Chemical and Materials Engineering

Chemical engineers use chemistry, biology, physics and math in an integrated engineering mode in order to manufacture materials and products to modern society. They are involved with the full scale of processes, from the laboratory bench to the pilot plant and eventually to the manufacturing facility. The academic training of chemical engineers provides a strong background for a variety of areas, including;

- Process Design
- Pharmaceutical Engineering
- Production Engineering
- Research and Development
- Marketing/Technical Sales
- Environmental and Waste Management
- Safety

At present, chemical engineers are involved in areas such as producing more effective pharmaceuticals and more durable plastics, developing, biotechnology, genetic engineering applications, and producing electronic materials. They are also involved in the more traditional areas of petroleum refining and chemical manufacturing. A Chemical engineer may choose to work in a variety of industries which include chemicals, pharmaceuticals, food, energy, and environmental control. A chemical engineering degree also serves as a good preparation for law, business, or medical school.

The Mission of the Department is to:

1. Educate undergraduate students for employment in industry and the pursuit of graduate studies;
2. Educate graduate students for employment in industry, government, or academe;
3. Educate students, both undergraduate and graduate, for leadership roles;
4. Engage in research to support the advanced education of graduate students, maintain the intellectual vitality of the faculty, and expand the frontiers of knowledge in areas of importance to the state and nation;
5. Publish and present the results of our intellectual activities, resulting from both research as well as teaching advances;
6. Serve our profession through membership and leadership on national and international societies, journals and editorial boards; and
7. Serve our wider constituencies by offering our expertise to industries, state and local communities, and pre-college students and teachers.

Chemical Engineering Program Education Objectives

Engineering Practice

Graduates of our program are successfully engaged in the practice of chemical engineering within industry, academe and government working in a wide array of technical specialties including but not limited to process and plant design operations.

Professional Growth

Graduates of our program advance their skills through professional growth and development activities such as graduate study in engineering or complimentary disciplines, and continuing education; some graduates will transition into other professional fields such as business, law and medicine through further education.

Service

Graduates of our program perform service to the society and the engineering profession through participation in professional societies, government, civic organizations, and humanitarian endeavors.

Chemical Engineering Program Outcomes

Graduates of the Otto H. York Department of Chemical and Materials Engineering will have:

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- an ability to communicate effectively with a range of audiences
- an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

This program is accredited by the Engineering Accreditation Commission of ABET, http://abet.org.

Advisement

All students are required to see their advisor at least once each semester immediately prior to formal registration for the following semester(s). Registration holds are removed following the meeting. All undergraduates must schedule their appointments online using Map-Works, to see their undergraduate advisor, Gordana Obuskovic.

Freshman Advisement

Some freshmen are assigned courses (CHEM 121 Fundamentals of Chemical Principles I-CHEM 122 Fundamentals of Chemical Principles II;ENGL 090 General Skills in the English Language -HUM 099 -HUM 100) and/or lightened credit loads. It is particularly important for these students to see their advisor to plan their courses for subsequent semesters. Completing pre-requisites for sophomore courses may involve attending summer sessions and/or spending an additional semester at NJIT.

NJIT Faculty

A

Armenante, Piero M., Distinguished Professor

Axe, Lisa, Professor

B

Baltzis, Basil C., Professor

Barat, Robert B., Professor Emeritus

Basuray, Sagnik, Associate Professor

Bilgili, Ecevit A., Professor

C

Chintersingh, Kerri-lee, Assistant Professor

Cimino, Richard, Senior University Lecturer

D

Dave, Rajesh N., Distinguished Professor

Dreyzin, Edward L., Distinguished Professor

G

Gogos, Costas, Distinguished Research Professor

Gor, Gennady, Assistant Professor

Guvendiren, Murat, Assistant Professor

K

Khusid, Boris, Professor

Kimmel, Howard, Professor Emeritus

L

Loney, Norman, Professor Emeritus

M

McEnnis, Kathleen, Assistant Professor

Molodetsky, Irina, Senior University lecturer

P

Pfeffer, Robert, Distinguished Professor Emeritus

R

Reid, Nellone, Senior University Lecturer

S

Schoenitz, Mirko, Associate Research Professor

Sebastian, Donald H., Professor

Simon, Laurent, Professor

Sirkar, Kamalesh K., Distinguished Professor

T

Tomkins, Reginald P.T., Professor Emeritus

V

Venerus, David, Professor

Voronov, Roman S., Associate Professor

W

Wang, Xianqin, Professor

X

Xu, Xiaoyang, Associate Professor

Y

Young, Joshua, Assistant Professor

Z

Zhao, Mark, Assistant Professor

- Chemical Engineering - B.S. (http://catalog.njit.edu/undergraduate/newark-college-engineering/chemical-materials-engineering/bs/)
- Materials Engineering - B.S. (http://catalog.njit.edu/undergraduate/newark-college-engineering/chemical-materials-engineering/cme-bs/)

- Chemistry Minor (http://catalog.njit.edu/undergraduate/newark-college-engineering/chemical-materials-engineering/chemistry-minor-chemical-engineering-majors/) (for Chemical Engineering majors)
- Materials Engineering Minor (http://catalog.njit.edu/undergraduate/newark-college-engineering/chemical-materials-engineering/materials-engineering-minor/)

Chemical and Materials Engineering Courses

CHE 101. Introduction to Chemical Engineering. 1 credit, 1 contact hour (1;0;0).
Pre or Corequisite: CHEM 125. Restriction: CHE students only. An introduction to the field of chemical engineering and to the Otto H. York Department of Chemical and Materials Engineering. Topics include the curriculum, student professional societies (AIChE Student Chapter), undergraduate research opportunities, cooperative education, and learning more about the chemical engineering profession and career pathways. The course also introduces basic engineering calculations as well as processes and their variables.

CHE 201. Material and Energy Balances. 4 credits, 5 contact hours (4;0;1).
Prerequisites: CHEM 126, MATH 112. Pre or Corequisites: CHE 101. Corequisites: CHE 230. This course covers the basic principles of material and energy balances for a variety of chemical engineering systems. Basic unit operations and simple designs of chemical processes are introduced.

CHE 210. Chemical Process Calculations I. 2 credits, 3 contact hours (2;0;1).
Prerequisites: CHEM 126, MATH 112. Analysis of chemical processes is introduced, emphasizing steady and unsteady-state mass and species balances. This course uses primarily chemistry and algebra to determine, for a wide variety of processes and applications, the flow and concentrations of different chemical species.

CHE 230. Chemical Engineering Thermodynamics I. 3 credits, 4 contact hours (3;0;1).
Prerequisites: CHEM 126, MATH 112, PHYS 111. Corequisite MATH 211 (or MATH 213). The Fundamentals of thermodynamics are applied to chemical engineering processes. Thermophysical properties and their engineering correlations are covered. Applications include chemical engineering and related fields such as environmental and biomedical engineering.

CHE 240. Chemical Process Calculations II. 2 credits, 3 contact hours (2;0;1).
Prerequisites: CHE 210 and CHE 230. This course covers the basic principles of energy balances for a variety of engineering systems. Combined with material from other sophomore courses, simple designs of chemical processes are considered. The course also introduces chemical process simulation software.

CHE 260. Fluid Flow. 3 credits, 4 contact hours (3;0;1).
Prerequisites: CHE 201 or CHE 210, CHE 230. Corequisite: MATH 222. This course considers the principles of molecular and turbulent transport of momentum, particularly as they apply to pressure drop calculations in piping systems, packed columns, and other flow devices. Flow around submerged objects is also considered.

CHE 312. Chemical Process Safety. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHE 342, CHE 370. Corequisites: CHE 349, MTEN 201 or CHE 375. A study of the technical fundamentals of chemical process safety: includes impact of chemical plant accidents and concepts of societal and individual risk; hazards associated with chemicals and other agents used in chemical plants, including toxic, flammable and reactive hazards: concepts of inherently safer design; control and mitigation of hazards to prevent accidents, including plant procedures and designs; major regulations that impact safety of chemical plants; consequences of chemical plant incidents due to acute and chronic chemical release and exposures; hazard identification procedures; introduction to risk assessment.

CHE 342. Chemical Engineering Thermodynamics II. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHE 230, MATH 211 (or MATH 213), CHEM 236. The principles and methods developed in Chemical Engineering Thermodynamics I are extended to multicomponent systems, and used to treat phase and chemical equilibrium as well as such applications as chemical reactors and refrigeration systems.

CHE 349. Kinetics and Reactor Design. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHE 342, CHE 370, MATH 222, CHEM 236. Derive and solve species and energy balances for single chemical reactors; introduces heterogeneous catalysis, non-ideal reactors as ideal reactor combinations, and special topics such as polymeric or biochemical reactions.

CHE 360. Separation Processes I. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHE 342, CHE 370. This is the first course in separations, examines traditional methods and technologies by which chemical engineers separate and purify mixtures. Emphasis here is on strippers, absorbers, distillations, and extractions.

CHE 365. Chemical Engineering Computing. 3 credits, 4 contact hours (2;2;0).
Prerequisites: CHE 370, CS 115 co-requisite: CHE 360. Introduction to basic concepts of computational methods for solving chemical engineering problems and performing process simulations. Topics include common numerical techniques encountered in chemical engineering, for the solution of linear and nonlinear algebraic equations and ordinary differential equations, differentiation/integration, optimization and interpolation/regression of data. Students will be exposed to modern computational software and commercial chemical processes simulators.

CHE 370. Heat and Mass Transfer. 4 credits, 4 contact hours (4;0;0).
Prerequisites: CHE 201 or CHE 240, CHE 260, MATH 222. The principles of heat and mass transfer in chemical engineering systems are covered. Steady and unsteady heat transfer is examined, with emphasis on the heat exchanger design. Mass transfer by steady and unsteady molecular diffusion, and turbulent convective mass transfer is studied.

CHE 375. Structure, Properties and Processing of Materials. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHEM 126, PHYS 121 or PHYS 122, MATH 112. This course introduces the principles of materials engineering from the perspective of structure-property-processing relationships. Instead of covering different types of materials separately, this course will use the principles common to engineering of all important materials as an underlying theme. These are atomic/molecular structure, nanoscale, morphology, principles of phase transformation, structure development during processing, and property dependence on structure. All these topics will be introduced through the paradigm of comparing metals, ceramics and polymers. Besides single component systems, advanced materials such as multiphase and/or multicomponent systems (e.g. composites and gels) and nanomaterials will be discussed based on these principles. An integral part of this course will be the criteria for selection of materials for specific end-use conditions and customer specifications, which can incorporate various engineering standards and multiple constraints such as public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

CHE 380. Introduction to Biotechnology. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHEM 122 or CHEM 126. Basic principles of molecular biotechnology with selected examples of applications.

CHE 396. Chemical Engineering Laboratory I. 3 credits, 5 contact hours (0;5;0).
Prerequisites: CHE 370, COM 313. Corequisite: MATH 225A. In this first course in chemical engineering capstone laboratory, experiments are conducted in the areas of fluid mechanics and heat transfer. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

CHE 402. ST:. 3 credits, 3 contact hours (3;0;0).
Prerequisites: Junior or senior standing in chemical engineering. Combined laboratory and lecture course emphasizing photonics and laser applications in chemical engineering.

CHE 415. Introduction to 3D Printing. 3 credits, 4 contact hours (2;2;0).
Prerequisites: Junior standing or higher. This course introduces 3D printing technologies including history and basics of 3D printing, currently available 3D printing methods and printable materials as well as current and emerging applications of 3D printing. Students will get a general idea on the major players in 3D printing industry and global effects of 3D printing. The course will be composed of a lecture and a hands-on laboratory session, during which students will create a 3D design and print a functional prototype.

CHE 427. Biotransport. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHE 230 and MATH 222. Introduction to basic concepts of transport phenomena as applied to biological systems. Topics include the structure and composition of the human body, the properties of the blood and its flow in the cardiovascular system, and the body as a heat source and as a series of compartments involved in the mass transfer of materials (such as those in the kidneys and lungs). Students learn to analyze solute transport in biological systems and apply it to the design of biomedical devices.

CHE 444. Introduction to Polymer Engineering. 3 credits, 3 contact hours (3;0;0).
Prerequisite: CHE 370. Introduction to the basic concepts of polymer engineering. Topics covered include rheology, heat transfer, and kinetics of polymerization reactors.

CHE 460. Separation Processes II. 3 credits, 3 contact hours (3;0;0).
Prerequisite: CHE 360. This second course in separations examines non-traditional methods and technologies such as fixed-bed processes, membranes, crystallization, and mechanical separations.

CHE 472. Process and Plant Design. 4 credits, 4 contact hours (4;0;0).
Prerequisites: CHE 312, CHE 349, CHE 360, CHE 365, IE 492, MTEN 201 or CHE 375. A capstone course in the chemical engineering program that incorporates various engineering standards and multiple constraints such as public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. This class is divided into four- to six-student groups in the design process. Each group must solve an open-ended plant design problem, including process–equipment specification while considering various engineering standards and constraints. They write a project report and present their project to a wide audience (open to public) at the end of the semester.

CHE 473. Mathematical Methods in Chemical Engineering. 3 credits, 3 contact hours (3;0;0).
Prerequisites: MATH 222, CHE 349, CHE 360, and CHE 370. An introduction to the use of differential equations to solve chemical engineering problems.

CHE 476. Introduction to Biochemical Engineering. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHEM 245, CHE 349. Corequisite: CHE 349. The application of chemical engineering to biochemical processes. Topics include enzyme reactions, dynamics of microbial populations, fermentation equipment, bioreactor design, and sterilization.

CHE 489. Process Dynamics and Control. 3 credits, 4 contact hours (3;0;1).
Prerequisites: CHE 349, CHE 365. This course is an introduction to chemical process dynamics and control. Topics include analysis of the dynamics of open-loop systems, the design of control systems, and the dynamics of closed-loop systems. Control techniques and methodologies, used by practicing chemical engineers, are emphasized.

CHE 490. Special Topics in Chemical Engineering. 3 credits, 3 contact hours (3;0;0).
Prerequisites: Junior or senior standing and approval of the CHE Program Director. Restrictions: Restricted to majors in NCE only. The study of novel, contemporary, and/or advanced topics in an area of chemical engineering not regularly covered in any other CHE course. The precise topics to be covered in the course will be announced in the semester prior to the offering of the course.

CHE 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).
Restriction: senior standing in chemical engineering, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. Normally a GPA greater than 3.0 is required to participate in the course. Provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion.

CHE 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).
Prerequisite: CHE 491. A continuation of CHE 491.

CHE 495. Chemical Engineering Laboratory I. 2 credits, 5 contact hours (0;5;0).
Prerequisites: FED 101, CHE 312, CHE 360, CHE 370, COM 313, MATH 225. In this first course in chemical engineering capstone laboratory, experiments are conducted in the areas of fluid mechanics and heat transfer. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

CHE 496. Chemical Engineering Laboratory II. 3 credits, 6 contact hours (0;6;0).
Prerequisites: CHE 349, CHE 489, CHE 495, CHEM 339. In this second course in chemical engineering capstone laboratory, experiments are conducted in the areas of mass transfer, separations, reaction engineering, and process dynamics and control. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

MTEN 101. Introduction to Materials Engineering. 1 credit, 1 contact hour (1;0;0).
This course provides an introduction to the field of materials engineering and to the Otto H. York Department of Chemical and Materials Engineering. Topics include the program curriculum, student professional societies, undergraduate research and cooperative education (co-op) opportunities, and learning about materials engineering profession and career pathways. Also included are lectures by MTEN faculty integrated with research laboratory tours and hands-on research experience.

MTEN 201. Introductory Principles of Materials Engineering. 3 credits, 3 contact hours (3;0;0).
Prerequisites: CHEM 126, PHYS 121 or PHYS 122, MATH 112. This course introduces the basic concepts of Materials Engineering, with introductory topics including structure, property, performance, and processing of materials. This course focuses on conventional materials including metallic materials and their alloys, ceramics, polymers, and composites. Relationship between structure and material properties, such as mechanical, electronic, thermal, optical, magnetic, and electrochemical, are investigated.

MTEN 205. Mechanical Behavior of Materials. 3 credits, 3 contact hours (3;0;0).
Prerequisites: MATH 211 or MATH 213, MTEN 201 and MECH 234. The course will introduce the fundamentals of the mechanical behavior of materials. The principles of stress, strain will be introduced. The elements of elasticity, plasticity, will be discussed in depth. The concept of crystal geometry, different lattice defects, work hardening will be taught. Furthermore, the fundamentals of plastic deformation of polycrystalline materials, dislocation theory, and fracture will be discussed in detail. The course will include written and oral presentation of team projects on analysis of relevant peer-reviewed papers on the latest development of the field.

MTEN 301. Thermodynamics of Materials. 3 credits, 3 contact hours (3;0;0).
Prerequisites: MATH 211 or MATH 213, PHYS 234, MTEN 205. Laws of thermodynamics and their correlation with molecular phenomena describing materials systems in equilibrium. Applications to properties, reactions and phase equilibria in materials. Thermodynamic foundation, interpretation and utilization of binary phase diagrams. Contemporary software for phase diagram calculation. Thermodynamic principles describing liquid and solid solutions, chemical reactions, and order-disorder phase transitions.

MTEN 305. Materials Characterization Methods. 3 credits, 4 contact hours (2;2;0).
Prerequisites: MATH 211 or MATH 213, PHYS 234, CHEM 243, MTEN 201. This course gives an introduction to instrumentation for characterization of material structures and compositions and methods for measuring a wide range of material properties such as mechanical, electrical, thermal. Principles of microscopic imaging and the major branches of microscopy: optical, electron and scanning will be discussed. Principles of X-ray diffraction and X-ray, IR, UV, electron and ion spectroscopies will be introduced by considering interaction of materials with electromagnetic radiation, electrons, and ions. Principles of thermal analysis in which the properties of materials are studied as they change with temperature will be introduced. Characterization of hardness, strength, electrical conductivity will be discussed. Students will learn operation of analytical instrumentation and interpretation of experimental data at the NJIT Materials Characterization facility and CME undergraduate laboratory. The course will include written and oral presentation of team projects on analysis of peer-reviewed papers on specific techniques and equipment for materials characterization.

MTEN 310. Transport Phenomena in Materials I. 3 credits, 3 contact hours (3;0;0).
Prerequisites: MATH 222, PHYS 234, CHEM 243, MTEN 205. This course introduces the concepts of transport phenomena and develops the balance equations for the transport of mass, momentum, and energy. Classical force-flux relations that include Newton’s law of viscosity and Fourier’s law are considered. These equations, along with suitable boundary conditions, are applied to fluid mechanics and heat transfer problems relevant to materials characterization and processing. This includes laminar flows of both Newtonian and non-Newtonian fluids, conduction in solids, convective heat transfer, and phase change in single-component materials.

MTEN 311. Transport Phenomena in Materials II. 3 credits, 3 contact hours (3;0;0).
Prerequisites: MTEN 301 and MTEN 310. This course continues the development and application of the equations of transport phenomena and includes balance equations for transport at interfaces. Classical constitutive equations that include Fick’s law and the Nernst-Planck equation as well as expressions for both homogeneous and heterogeneous chemical reaction are considered. These equations, along with suitable boundary conditions, are applied to multi-component and charged systems that are relevant to materials characterization and processing. This includes diffusion, chemical reaction, charge and coupled transport, and phase change in multi-component materials.

MTEN 395. Materials Engineering Laboratory I. 3 credits, 6 contact hours (0;6;0).
Prerequisites: FED 101, MTEN 301, MTEN 305, MTEN 310, MATH 333. This course introduces modern materials characterization equipment, techniques and methods for qualitative and quantitative analysis of materials properties, methods of presenting collected data. Course emphasizes structure-properties relationships via the measuring properties of different classes of materials. This course includes physical, mechanical, thermal, electrical and optical properties measurements. Techniques for direct micro- and macrostructural analysis include X-Ray diffraction, optical and electron imaging.

MTEN 410. Soft Materials. 3 credits, 3 contact hours (3;0;0).
Prerequisites: MTEN 301 (or CHE 230 or ME 311 or BME 352) and MTEN 310 (or CHE 260 or ME 304 or BME 427). This course is an introduction to soft materials such as polymers, colloids, liquid crystals, gels, and biomaterials. The course will cover the structure, properties, and applications of soft materials. Specific topics will include kinetics in material synthesis/growth, assembly, phase behavior, phase transitions, dynamics, characterization techniques, and applications.

MTEN 450. Materials Engineering Design. 3 credits, 3 contact hours (3;0;0).
Prerequisites: MTEN 311, MTEN 395, MATH 333. An advanced course focusing on the selection of materials to solve engineering problems, and processing, structure, property, and performance tradeoffs. Families of materials and their properties and how selection software can be used to optimize selection of the best material for a variety of applications given one or more constraints will be the main focus. Students will learn how processing influences material selection, and optimize selection with cost, health, safety, failure, and environmental effects. Finally, we will discuss recent advances in material databases.

MTEN 460. Materials Processing. 3 credits, 3 contact hours (3;0;0).
Prerequisite: MTEN 395. This course gives an introduction to fundamentals of material processing. Specifically, this course will deal with metals, polymers, and ceramics. The course will follow the processing and manufacturing of these materials from vapor and melt (or, liquid phase) to solid. Start-up material will be powder, solutions and dispersion. The effects of a particular processing technology on the final product structure, shape and properties will be described. Conventional and advanced manufacturing approaches will be discussed.

MTEN 490. Special Topics in Materials Engineering. 3 credits, 3 contact hours (3;0;0).
Prerequisite: MTEN 311. Special topics related to materials engineering are covered in areas such as biomaterials, ceramics, electronic materials, energetic materials, metals and alloys, and polymeric materials.

MTEN 491. Research & Independent Study I. 3 credits, 3 contact hours (3;0;0).
Restriction: junior or senior standing in materials engineering, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. Normally a GPA greater than 3.0 is required to participate in the course. Provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion.

MTEN 492. Research and Independent Study II. 3 credits, 3 contact hours (3;0;0).
Prerequisite: MTEN 491. Restriction: junior or senior standing in materials engineering, agreement of a department faculty advisor, and approval of the undergraduate advisor. Normally a GPA greater than 3.0 is required to participate in the course. Provides the student with an opportunity to work on a research project under the guidance of a CME department faculty. A written report is required for course completion.

MTEN 496. Materials Engineering Laboratory II. 3 credits, 6 contact hours (0;6;0).
Prerequisite: MTEN 395. This course offers students hands on experience to synthesize and characterize a diverse set of material samples. Students will be establishing synthesis/structure/properties relationships for metal alloys with emphasis on shape memory alloys, composite materials with emphasis on filled silicones, and porous materials with focus on zeolites. Students will learn how the synthesis and processing affect the material crystallinity and properties; they will measure the processing characteristics of powders, and prepare and characterize gels.