Chemical Engineering (CENG)

Chemical engineers are concerned with the chemical and physical processes that change raw materials into useful products. They work in many industries: chemicals, drugs, environmental, explosives, food, lubricants, paint, paper, petroleum, plastics, primary metals, rubber, and soap, among others. The design and control of large scale processes in a manufacturing plant require knowledge of the handling and transporting of large quantities of chemicals, heat transfer from one substance to another, absorption of liquids and gases, evaporation, distillation, crystallization, filtration, mixing, drying, and chemical reaction.

The chemical engineering program at Tulane has a firm basis in classroom fundamentals, coupled with direct practical experience. This commitment is reflected in many ways, particularly the unique Practice School for seniors. Practice School provides on-site internships in local industrial facilities, government agencies, and hospitals, permitting students to apply knowledge to problems of current professional concern. The students work closely with faculty members and professionals from the host site, gaining experience in effective problem-solving and presentation of their findings while still under the eye of sympathetic counselors.

Chemical engineering faculty research covers areas including tissue engineering, new-generation nanochips, new catalysts for use in petroleum processing, developing designer microbes to clean up bio-environmental toxins, studying how to reduce greenhouse gases, and using polymer membranes to separate toxins from water. Faculty members often involve students in their laboratory efforts. Through technical electives and research, students may prepare for a career in biotechnology. A large percentage of Tulane's graduating chemical engineers are immediately recruited into a wide variety of industries, while others continue to graduate studies in engineering, management, or law. A chemical engineering undergraduate degree may arguably be the best preparation for admission to Medical School.

DEPARTMENTAL MISSION

The mission of the chemical engineering department at Tulane University is to provide the highest quality program for educating students in the principles and applications of chemical engineering. The excellence of the program is to be ensured by the high valuation of teaching, strong research activities and solid industrial ties. The program will educate students to take leadership roles in industry, academia and government.

PROGRAM EDUCATIONAL OBJECTIVES

Our students will obtain expertise in mathematics, science and engineering principles, with particular emphasis on those that apply to chemical engineering practice.

Our graduates will be able to apply this expertise to identify and solve chemical engineering problems, design chemical engineering processes and conduct and analyze experiments, using the most up-to-date engineering tools and techniques. The students will be able to work effectively with others on such problems, and communicate their results effectively.

Our graduates will be able to carry out their work professionally and ethically, and understand the impact of their work in a global and societal context.

Our graduates will be able to function in an engineering profession which is continually evolving, will be aware of contemporary issues and will be prepared for life-long learning.

CURRICULUM

Sophomore Year

Fall Semester		*Credits*
CENG 211	Material and Energy Balances	3
CENG 212	Thermodynamics I	3

CHEM 241	Organic Chemistry I	3
CHEM 243	Organic Chemistry Lab I	1
MATH 221	Calculus III	4
	Humanities or Social Science Elective	3
	Fall Semester Total:	**17**
Spring Semester		*Credits*
CENG 232	Transport Phenomena I	3
CHEM 242	Organic Chemistry II	3
CHEM 244	Organic Chemistry Lab II	1
MATH 224	Introduction to Applied Mathematics	4
	Humanities or Social Science Elective	3
	Technical Elective 1	3
	Spring Semester Total:	**17**

Junior Year

Fall Semester		*Credits*
CENG 311	Thermodynamics II	4
CENG 323	Numerical Methods for Chemical Engrs.	3
CENG 333	Transport Phenomena II	3
	Humanities or Social Science Elective	3
	Technical Elective 2	3
	Fall Semester Total:	**16**

Spring Semester		*Credits*
CENG 324	Unit Operations Lab I	3
CENG 325	Unit Operations Lab II	3
CENG 334	Separation Processes	3
CENG 415	Kinetics & Reactor Design	3
CENG 450	Process Control	3
	Humanities or Social Science Elective	3
	Spring Semester Total:	**15**

Senior Year

Fall Semester		*Credits*
CENG 431	Chemical Process Design	3
	Advanced Chemistry*	4
	Humanities or Social Science Elective	3
	Technical Elective 3	3
	Advanced Technical Elective 4	3
	Fall Semester Total:	**16**

Spring Semester		*Credits*
CENG 460	Practice School I	3
CENG 462	Practice School II	3
	Advanced Chemistry*	4
	Humanities or Social Science Elective	3
	Advanced Technical Elective 5	3
	Spring Semester Total:	**16**

**Advanced Chemistry course can be chosen from Physical Chemistry (CHEM 311+313, 312+314), Inorganic Chemistry (CHEM 321+323) or Biochemistry (CHEM 383+385, 384). Other courses with permission only.*

Technical electives are normally engineering, science, or math courses, in consultation with the departmental advisor. Also, ROTC students may receive up to 6 credit hours for their ROTC courses.

THE CONCENTRATION ORIENTED CURRICULUM

In addition to the required Core Chemical Engineering Courses, the Basic Science and Mathematics Sequence, and the Humanities and Social Science Elective Courses (HUSSEL), five technical electives will be required. These Technical Electives constitute a concentration in one of three areas: Biochemical Engineering, Environmental Engineering, or Business Studies. A concentration will consist of five courses in the following tracks:

1. Biochemical Engineering
CELL 101, CELL 205, and 3 courses chosen from:

BMEN 303/313, BMEN 304/314, BMEN 340, CENG 671, CENG 772, CELL 301, CELL 311

2. Environmental Engineering
CVEN 381, and 4 of the following:

CHEM 250, CENG 613, CENG 671, CVEN 348, CVEN 424, CVEN 438.

3. Business Studies
ACCT 203, ACCT 301, FINC 352, OBHR 331-Organizational behavior, MKTG 382-Marketing management.

(Additionally if the student also takes ECON 101 (as a HUSSEL requirement), he/she will qualify for a minor in business).

Note: Consult with the department regarding the Technical Electives.

PREMEDICAL CURRICULUM IN CHEMICAL ENGINEERING

A premedical program via the chemical engineering curriculum provides an excellent foundation for medical studies. If the student does not proceed to medical school, there is an opportunity for a professional career in industry.

Premedical students make the following changes:

Technical Electives 1 and 2 can be replaced with Biology courses, EEOB 101. 111 and CELL 101, 111.

Premedical students should also take a second English course as one of their humanities and social science electives. Some medical schools may require it.

MINORS & SECOND MAJORS

A chemical engineering student may also elect to pursue a major or minor in another division of the university. Anyone who is interested should contact the appropriate department chair and work out a program of courses. This should be approved by the department chair and forwarded to the engineering dean’s office. When all requirements are met, the transcript will reflect that a major or minor has been completed.

Since many chemical engineering students elect to add a minor in business or a minor or major in mathematics, these programs are as follows.

Business Minor
An undergraduate business minor is awarded for the following coursework.

ECON 101 Microeconomics

ACCT 203 Financial Accounting

And any four of the following:

ACCT 301 Managerial Accounting

FINC 352 Financial Management

OBHR 331 Organization Behavior

PSOM 371 Operations Management

MKTG 382 Marketing Management

Plus:
One additional course from the A. B. Freeman School of Business.

Mathematics Minor
A mathematics minor or major is awarded for the following coursework.

MATH 121, 122, 221 Calculus I, II, III

MATH 224 Introduction to Applied Math **or**

MATH 217 Discrete Math

MATH 309 Linear Algebra

Plus:

One additional course at the 300 level or above.

Mathematics Major

All requirements for the minor

Plus:

MATH 305, and Two additional courses at the 300 level or above, one of which must be a 400 level course.

Students contemplating either a minor or major in mathematics should consult with the major adviser for School of Engineering students in the Department of Mathematics during the spring of the sophomore year.

If a liberal arts degree is desired, then all liberal arts, as well as engineering requirements, must be met. Also, the student must spend one year either in Paul Tulane College or Newcomb College to fulfill the residence requirement.

FACULTY AND COURSE DESCRIPTIONS

Office: Suite 300, Lindy Claiborne Boggs Center

Phone: (504) 865-5772

Professors

Daniel De Kee, Ph.D., University of Montreal, 1977. Rheology of Synthetic and Natural Materials, Constitutive Equations, Transport Phenomena and Applied Mathematics.

Richard D. Gonzalez, Ph.D., Johns Hopkins University, 1965. Catalysis, New Materials

Vijay T. John, Engr. Sc.D., Columbia University, 1982; Chemical Engineering. Nanotechnology, Biotechnology

Daniel J. Lacks, Ph.D., Harvard University, 1992. Molecular Simulations, Applications to Biotechnology

Victor John Law, P.E., Ph.D., Tulane University, 1963. Process Design, Simulation & Control; Transport Phenomena and Applied Mathematics.

Brian S. Mitchell, Ph.D., University of Wisconsin, Madison, 1991.High-Tech Composite Materials, Polymers

Kim C. O'Connor, Ph.D., California Institute of Technology, 1987. Bioengineering and Biotechnology, Tissue Engineering, Cancer Research

Kyriakos D. Papadopoulos, Deparment Chair, Engr. Sc.D., Columbia University, 1982. Novel Drug-Delivery Systems, Emulsion Applications

Assistant Professor

Yunfeng Lu, Ph.D., University of New Mexico, 1998. Nanofabrication of Computer Chips

CENG 211 Material and Energy Balances (3) Lecture 3.
Basic concepts in mass and energy balances are presented in this introduction to chemical process engineering. Properties of pure materials and relevant equations of state are reviewed in illustrative examples.

CENG 212 Thermodynamics I (3) Lecture 3.
Concepts of energy, equilibrium, and reversibility are presented in the setting of the theoretical development of classical thermodynamics. Energy conversion cycles and elementary fluid mechanics are used to illustrate applied thermodynamics in chemical process technology.

CENG 232 Transport Phenomena I (3) Lecture 3.
Prerequisites: 211, 212, equivalents or approval of instructor. Principles of hydrostatics and fluid mechanics. Emphasis is on mass, energy and momentum balances. Fluid flow through pipes and other types of chemical engineering equipment are considered in detail. The fundamental operations of vector analysis and the development of basic differential equations that govern fluid flow are used to solve representative problems in which viscosity is important.

CENG 311 Thermodynamics II (3) Lecture 3.
Basic concepts in physical and chemical equilibria. Systems of variable composition. Chemical reaction equilibria. Thermodynamic analysis of processes. Principles of statistical mechanics. Partition functions.

CENG 323 Numerical Methods for Chemical Engineers (3) Lecture 3.
Numerical methods using Matlab with some programming in either Fortran or C++. Numerical differentiation and integration. Solution of linear and nonlinear equations. Numerical solution of ordinary and partial differential equations. Optimization. Use of spreadsheets and graphical presentations. Applications are to design oriented problems.

CENG 324 Unit Operations Lab I (3) Laboratory 3.
Prerequisites: 333, 334. Bench scale laboratory experiments in Unit Operations. Report writing, safety, oral presentations, ethics and group activities are emphasized.

CENG 325 Unit Operations Lab II (3) Laboratory 3. (40 hours per week for 3 weeks in summer.)
Prerequisites: 324. Pilot plant scale laboratory experiments in Unit Operations. Safety, report writing and group activities are emphasized in this simulated work environment.

CENG 333 Transport Phenomena II Lecture 3.
Molecular mechanisms of energy transport (heat conduction), and mass transport (diffusion). The development of nonisothermal and multicomponent equations of change for heat and mass transfer. Exact and numerical solutions to steady-state and transient heat and mass transfer problems. Convective heat and mass transfer. Introduction to radiation heat transfer. Heat and mass transfer in boundary layers. Correlations for convective heat and mass transfer. Boiling and condensation. Interphase mass transfer. The analogies between heat, mass, and momentum transfer are emphasized throughout the course.

CENG 334 Separation Processes (3) Lecture 3.
Prerequisites: CENG 211, equivalent, or approval of instructor. Principles of separations processes, including distillation, liquid-liquid extraction, stripping, gas absorption, and adsorption processes. Single stage and multiple stage processes. Design of plate and packed separations columns. Plate and column efficiencies.

CENG 415 Kinetics & Reactor Design (3) Lecture 3, Laboratory 2.
Prerequisite: MATH 224. The design and analysis of chemical, biological, and polymerization reactor systems are achieved by application of the principles of chemical kinetics and equilibrium coupled with mass and energy transport. Specific areas of study include kinetics, ideal reactors, multiple reactor systems, nonideal flow and mixing, and catalysis. Two laboratory experiments are included.

CENG 431 Chemical Process Design (3) Lecture 3.
Prerequisites: Senior standing or departmental approval. The elements of industrial design and supporting economics are presented in the context of a representative design project. Extension of the student’s early background in unit operations through practical design considerations including materials of construction is accomplished. Methods are presented for capital and operating cost estimation, raw materials and utilities pricing, and assembly of investment costs, taxes, environmental and other site requirements. Realistic design constraints are included; e.g., economic factors, safety, reliability aesthetics, ethics, and social impact.

CENG 450 Chemical Process Control (3) Lecture 3, Laboratory 2.
Prerequisite: MATH 224. An introduction to linear control theory is presented in which processes are described mathematically through transfer functions and conventional three-mode controllers are specified. Frequency and time domain stability studies are made including Bode, Nyquist and root locus methods. Other topics are introduced including cascade control, modal analysis, optimal control, and multivariate system analysis. Automatic control systems are designed for a number of processes. Two laboratory experiments are included.

CENG 460, 462 Practice School (3 each) Lecture plus Practicum.
Prerequisite: Senior Standing. Students are placed in groups of three or four and are assigned to a project at a local industrial facility, hospital, or government agency. The project is one of current concern to the organization and may range from a study of an operating process to the development of a new process. The projects are open ended and the students are expected to apply the principles of good design practice involving realistic constraints such as economics, safety, reliability, aesthetics, ethics, and social impact. Students normally are assigned to a project which fulfills certain career goals. This internship, under the direction of a faculty member, utilizes engineers and other personnel at the host site. Students are required to submit interim and final written and oral reports.

CENG 481, 482 Undergraduate Independent Studies (2,2).
Under special circumstances, course credit is granted to students undertaking independent research studies. A project adviser should be identified and permission for enrollment filed with the department chair prior to registration.

CENG 600 Chemical Engineering Research Seminar (0) Lecture 1.
Students are exposed to the important research findings, presented by invited speakers as well as by professors and advanced PhD candidates of our own department.

CENG 601 Mathematical Methods for Engineers (3) Lecture 3.
Prerequisite: MATH 224. Review of calculus and ordinary differential equations, series solutions and special functions, complex variables, partial differential equations, and integral transforms.

CENG 611 Thermodynamics and Properties of Matter (3) Lecture 3.
Prerequisite: CHEM 311. Molecular thermodynamics of multi-component systems are reviewed with particular attention to separation processes. Thermal and chemical equilibrium properties are examined for pure and mixed fluids.

CENG 612 Graduate Transport Phenomena
Prerequisites: 232, 333, 334, and MATH 221, MATH 224 or equivalents. Mathematical formulation and solution of problems involving theoretical concepts in fluid mechanics, heat and mass transfer, thermodynamics and elementary reaction theory. Emphasis is placed upon transient transport processes and the associated partial differential equations.

CENG 613 Surface and Colloid Phenomena (3) Lecture 3.
A study of surface and colloid chemistry. Topics include characterization of particles and surfaces, stability of colloidal systems, interactions of charged particles, and electrokinetic phenomena.

CENG 616 Heterogeneous Catalysis (3) Lecture 3.
A study of the fundamental concepts underlying catalytic processes in the petroleum processing industry and in synthetic fuels research. Topics include molecular theories of adsorption and catalysis, catalyst design and formulation, instrumental methods of catalyst characterization, transport in catalysts, shape-selective catalysis, etc. Applications discussed include catalytic cracking, reforming, hydrodesulfurization, Fischer-Tropsch synthesis, direct and indirect coal liquefaction, etc.

CENG 625 Applied Numerical Analysis (3) Lecture 3.

Prerequisite: CPSC 101 or equivalent, MATH 224. Numerical techniques for the solution of mathematical problems in the engineering analysis of systems are presented for computer implementation. Topics include interpolation, integration, solution of systems of linear and nonlinear algebraic equations, optimization, and regression. A comparison of numerical solution methods for ordinary and partial differential equations is given. Eigenvalue and split boundary problems are included.

CENG 633 Advanced Separations Design (3) Lecture 3.
Prerequisites: CHEM 232, CHEM 333, CHEM 334 or approval of instructor. Design of separations processes based upon newer technologies. Special emphasis is placed upon membrane separations and those processes involving colloidal and surface phenomena.

CENG 655 Sol-Gel Science (3) Lecture 3.
A study of chemistry, physics, and applications of sol gel processing. Designs and fabrications of functional and nanostructured materials. Recent advances of sol-gel science in nanotechnology, microelectronics, and biomedical engineering.

CENG 671 Biochemical Engineering Fundamentals (3) Lecture 3.
The course provides an overview of biochemical engineering. Topics include enzyme-catalyzed and cell-associated reactions, engineering aspects of recombinant DNA technology, cell culture, and bioreactors.

CENG 688 Polymer Rheology (3) Lecture 3.
Non-Newtonian phenomena, material functions and generalized Newtonian fluids, rheometry, linear viscoelasticity, multiphase systems and mixing.

CENG 689 Polymer Engineering (3) Lecture 3.
Review of principles of continuum mechanics and energy transfer processes. Flow of molten polymers in various geometries. Polymer extrusion, coating, fiber spinning, film blowing and injection molding.

CENG 712 Thermodynamics of Macromolecules (3) Lecture 3.
Prerequisite: 611 or equivalent. Thermodynamics is applied to macromolecules.

CENG 715 Advanced Reactor Design (3) Lecture 3.
Coupled reaction and transport phenomena as they are involved in major reactor configurations are studied with attention to data resources and computational capabilities.

CENG 742 Applied Materials Design (3)
Prerequisite: Consent of instructor. Fundamentals of condensed matter are elaborated upon, namely bonding, structure, physical properties, phase equilibria and thermodynamics of solids. Characterization of condensed phases as it reviewed. Manipulation of material properites for specific applications is discussed.

CENG 752 Applied Statistical Mechanics (3)
The course covers the fundamental principles and methods of statistical mechanics. Emphasis is placed on applications to thermodynamics, kinetics, polymer science and transport phenomena.

CENG 772 Advances in Biotechnology (3) Lecture 3.
The objectives of the course are to enhance understanding of the basic principles of biotechnology and to introduce the most current biotechnology research. Topics include gene therapy, biocomputation, molecular biochemical engineering, stem-cell technology and tissue engineering.

CENG 781-782 Advanced Independent Research (3,3)
Research studies performed under faculty tutelage by prior arrangement.

CENG 788 Polymer Rheology

CENG 791-794 Master's Level Research Orientation and Methods (1,1,1,1)

CENG 891-892 Doctoral Level Research Seminar (1,1)

CENG 998 Master's Research

CENG 999 Dissertation Research