

# CHEMICAL ENGINEERING (CEN)

## CEN 500 Selected Topics (1-6 Credits)

*Engineering & Comp Sci*

Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester. Repeatable

## CEN 520 Radiochemistry, Nuclear Fuel Reprocessing and Nonproliferation (3 Credits)

*Engineering & Comp Sci*

Cross-listed with NUC 520

Radiochemistry for nuclear reactors and nuclear fuel reprocessing; nonproliferation issues through detection and monitoring, nuclear fuel reprocessing and design, waste vitrification and storage facilities, safety issues in nuclear fuel reprocessing.

Prereq: NUC 301

## CEN 522 Biomedical-Device Infections (3 Credits)

*Engineering & Comp Sci*

Cross-listed with BEN 522

Discussion of the complex issues related to biomedical-device infections. Investigation of the impact of biomaterials, microbiology, detection, and device regulation to reduce biomedical-device infections.

Shared Competencies: Communication Skills (<https://coursecatalog.syracuse.edu/shared-competencies/communication-skills/>); Scientific Inquiry and Research Skills (<https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/>)

## CEN 540 Experiential Studies in Nuclear Technology (3 Credits)

*Engineering & Comp Sci*

Cross-listed with NUC 540

Introduction to experimental methods, procedures and research techniques through projects at participating government facilities, industrial entities or Syracuse University.

Prereq: NUC 301 and (NUC 510 or NUC 520)

## CEN 545 Physuichem/Mthds/Waste Tr (3 Credits)

*Engineering & Comp Sci*

Applicability of chemical-engineering unit operations and unit processes in fluid-waste treatment. Membrane process, including electrodialysis and reverse osmosis, IPC (independent physical and chemical) process of waste treatment, coagulation, deep-bed filtration, and carbon-column operation.

## CEN 561 Polymer Science & Engineering (3 Credits)

*Engineering & Comp Sci*

Cross-listed with BEN 561

Polymer structure, physical properties, and applications of polymers. Polymer synthesis, characterization of molecular structure, and copolymerization and blending. Unique physical properties of polymeric materials. Processing and applications of polymers.

Shared Competencies: Critical and Creative Thinking (<https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/>)

## CEN 562 Air Resources (3 Credits)

*Engineering & Comp Sci*

Cross-listed with CEE 562

Occurrence, nature and properties, major sources and quantities of contaminants. Ambient air concentration levels, community distribution patterns, and control of air pollution.

Shared Competencies: Critical and Creative Thinking (<https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/>); Civic and Global Responsibility (<https://coursecatalog.syracuse.edu/shared-competencies/civic-and-global-responsibility/>); Scientific Inquiry and Research Skills (<https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/>)

## CEN 573 Principles and Design in Air Pollution Control (3 Credits)

*Engineering & Comp Sci*

Fundamental principles of pollution control, design of control processes and equipment. Criteria for selection of control processes and equipment for gaseous and particulate pollutants.

## CEN 575 Process Control (3 Credits)

*Engineering & Comp Sci*

Modeling and linearization of process dynamics. Transfer functions. Performance and stability of feedback control loops. Introduction to multivariable and digital controls.

Prereq: MAT 485

Shared Competencies: Critical and Creative Thinking (<https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/>); Information Literacy and Technological Agility (<https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/>)

## CEN 576 Green Engineering (3 Credits)

*Engineering & Comp Sci*

Review of environmental regulations. Evaluating the environmental fate of chemicals. Techniques for improving environmental performance of processes. Methods for evaluating environmental performance, design of unit operations, and flowsheets for pollution prevention. Environmental cost accounting.

Prereq: CEN 341 and 353

## CEN 580 International Course (1-12 Credits)

*Engineering & Comp Sci*

Offered through SUAbroad by educational institution outside the United States. Student registers for the course at the foreign institution and is graded according to that institution's practice. SUAbroad works with the S.U. academic department to assign the appropriate course level, title, and grade for the student's transcript.

Repeatable

## CEN 587 Chemical Reaction Engineering (4 Credits)

*Engineering & Comp Sci*

Conversion and reactor sizing, isothermal reactor design for flow and batch systems, rate laws and stoichiometry, analysis of rate data, multiple reactions, introduction to heterogeneous reactor design.

Prereq: CEN 341

Shared Competencies: Critical and Creative Thinking (<https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/>)

## CEN 590 Recent Advances In CEN (3 Credits)

*Engineering & Comp Sci*

Selected topics in research and new areas of competence in chemical engineering.

Repeatable

**CEN 600 Selected Topics (1-6 Credits)***Engineering & Comp Sci*

Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester. Repeatable

**CEN 601 Graduate Bioengineering and Chemical Engineering Seminar (0-1 Credits)***Engineering & Comp Sci*

Cross-listed with BEN 601

Selected topics in bioengineering. Presentations by internal and external speakers, discussions with students.

Repeatable

**CEN 602 Ethical Issues in Engineering and Research (1-3 Credits)***Engineering & Comp Sci*

Cross-listed with BEN 602

Explores the application of professional norms to ethical decision making in engineering and scientific research. Includes examination of cases in light of the requirements of the Responsible Conduct of Research.

**CEN 621 Biochemical Engineering (3 Credits)***Engineering & Comp Sci*

Cross-listed with BEN 621

Double-numbered with BEN 421, CEN 421

Introduction to microbiology, biochemical kinetics. Biochemical-reactor design, including methods for oxygen transfer and control. Introduction to separation processes in biochemical engineering. Additional work for graduate students.

Shared Competencies: Critical and Creative Thinking (<https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/>)

**CEN 629 Methods in Materials Characterization (3 Credits)***Engineering & Comp Sci*

Double-numbered with CEN 429

Establish working knowledge of experimental tools to characterize solid materials (catalysts, metals, semiconductors). Theory for each technique, information provided for various research topics, experimental parameters, and data interpretation will be discussed. Additional work required of graduate students.

**CEN 632 Behavior of Fluid-Particle Systems (3 Credits)***Engineering & Comp Sci*

Mechanical, electrical, and physiochemical behavior of aerosol particles. Theories of deposition and filtration of particles from gases. Experimental methods for measuring particle size distributions.

**CEN 633 Drug Delivery (3 Credits)***Engineering & Comp Sci*

Cross-listed with BEN 633

Double-numbered with BEN 433, CEN 433

Integration of biology, chemistry, and engineering to understand how pharmaceuticals are delivered to, and behave within, the body. Includes drug formulation, pharmacokinetics, pharmacodynamics, controlled release, and targeted delivery. Additional work is required of graduate students.

Shared Competencies: Critical and Creative Thinking (<https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/>)

**CEN 634 Polymer Physics (3 Credits)***Engineering & Comp Sci*

Cross-listed with BEN 634

Exploration into the physical properties of polymers focusing on polymer theoretical physics, characterization of their physical properties, and the importance of their structure-property relationships in various applications.

**CEN 635 Physical Cell Biology (3 Credits)***Engineering & Comp Sci*

Cross-listed with PHY 635, CHE 635, BIO 635, BEN 635

This interdisciplinary class for science and engineering students provides an introduction to the quantitative description of biological systems and processes. The focus is on the biological and physical aspects of structure and function of cells and their subsystems.

**CEN 638 Open Problems in Soft Interfaces (3 Credits)***Engineering & Comp Sci*

Cross-listed with BIO 638, PHY 638, CHE 638, BEN 638

In this seminar course on soft and biological materials and interfaces, teams from science and engineering will identify, discuss and assess current articles from the literature. Writing skills related to publishing peer-reviewed research are introduced.

**CEN 643 Fluid Dynamics (3 Credits)***Engineering & Comp Sci*

Cross-listed with MAE 643

Review of undergraduate fluids; kinematics, vorticity; dynamics, stresses, Euler and Navier-Stokes equations; energy, Bernoulli's equation; potential flows; Stokes flows; boundary layers; flow separation; other applications.

Advisory recommendation Prereq: MAE 341 or CEN 333

**CEN 645 Introduction to Transport Phenomena (3 Credits)***Engineering & Comp Sci*

Parallel, systematic treatment of momentum, energy, and mass transfer processes. Problem formulation by "shell balances" and the use of general conservation equations. Applications include the description of velocity, temperature, and concentration profiles.

**CEN 650 Environmental Risk Assessment & Toxicology (3 Credits)***Engineering & Comp Sci*

Cross-listed with BEN 650, CEE 650

Double-numbered with BEN 450, CEN 450, CEE 450

Students will analyze the human health impact of exposure to toxic chemicals in air, water, and soil according to USEPA Risk Assessment Guidance for Superfund. Additional work required of graduate students.

Shared Competencies: Scientific Inquiry and Research Skills (<https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/>)

**CEN 651 Molecular and Statistical Thermodynamics (3 Credits)***Engineering & Comp Sci*

Double-numbered with CEN 451

Classical and molecular thermodynamics in chemical equilibrium, with applications. Emphasis on concepts of statistical mechanics and correlation with properties of gases and condensed matter. Additional work required of graduate students.

Shared Competencies: Scientific Inquiry and Research Skills (<https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/>)

**CEN 655 Materials for Energy Systems (3 Credits)***Engineering & Comp Sci*

Double-numbered with CEN 455

Materials related to energy technologies and existing energy resources. Topics include: geologic fuels; photovoltaics; wind energy; thermoelectrics; electrical energy storage; hydrogen production, storage, and use; solid-state lighting; nuclear energy. Additional work required of graduate students

Shared Competencies: Information Literacy and Technological Agility (<https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/>)

**CEN 661 Environmental Chemistry and Analysis (3 Credits)***Engineering & Comp Sci*

Cross-listed with CEE 671

Double-numbered with CEE 471, CEN 461

An introduction to chemical principles in natural and engineered environmental systems. Thermodynamics and kinetics of reactions; acid-base chemistry; environmental organic chemistry; treatment process design applications. Includes selected laboratory exercises. Additional work is required of graduate students.

Shared Competencies: Scientific Inquiry and Research Skills (<https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/>)

**CEN 662 Biofuels, Bioproducts, and Biorefining (3 Credits)***Engineering & Comp Sci*

Cross-listed with BEN 662

Double-numbered with CEN 462, BEN 462

Survey of modern technologies available for the production of transportation fuels from abundant natural resources. Additional work required of graduate students.

**CEN 666 Heterogeneous Catalysis (3 Credits)***Engineering & Comp Sci*

Surface chemistry and modern methods in analysis of catalytic systems. Special consideration will be given to green chemistry and sustainability.

**CEN 670 Experience Credit (1-6 Credits)***Engineering & Comp Sci*

Participation in a discipline or subject related experience. Student must be evaluated by written or oral reports or an examination. Permission in advance with the consent of the department chairperson, instructor, and dean. Limited to those in good academic standing.

Repeatable

**CEN 671 Chemical Engineering Methods I (3 Credits)***Engineering & Comp Sci*

Use of fundamental physical, chemical and mathematical principles involving chemical engineering problems. Problems associated with transport theory and chemical kinetics requiring the solution of partial differential equations using orthogonal function expansions. Duhammel's theorem and other techniques.

**CEN 672 Applied Env Microbiology (3 Credits)***Engineering & Comp Sci*

Cross-listed with CEE 672

Double-numbered with CEE 472, CEN 472

General Principles and application of environmental microbiology and microbial processes. Role of microbes in water pollution control, environmental health, and element cycling in the environment. Additional work is required of graduate students.

Shared Competencies: Scientific Inquiry and Research Skills (<https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/>)

**CEN 673 Biomanufacturing (3 Credits)***Engineering & Comp Sci*

Cross-listed with BEN 673

Double-numbered with BEN 473, CEN 473

Students learn the governing principles of conventional and advanced manufacturing techniques, which are adapted/modified to engineer living tissues/organs, biomedical products and test-platforms for investigating fundamental cell biology. Additional work required for grad students.

Shared Competencies: Critical and Creative Thinking (<https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/>); Scientific Inquiry and Research Skills (<https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/>)

**CEN 687 Advanced Chemical Engineering Design (3 Credits)***Engineering & Comp Sci*

Chemical Engineering Masters Project, to be completed by each student as an individual advanced design project, involving a chemical process synthesis. Students are expected to apply mathematical and engineering concepts to complete the design calculations.

**CEN 690 Independent Study (1-6 Credits)***Engineering & Comp Sci*

Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.

Repeatable

**CEN 691 Chemical Engineer Problem (1-3 Credits)***Engineering & Comp Sci***CEN 700 Selected Topics (1-6 Credits)***Engineering & Comp Sci*

Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.

Repeatable

**CEN 741 Transport Phenomena I (3 Credits)***Engineering & Comp Sci*

Tensor analysis. Reynold's transport theorem. Constitutive equations for stress. Momentum transport equations. Creeping flow, nonviscous flow, boundary layer flow. Flow through porous media. Turbulence. Energy transport equation. Conduction, natural and forced convection solutions. Boundary layer heat transfer.

Advisory recommendation Prereq: CEN 542, 671

**CEN 742 Transport Phenomena II (3 Credits)***Engineering & Comp Sci*

Multicomponent molecular and convective diffusion. Associated boundary value problems. Limitations of analogies for heat, mass, and momentum transfer. Boundary layer calculations. Eddy diffusion. Interphase energy and mass transport. Interfacial phenomena.

Advisory recommendation Prereq: CEN 741

**CEN 743 Transport Phenomena III (3 Credits)***Engineering & Comp Sci*

Selected topics, such as "Introduction to Statistical Theory of Turbulence." Probability theory, statistical mechanical concepts. Cartesian tensors. Correlation functions. Energy spectrum. Turbulent diffusion. Diffusion and reaction in boundary layers.

Advisory recommendation Prereq: CEN 742, 772

**CEN 752 Chemical Engineering Thermodynamics II (3 Credits)***Engineering & Comp Sci*

Foundations of chemical equilibrium computation. Mathematical structure of the chemical equilibrium problem. Methods based on optimization techniques. Methods based on the solution of non-linear equations. Consideration of nonideality and condensed phases. Industrial application.

Advisory recommendation Prereq: CEN 651, 671

**CEN 761 Rheology & Polymer Process (3 Credits)***Engineering & Comp Sci*

Introduction to flow phenomena in polymeric fluids; the non-Newtonian rheological behavior of polymer solutions and melts; constitutive relations for the flow properties; applications in polymer processing; characterization of polymer mechanical properties, morphology and structure.

Advisory recommendation Prereq: CEN 741

**CEN 775 Separation Processes (3 Credits)***Engineering & Comp Sci*

Diffusion as a kinetic-molecular phenomenon. Steady-state cascade theory. The ideal cascade. Squared-off and square cascades. Criteria of cascade optimization. Gaseous diffusion processes. Membrane separation processes, selective permeation of gases, vapors, and liquids; reverse osmosis and water desalination, electrodialysis.

**CEN 776 Multicomponent Separation Processes (3 Credits)***Engineering & Comp Sci*

Multicomponent distillation. Extractive and azeotropic distillation. Gas adsorption and stripping, cryogenic separation and purification processes. Fixed-bed gas and vapor adsorption. Unsteady-state behavior of cascades.

**CEN 786 Kinetics (3 Credits)***Engineering & Comp Sci*

Homogenous reactions: tubular and stirred reactors, axial and radial transport. Residence time distribution. Heterogenous reactions-catalytic: rates, pores, transport, in fixed and fluid beds, non-catalytic reaction and growth of new phases.

Advisory recommendation Prereq: CEN 587, 651, 671

**CEN 787 Multiphase Reactive Systems (3 Credits)***Engineering & Comp Sci*

Multicomponent mass transport with reaction in two-phase dispersions, particularly liquid extractions. Convective diffusion with reaction, turbulent mass transport, population balance and simulation models, two-phase flow models, reactor/extractor design. Application of models to design gas-liquid-solid slurry may also be covered.

Advisory recommendation Prereq: CEN 587, 742

**CEN 790 Advanced Topics in Chemical Engineering (1-3 Credits)***Engineering & Comp Sci*

Recent advances in chemical engineering science.

Repeatable

**CEN 890 Advanced Topics In Chemical Engineering (3 Credits)***Engineering & Comp Sci*

Recent advances in chemical engineering research, including experimental techniques.

Repeatable

**CEN 990 Independent Study (1-6 Credits)***Engineering & Comp Sci*

Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.

Repeatable

**CEN 991 Introduction to MS Research (3 Credits)***Engineering & Comp Sci*

Preliminary research and investigation on a topic of interest under supervision of a member of the faculty.

**CEN 996 Masters Project (0 Credits)***Engineering & Comp Sci*

Investigation of a chemical engineering problem. An oral defense is required in accordance with current departmental guidelines. Required of all students electing the non-thesis option for a master's degree.

**CEN 997 Masters Thesis (3 Credits)***Engineering & Comp Sci*

Independent investigation on a topic of interest under supervision of a member of the faculty.

Advisory recommendation Prereq: CEN 991