.

CHE 695. Independent Study. 1-9 Hours.
Faculty-supervised study of topics not available through regular course offerings.

CHE 697. Research. 1-9 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.).

CHE 716. Advanced Fluid Dynamics. 3 Hours.
PR: Consent. Analysis of flow of fluids and transport of momentum and mechanical energy. Differential equations of fluid flow; potential flow, laminar boundary-layer theory, and non-Newtonian fluids. (3 hr. lec.).

CHE 717. Advanced Heat Transfer. 3 Hours.
PR: Consent. Theory of transport of thermal energy in solids and fluids as well as radiative transfer. Steady state and transient conduction; heat transfer to flowing fluids; evaporation; boiling and condensation; packed- and fluid-bed heat transfer. (3 hr. lec.).

CHE 718. Advanced Mass Transfer. 3 Hours.
PR: Consent. Theory of diffusion, interphase mass-transfer theory, turbulent transport, simultaneous mass and heat transfer, mass transfer with chemical reaction, high mass-transfer rates, and multicomponent macroscopic balances. (3 hr. lec.).

CHE 720. Applied Statistical and Molecular Thermodynamics. 3 Hours.
PR: CHE 620 and consent. The connection between macroscopic phenomena (thermodynamics) and microscopic phenomena (statistical and quantum mechanics). Thermodynamics modeling for process analysis. Equations of state, perturbation theories, mixing rules, computer simulation, group-contribution models, and physical-property prediction. (3 hr. lec.).

CHE 726. Catalysis. 3 Hours.
PR: CHE 625 or consent. Physical and chemical properties of catalytic solids, nature and theories of absorption, thermodynamics of catalysis, theories of mass and energy transport, theoretical and experimental reaction rates, reactor design, and optimization. (3 hr. lec.).

CHE 730. Advanced Numerical Methods. 3 Hours.

CHE 731. Optimization of Chemical Engineering Systems. 3 Hours.
PR: Consent. Optimization in engineering design, unconstrained optimization and differential calculus, equality constraints optimization, search technique, maximum principles, geometric and dynamic programming, linear and nonlinear programming, and calculus of variations. (3 hr. lec.).

CHE 786. Professional Development Seminar for Chemical and Biomedical Engineering. 0 Hours.
This course is designed for graduate students to learn technical presentation skills. The class will have lectures and discussion on contemporary problems of interest to chemical engineers and biomedical engineers. The course consists of a one-hour lecture each week by visiting speakers as well as department graduate students.

CHE 790. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of chemical engineering. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It will also present a mechanism for students not on assistantships to gain teaching experience. (Grading may be S/U.).

CHE 791. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

CHE 792. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

CHE 793. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.
CHE 795. Independent Study. 1-9 Hours.
Faculty supervised study of topics not available through regular course offerings.

CHE 796. Graduate Seminar. 1-3 Hours.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

CHE 797. Research. 1-9 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.).