Chemical Engineering

Chemical engineers contribute to society through the useful application of knowledge and understanding of chemistry, physics, biology, and mathematics. Chemical engineers traditionally have participated in many decisions crucial to the preservation and improvement of society, including energy, fuel, commodity chemical and food production, resource management, and the design of necessary pollution control measures. Emerging new areas such as biotechnology, space technology, nanofabrication technology, semiconductor devices and modern construction materials also utilize the unique capabilities of the chemical engineer. Many technologies to improve public health depend significantly on chemical engineering such as biomaterials, biomedical devices, medical diagnostics, the chemical design and synthesis of drugs, the genetic engineering of therapeutic materials, drug delivery systems and medical imaging technology. Finally, chemical engineering plays an essential role in important environmental technologies such as atmospheric chemistry, product life cycle analysis, bioremediation, environmental risk and impact analysis, environmental friendly manufacturing technology and products, separation and conversion technologies for waste reduction and the cleanup of contaminated sites.

The instructional mission of the department is to provide its chemical engineering graduates with the tools, skills and competencies necessary to understand and apply today’s technologies and, through life-long learning, successfully develop and employ tomorrow’s technologies.

The Program Educational Objectives and Student Outcomes can be found at the following URL:
http://www.eng.auburn.edu/chen/academics/undergraduate/educational-objectives-outcomes.html

Because of their broad training and education, chemical engineers contribute to society in many functions, such as pure research, development, environmental protection, process design, plant operation and manufacturing, marketing, sales, and corporate or government administration.

The program is specially designed to assure all students have demonstrated capabilities in the core chemical engineering topics including material and energy balances, thermodynamics, chemical equilibria, heat, mass and momentum transfer, chemical reaction engineering, continuous and stagewise separation operations, process dynamics, statistics and control. The design experience is interwoven throughout the curriculum from elementary design principles in material and energy balances to the capstone senior process design and process control sequence employing advanced computer process and control simulators and experimental control systems.

The curriculum is specifically designed to enable graduates to model and design chemical and physical processes, design and conduct experiments, analyze and interpret chemical engineering data, and to determine capital and operating costs for chemical and physical processes. The curriculum prepares graduates to understand the need for professional integrity and ethical decision making in the practice of chemical engineering as well as providing an understanding of contemporary issues including business practices, environmental, health, and safety and other public interests. Students are also prepared for graduate study in chemical engineering, medicine, business and law.

Because of the breadth of chemical engineering opportunities, the department offers a number of specially designed program specializations that provide unique training and course selection to those students who wish to concentrate in a particular area or technology. The current program specializations are biochemical engineering, biomedical engineering, computer-aided chemical engineering, environmental chemical engineering, pre-medicine specialization and pulp, paper and bio-resource engineering.

Biochemical Engineering Specialization

Chemical engineers trained in biochemical engineering and biotechnology are the key to successful commercialization of new biologically based processes ranging from high value pharmaceuticals to new food processes. This program specialization provides a strong biology and chemistry fundamental background for graduate work in biochemical engineering and a plan of study to meet these objectives.

Students in this specialization take CHEN 5800 and Biochemical Engineering Technical Electives (9 hours). These courses replace Technical Electives I-IV.

Biomedical Engineering Specialization

This specialization provides the necessary preparation for students wanting to do graduate work in biomedical engineering or work in a career with an emphasis of medical applications of chemical engineering.
Students in this specialization take:

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>PHIL 1030</td>
<td>Ethics and the Health Sciences</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 5810</td>
<td>Biomedical Engineering</td>
<td>3</td>
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<tr>
<td>or CHEN 5970</td>
<td>Advanced Special Topics in Chemical Engineering</td>
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Biomedical Engineering Technical Electives 9

In the table above CHEN 5970 is listed as Advanced Special Topics in Chemical Engineering, which is the generic title for CHEN 5970. Students in this specialization are required to take either CHEN 5810 Biomedical Engineering or CHEN 5970 with the specific title Cell & Tissue Engineering. These courses replace Technical Electives I-IV and PHIL 1040.

Computer-Aided Chemical Engineering Specialization

Chemical engineers with expertise in the application of advanced computer-aided tools in areas like process systems engineering, process control, and advanced process technology are highly sought after by all process industries. The program specialization provides appropriate courses for an individual with interests in advanced use of computers for solving chemical and biological engineering problems.

Students in this specialization take Computer-Aided Chemical Engineering Technical Electives (12 hours). These courses replace Technical Electives I-IV.

Environmental Chemical Engineering Specialization

The environmental specialization in chemical engineering prepares students for careers in the expanding environmental arena. Students specializing in this area learn about the chemical processes and reactions that affect the environment, pollution prevention, the latest standards for air, water and land quality, as well as, hazardous materials management. This specialization prepares students for environmental positions in a broad range of manufacturing and service industries all of which must comply with increasingly complex environmental standards, and in various state and federal agencies.

Students in this specialization take Environmental Chemical Engineering Technical Electives (12 hours). These courses replace Technical Electives I-IV.

Pre-Medicine Specialization

This specialization provides the necessary preparation for students wanting to go to medical school. A Pre-Med series of courses, when completed, provides a chemical engineering degree while simultaneously meeting medical school requirements.

Students in this specialization take:

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<tr>
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<tbody>
<tr>
<td>PHIL 1030</td>
<td>Ethics and the Health Sciences</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 2081</td>
<td>Organic Chemistry II Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>BCHE 5180</td>
<td>Biochemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 5810</td>
<td>Biomedical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>or CHEN 5970</td>
<td>Advanced Special Topics in Chemical Engineering</td>
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</tbody>
</table>

Pre-Medicine Technical Electives 5

In the table above CHEN 5970 is listed as Advanced Special Topics in Chemical Engineering, which is the generic title for CHEN 5970. Students in this specialization are required to take either CHEN 5810 Biomedical Engineering or CHEN 5970 with the specific title Cell & Tissue Engineering. These courses replace Technical Electives I-IV and PHIL 1040. Students in this program specialization who are interested in medical school must also work with the director for Pre-Health Professions in the College of Science and Mathematics.

Pulp, Paper and Bio-Resource Engineering Specialization

This specialization prepares students for challenging and rewarding careers in the pulp, paper and bio-resource industries. These industries are unique in being capable of sustainable development with a renewable raw material base, recyclable products, and processing technology able to achieve energy self-sufficiency and environmental compatibility. This specialization prepares students for a broad range of career paths in process engineering, product development, bio-technology and sustainable engineering.
Students in this specialization take:

<table>
<thead>
<tr>
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<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>CHEM 2081</td>
<td>Organic Chemistry II Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CHEN 4100</td>
<td>Pulp and Paper Processing Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEN 5090</td>
<td>Pulp and Paper Technology</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 5110</td>
<td>Pulp and Paper Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 5800</td>
<td>Biochemical Engineering</td>
<td>3</td>
</tr>
</tbody>
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These courses replace Technical Electives I-IV.

**Major**

- Chemical Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofchemicalengineering/chemicalengineering_major/)

**Courses**

**CHEM 2100 PRINCIPLES OF CHEMICAL ENGINEERING (4) LEC. 3. LAB. 3. Pr. (CHEM 1110 or CHEM 1117 or CHEM 1030 or CHEM 1033) and (MATH 1610 or MATH 1613 or MATH 1617) and (P/C CHEM 1120 or P/C CHEM 1127 or P/C CHEM 1040 or P/C CHEM 1043) and (P/C MATH 1620 or MATH 1623 or P/C MATH 1627) and (P/C PHYS 1600 or P/C PHYS 1607). Application of multicomponent material and energy balances to chemical processes involving phase changes and chemical reactions.**

**CHEN 2110 CHEMICAL ENGINEERING THERMODYNAMICS (3) LEC. 3. Pr. (CHEM 1030 or CHEM 1033 or CHEM 1110 or CHEM 1117) and (MATH 1620 or MATH 1623 or MATH 1627) and (CHEN 2100) and (P/C PHYS 1600 or P/C PHYS 1607) and (P/C CHEN 2650). This course is intended to comprehensively introduce the thermodynamics of single- and multi-phase, pure systems, including the first and second laws of thermodynamics, equations of state, simple processes and cycles, and their applications in chemical engineering.**

**CHEN 2610 TRANSPORT I (3) LEC. 3. Pr. (PHYS 1600 or PHYS 1607) and CHEN 2100 and (P/C MATH 2630 or MATH 2637) and (P/C ENGR 2010 or P/C CHEN 2110). CHEN 2100 requires a grade of C or better. Introduction to fluid statics and dynamics; dimensional analysis; compressible and incompressible flows; design of flow systems, introduction to fluid solids transport including fluidization, flow through process media and multiphase flows.**

**CHEN 2650 CHEMICAL ENGINEERING APPLICATIONS OF MATHEMATICAL TECHNIQUES (3) LEC. 3. Pr. CHEN 2100 and P/C CHEN 2610 and (P/C MATH 2630 or P/C MATH 2637) and P/C MATH 2650 and COMP 1200. CHEN 2100 requires a grade of C or better. CHEN 2610 and MATH 2650 are Prerequisites with Concurrency. COMP 1200 should be the Matlab section, if it is possible to specify this. Otherwise just COMP 1200. Application of a broad range of mathematical techniques to chemical engineering problems. Emphasis on engineering significance and interpretation of mathematical operations.**

**CHEN 2AA0 CHEMICAL ENGINEERING PROGRESS ASSESSMENT I (0) LAB. SU. Pr. CHEN 2100. Progress assessment examination in basic science, general chemistry, physics, basic math principles (geometry, algebra), multivariable calculus, chemical engineering process principles (mass and energy balances). Course may be repeated with change in topics.**

**CHEN 3090 PULP AND PAPER TECHNOLOGY (3) LEC. 3. Pr. (CHEM 1030 or CHEM 1110 or CHEM 1117) and ENGR 2010. An introductory course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background.**

**CHEN 3370 PHASE AND REACTION EQUILIBRIA (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and (ENGR 2010 or CHEN 2110) and CHEN 2100 and P/C CHEN 3600 and P/C CHEN 2650. Molecular thermodynamics of phase and chemical reaction equilibria including non-ideal thermodynamics and multicomponent applications. (ENGR 2010 and CHEN 2100 require a grade of C or better).**

**CHEN 3410 CREATIVITY AND CRITICAL THINKING IN ENGINEERING (3) LEC. 3. Application of creativity and critical thinking principles to effectively approach solving engineering problems. Convincing presentation of information to technical audiences.**

**CHEN 3600 COMPUTER-AIDED CHEMICAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. COMP 1200 and MATH 2650 and CHEN 2610 and P/C CHEN 2650 and (MATH 2630 or MATH 2637) and CHEN 2110 and CHEN 2100. CHEN 2650 is prerequisite with concurrency. General and structured programming concepts, numerical methods, and introductory probability and statistics concepts. Application to chemical engineering problems involving material and energy balances and transport process, data validation, and analysis. (CHEN 2610 requires a grade of C or better).**
CHEN 3620 TRANSPORT II (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and (ENGR 2010 or CHEN 2110) and CHEN 2610 and P/C CHEN 3600 and MATH 2650 and P/C CHEN 2650. Fundamentals and applications of heat and mass transfer in chemical processes including conduction, convection, and radiation, heat exchange, evaporation, chemical reaction gas absorption, drying and humidification. (ENGR 2010 and CHEN 2610 require a grade of C or better).

CHEN 3650 CHEMICAL ENGINEERING ANALYSIS (3) LEC. 2. LAB. 3. Pr. CHEN 2650 and CHEN 3600 and CHEN 3620 and CHEN 2AA0 and MATH 2650 and P/C CHEN 3700. CHEN 2650, CHEN 3600 and CHEN 3620 all require a grade of C or better. Mathematical modeling, analytical, numerical and statistical analysis of chemical processes.

CHEN 3660 CHEMICAL ENGINEERING SEPARATIONS (3) LEC. 3. Pr. CHEN 3370 and CHEN 3620 and CHEN 3600. Separations processes including distillation, extraction, membrane separation, and other separation operations. (CHEN 3370 and CHEN 3620 require a grade of C or better).

CHEN 3700 CHEMICAL REACTION ENGINEERING (3) LEC. 3. Pr. MATH 2650 and CHEN 2610 and (ENGR 2010 or CHEN 2110) and P/C CHEN 3620 and P/C CHEN 3600. Design of chemical reactors with homogeneous reaction systems. (CHEN 2610 and ENGR 2010 require a grade of C or better).

CHEN 3820 CHEMICAL ENGINEERING LABORATORY I (2) LEC. 1. LAB. 3. Pr. CHEN 3600 and CHEN 3620 and MATH 2650. Experimental study of chemical thermodynamics, heat and momentum transfer with analytical, numerical, and statistical analysis.

CHEN 3AA0 CHEMICAL ENGINEERING PROGRESS ASSESSMENT II (0) LAB. SU. Pr. CHEN 2AA0 and P/C CHEN 3370 and P/C CHEN 3650 and P/C CHEN 3700 and P/C CHEN 3660 and CHEN 2650. Progress assessment examination in thermodynamics, linear differential equations, organic chemistry, transport phenomena (fluid mechanics, heat, mass transfer), phase and reaction equilibria, reaction engineering, design and conduction of experiments, analysis and interpretation of data, professional, ethical, societal and contemporary issues. Course may be repeated with change in topics.

CHEN 4100 PULP AND PAPER PROCESSING LABORATORY (2) LAB. 6. Pr. CHEN 5090 or Departmental approval. Experimental study of pulping and papermaking operations. Departmental approval.

CHEN 4160 PROCESS DYNAMICS AND CONTROL (3) LEC. 2. LAB. 3. Pr. CHEN 3600 and (CHEN 3650 or CHEN 3653). Dynamic modeling of chemical processes, feedback systems and analog controller tuning and design, sequential control systems. (CHEN 3600 and CHEN 3650 require a grade of C or better).

CHEN 4170 DIGITAL PROCESS CONTROL (3) LEC. 3. Pr. (CHEN 3650 or CHEN 3653) and CHEN 3600 and CHEN 3660. Introduction of basic concepts and principles for control system. Analysis of open loop and closed-loop processes using transfer functions.

CHEN 4180 ADVANCED DIGITAL PROCESS CONTROL (3) LEC. 2. LAB. 3. Pr. CHEN 4170. Application of sequential, closed loop and open loop process control principles to actual industrial and experimental control laboratory process. (CHEN 4170 requires a grade of C or better).

CHEN 4450 PROCESS ECONOMICS AND SAFETY (3) LEC. 2. LAB. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and (CHEN 3650 or CHEN 3653) and CHEN 3660 and CHEN 3700 and CHEN 3600. Fundamentals and applications of process economics and design, computer-aided cost estimation, profitability analysis and process improvement. Application of chemical process safety, risk assessment and management, hazard and operability analysis, chemical engineering principles for risk reduction. (CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 require a grade of C or better).

CHEN 4460 PROCESS SIMULATION SYNTHESIS AND OPTIMIZATION (2) LEC. 1. LAB. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and CHEN 3650 and CHEN 3660 and CHEN 3700 and CHEN 3600. Fundamentals of computer-aided simulation and synthesis. Process integration and optimization principles including their applications in design, retrofitting and operation of chemical processes. (CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 require a grade of C or better).

CHEN 4470 PROCESS DESIGN PRACTICE (3) LEC. 2. LAB. 3. Pr. CHEN 3AA0 and CHEN 4450 and CHEN 4460 and CHEN 3650 and CHEN 3660 and CHEN 3700 and PHYS 1610. Flow sheet simulation and techno-economic analysis applied to complex, open-ended chemical processes. Screening of alternatives and economic optimizations. Capstone design course.
CHEN 4560 PULP AND PAPER PROCESS SIMULATION (2) LEC. 1. LAB. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3090 and CHEN 3370 and (CHEN 3650 or CHEN 3653) and CHEN 3660 and CHEN 3700 and P/C CHEN 4100 and P/C CHEN 5110. Fundamentals of microcomputer process simulation with applications to the pulp and paper industry. Design of pulp and paper unit operations and small scale processes using commercial simulation software. (CHEN 3090, CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 require a grade of C or better).

CHEN 4570 PULP AND PAPER PROCESS DESIGN (3) LEC. 2. LAB. 3. Pr. CHEN 3AA0 and CHEN 4450 and CHEN 4560. Application of process simulation and process economics to complex, open-ended design, retrofitting and operation problems in pulp and paper. Design of pulp and paper unit operations and processes. Screening of alternatives and economic optimization.

CHEN 4630 INTRODUCTION TO TRANSPORT PHENOMENA (3) LEC. 3. Pr. CHEN 3620 and (CHEN 3650 or CHEN 3653). Application of chemical engineering analysis to momentum, heat and mass transport problems for advanced undergraduate students preparing for graduate school. (CHEN 3620 and CHEN 3650 require a grade of C or better).

CHEN 4860 CHEMICAL ENGINEERING LABORATORY II (2) LEC. 1. LAB. 3. Pr. CHEN 3660 and CHEN 3820 and P/C CHEN 3700 and CHEN 3650 and P/C CHEN 4170. Experimental study of mass transfer, separations and reaction engineering. Emphasis is on open-ended laboratory projects with electronic instrumentation; experimental design with numerical and statistical analysis of data.

CHEN 4880 PULP AND PAPER ENGINEERING LABORATORY (3) LAB. 9. Pr. CHEN 4100 and CHEN 5110. Comprehensive open-ended projects on pulp and paper topics.

CHEN 4930 DIRECTED STUDIES (1) LEC. 1. Supervised study in specialized areas of chemical engineering. Topic must be arranged with instructor during preregistration. Project report.

CHEN 4970 SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-10) AAB. Departmental approval. Topical courses in special areas. Topic must be arranged with instructor during pre-registration. Course may be repeated for a maximum of 10 credit hours.

CHEN 4980 UNDERGRADUATE RESEARCH (1-3) IND. Pr. 3.00 GPA. Departmental approval. GPA of 3.0 or higher. Individual and small group projects. Topic must be arranged with instructor during preregistration. Research Report. Course may be repeated for a maximum of 3 credit hours.

CHEN 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Course may be repeated for a maximum of 6 credit hours.

CHEN 5090 PULP AND PAPER TECHNOLOGY (3) LEC. 3. Pr. (ENGR 2010 or CHEN 2110) and (CHEM 1030 or CHEM 1033) and (CHEM 1110 or CHEM 1117) and MATH 2650. An introductory course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background.

CHEN 5110 PULP AND PAPER ENGINEERING (3) LEC. 3. Pr. CHEN 3620 and CHEN 3700 and P/C CHEN 4450. Chemical and engineering principles in the manufacturing of pulp and paper. (CHEN 3090, CHEN 3620, and CHEN 3700 require a grade of C or better).

CHEN 5120 SURFACE AND COLLOID SCIENCE (3) LEC. 3. Pr. CHEN 3620 and CHEN 4100. Fundamentals of surface and colloid science with applications in pulping and papermaking, including sizing, retention and drainage, charge measurements, dry/wet strength additives, fillers, colorants, foams, pitch and deposits. (CHEN 3620 and CHEN 4100 require a grade of C or better).

CHEN 5400 MOLECULAR ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and P/C CHEN 3700. Introduction to how molecular structure and long range microstructure affect the properties of chemical engineering products and how this knowledge can be used to design chemical engineering products for specific applications. (CHEN 3370 requires a grade of C or better).

CHEN 5410 MACROMOLECULAR SCIENCE AND ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and P/C CHEN 3700. Statistical mechanics of chain molecules; thermodynamics of polymer solutions; dilute, semi-dilute, and concentrated solutions and gels; polymer physics; scaling concepts in polymer physics; reputation theory (deGennes, Doi, Edwards) and molecular dynamics; phase separations; crystallization of polymers; rubber elasticity theory; mechanical analysis; viscoelasticity; diffusion theory of polymers; surface properties of polymers. (CHEN 3370 requires a grade of C or better).

CHEN 5420 POLYMER CHEMICAL ENGINEERING (3) LEC. 2. LAB. 3. Pr. (CHEM 2070 or CHEM 2077) and CHEN 3620 and CHEN 5410. Polymer rheology, transport phenomena, thermodynamics, membranes, conducting polymers, surfaces, interfaces and processing. (CHEN 3620 and CHEN 5410 require a grade of C or better).
CHEN 5430 BUSINESS ASPECTS OF CHEMICAL ENGINEERING (3) LEC. 3. Pr., Departmental Approval. The procession of activities required to successfully commercialize and market new chemical-engineering-based technologies to the consumer and process industries.

CHEN 5440 ELECTROCHEMICAL ENGINEERING (3) LEC. 3. Pr. CHEN 3370 and CHEN 3620 and CHEN 3700. Thermodynamics, electrode kinetics and transport phenomena of electrochemical systems, current and potential distributions, double layer theory, electrochemical processes, power sources, synthesis, corrosion. (CHEN 3370, CHEN 3620, and CHEN 3700 require a grade of C or better).

CHEN 5650 HAZARDOUS MATERIALS MANAGEMENT AND ENGINEERING (3) LEC. 3. Pr. (CHEM 2030 or CHEM 2080 or CHEM 2087) and (CHEN 3820 or CIVL 5210). Fundamental principles and regulatory information related to hazardous material and process safety management and engineering, dispersion of chemicals, hazard and operability analysis, chemical engineering principles for risk education.

CHEN 5660 MACROSCALE ASSEMBLY AND APPLICATIONS OF NANOMATERIALS (3) LEC. 3. Departmental approval. Production of macroscopic assemblies and structures from nanomaterials. Processing and applications of inorganic, organic, biological and hybrid nanomaterials.

CHEN 5670 POLLUTION PREVENTION ENGINEERING (3) LEC. 3. Pr. (CHEM 2080 or CHEM 2087) and CHEN 3370 and CHEN 3620 and CHEN 3660 and CHEN 3660 and CHEN 3700. Chemical and engineering principles applied to pollution prevention. Theory and practice of basic separation methods, reaction engineering, process controls, and other fundamental chemical engineering disciplines as well as regulatory requirements to prevent unnecessary waste generation. Case studies. (CHEN 3370, CHEN 3620, CHEN 3660, and CHEN 3700 require a grade of C or better).

CHEN 5700 ADVANCED SEPARATION PROCESSES (3) LEC. 3. Pr. CHEN 3370 and CHEN 3660. Advanced treatment of modern chemical engineering separation processes. Theory and practice of staged multi-component mass transfer operations, non-ideal multi-phase separations and continuous rate processes. (CHEN 3370 and CHEN 3660 require a grade of C or better).


CHEN 5810 BIOMEDICAL ENGINEERING (3) LEC. 3. Pr. CHEM 2087 and P/C CHEN 3620. Application of chemical engineering principles to the study of medical physiology. Human biochemistry, anatomy and physiology, rheological properties of blood and synovial fluid, rheology of cell membranes. Biomedical fluid mechanics and heat and mass transfer. (CHEN 3620 and CHEN 3700 require a grade of C or better).

CHEN 5820 ADVANCED TOPICS IN ENVIRONMENTAL BIOTECHNOLOGY (3) LEC. 3. Application of biotechnology to environmental process treatment, bioremediation and bioreactor development.

CHEN 5970 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) LEC. Departmental approval. Topical courses in areas for advanced undergraduate and graduate students. Topics must be arranged with instructor during preregistration. Course may be repeated for a maximum of 24 credit hours.

CHEN 6090/6096 PULP AND PAPER TECHNOLOGY (3) LEC. 3. An introductory graduate level course on the technology of pulp and paper manufacturing with emphasis on raw materials, pulping, bleaching, paper making, coating and environmental control. For students with no previous formal pulp and paper background.CHEN Department Approval and Alabama Center for Paper and Bioresource Engineering Director approval.

CHEN 6110/6116 PULP AND PAPER ENGINEERING (3) LEC. 3. Chemical and engineering principles in the manufacturing of pulp and paper.

CHEN 6120/6126 SURFACE AND COLLOID SCIENCE (3) LEC. 3. Fundamentals of surface and colloid science with applications in pulping and papermaking, including sizing, retention and drainage, charge measurements, dry/wet strength additives, fillers, colorants, foams, pitch and deposits.

CHEN 6400/6406 MOLECULAR ENGINEERING (3) LEC. 3. Introduction to how molecular structure and long range microstructure affect the properties of chemical engineering products and how this knowledge can be used to design chemical engineering products for specific applications.
CHEN 6410/6416 MACROMOLECULAR SCIENCE AND ENGINEERING (3) LEC. 3. Statistical mechanics of chain molecules; thermodynamics of polymer solutions; dilute, semi-dilute, and concentrated solutions and gels; polymer physics; scaling concepts in polymer physics; reptation theory (deGennes, Doi, Edwards) and molecular dynamics; phase separations; crystallization of polymers; rubber elasticity theory; mechanical analysis; viscoelasticity; diffusion theory of polymers; surface properties of polymers.

CHEN 6420/6426 POLYMER CHEMICAL ENGINEERING (3) LEC. 3. Polymer rheology, transport phenomena, thermodynamics, membranes, conducting polymers, surfaces, interfaces and processing.

CHEN 6430/6436 BUSINESS ASPECTS OF CHEMICAL ENGINEERING (3) LEC. 3. Departmental approval. The procession of activities required to successfully commercialize and market new chemical-engineering-based technologies to the consumer and process industries.

CHEN 6440/6446 ELECTROCHEMICAL ENGINEERING (3) LEC. 3. Thermodynamics, electrode kinetics and transport phenomena of electrochemical systems, current and potential distributions, double layer theory, electrochemical processes, power sources, synthesis, corrosion.

CHEN 6650/6656 HAZARDOUS MATERIALS MANAGEMENT AND ENGINEERING (3) LEC. 3. Fundamental principles and regulatory information related to hazardous material and process safety management and engineering, dispersion of chemicals, hazard and operability analysis, chemical engineering, principles for risk education.

CHEN 6660/6666 MACROSacle ASSEMBLY AND APPLICATIONS OF NанOMATERIALS (3) LEC. 3. Production of macroscopic assemblies and structures from nanomaterials. Processing and applications of inorganic, organic, biological and hybrid nanomaterials. Or departmental approval. May count either CHEN 6660 or CHEN 6666.


CHEN 6810/6816 BIOMEDICAL ENGINEERING (3) LEC. 3. Application of chemical engineering principles to the study of medical physiology. Human biochemistry, anatomy, and physiology, rheological properties of blood and synovial fluid, rheology of cell membranes. Biomedical fluid mechanics and heat and mass transfer.

CHEN 6820/6826 ADVANCED TOPICS IN ENVIRONMENTAL BIOTECHNOLOGY (3) LEC. 3. Departmental approval. Application of biotechnology to environmental process treatment, bioremediation and bioreactor development.

CHEN 6970/6976 ADVANCED SPECIAL TOPICS IN CHEMICAL ENGINEERING (1-6) LEC. Departmental approval. Topical courses in areas for advanced undergraduate and graduate students. Topics must be arranged with instructor during preregistration. Course may be repeated for a maximum of 24 credit hours.

CHEN 7020/7026 INTERFACIAL PHENOMENA (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Fundamental analyses of interfacial phenomena at liquid/gas, liquid/liquid and solid/liquid interfaces.


CHEN 7110/7116 CHEMICAL ENGINEERING ANALYSIS AND ADVANCED TRANSPORT PHENOMENA (3) LEC. 3. Pr. CHEN 7100 or CHEN 7106. Analytical solutions of ordinary and partial differential equations pertaining to transport phenomena and other areas of chemical engineering.

CHEN 7120/7126 ADVANCED TOPICS IN PAPER PROCESSING OPERATIONS (3) LEC. 3. Pr. CHEN 6120 or CHEN 6126. Surface and colloidal interactions in the wet end of paper manufacturing. Colloidal stability theory, absorption of macromolecules, flocculation and retention of particles. Wet-end chemistry process control.

CHEN 7130/7136 ADVANCED PULP AND PAPER ENGINEERING (3) LEC. 3. Topics in pulping, chemical recovery and papermaking.

CHEN 7250/7256 CHEMICAL REACTION ENGINEERING (3) LEC. 3. Pr. P/C CHEN 7100 or P/C CHEN 7106. Analysis and design of homogeneous and heterogeneous chemical reactors. Physicochemical factors and analysis of non-ideal chemical reactor behavior.

CHEN 7600/7606 ENVIRONMENTAL TRANSPORT (3) LEC. 3. Pr. (CHEN 7110 or CHEN 7116) and (CHEN 7200 or CHEN 7206) and (P/C CHEN 7110 or P/C CHEN 7116). Environmental chemodynamics, interphase equilibrium, reactions, boundary layers, transport mechanisms and models or movement of substances across natural interfaces (air-water-sediment-soil).

CHEN 7710 INTRODUCTION TO RESEARCH SEMINAR (1) LEC. 1. SU. Pr. P/C CHEN 7100 or P/C CHEN 7106. Introductory graduate research seminars for entering graduate students.

CHEN 7720 ADVANCED PROCESS DESIGN SEMINAR (1) LEC. 1. Pr. (P/C CHEN 7100 or P/C CHEN 7106) and (P/C CHEN 7200 or P/C CHEN 7206). Fundamentals of advanced process design including process synthesis, simulation, analysis, optimization and integration. Systematic process synthesis tools for screening potential flow sheets.

CHEN 7900/7906 INDEPENDENT STUDY (1-10) IND. SU. Departmental approval. Supervised study in specialized areas of chemical engineering. Topic must be arranged with instructor during pre-registration. Course may be repeated for a maximum of 20 credit hours.

CHEN 7950 GRADUATE SEMINAR (1) SEM. 1. SU. Seminar. Course may be repeated for a maximum of 12 credit hours.

CHEN 8000/8006 GRADUATE CHEMICAL ENGINEERING ANALYSIS (2) LEC. 2. Pr. CHEN 7100 or CHEN 7106. Applications of advanced numerical methods to the analysis of complex chemical engineering problems.

CHEN 8010 ADVANCED CHEMICAL ENGINEERING NUMERICAL ANALYSIS (2) LEC. 2. Pr. CHEN 7100 or CHEN 7106. Advanced numerical methods for the analysis of chemical engineering problems. Computer applications.

CHEN 8020 ADVANCED TOPICS IN THE CHARACTERIZATION OF SURFACE PROPERTIES OF MATERIALS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Nature of surface and intermolecular forces. Surface chemical characterization of solid surfaces. Adhesion and the role of chemical, physical and mechanical properties of solid surfaces. Modern characterization techniques including scanning probe microscopy, thermodynamic and spectroscopic methods.

CHEN 8100 ADVANCED TOPICS IN CHEMICAL ENGINEERING PROCESSES (3) LEC. 3. Pr. CHEN 7110 or CHEN 7116. Advanced concepts in fluid dynamics with special emphasis on applications to chemical engineering, creeping flow, multiphase instabilities, computational fluid mechanics and turbulence.

CHEN 8110 ADVANCED TOPICS IN HEAT AND MASS TRANSFER (3) LEC. 3. Pr. CHEN 7110 or CHEN 7116. Application of transport operations to chemical engineering problems containing physical and chemical rate processes. Chemically reacting boundary layers, heat and mass transfer, eddy diffusion, phase change and separation processes.

CHEN 8210 ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Application of advanced thermodynamics to complex chemical engineering problems including advanced models for electrolyte solutions, critical and supercritical phenomena, high pressure equilibrium, non-equilibrium and surface thermodynamics and molecular modeling.

CHEN 8220 POLYMER THERMODYNAMICS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Fundamentals and applications of macromolecular thermodynamics to industrial polymer problems.

CHEN 8230 CHEMICAL ENGINEERING STATISTICAL THERMODYNAMICS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Applications of molecular theory and models to the properties of non-ideal gases and liquids using advanced statistical mechanics and chemical thermodynamics.

CHEN 8270 HETEROGENEOUS CATALYSIS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Advanced concepts, techniques, applications and principles for the use of heterogeneous catalysts in chemical and environmental processes. Departmental approval.
CHEN 8280 SURFACE CHARACTERIZATION/SOLIDS (3) LEC. 3. Pr. CHEN 7200 or CHEN 7206. Advanced concepts and techniques in the physical and chemical characterization of solid surfaces by microscopic, spectroscopic and chemical methods including various photon and/or electron spectroscopies, thermal desorption.

CHEN 8300 PROCESS DYNAMICS AND CONTROL (3) LEC. 3. Pr. CHEN 7100 or CHEN 7106 and (P/C CHEN 7110 or P/C CHEN 7116). Advanced linear and nonlinear chemical process dynamics and control systems.

CHEN 8310 PROCESS DYNAMICS AND CONTROL II (2) LEC. 2. Advanced chemical process dynamics and control.

CHEN 8320 ADVANCED TOPICS IN CHEMICAL PROCESS COMPUTER CONTROL SYSTEMS (3) LEC. 2. LAB. 3. Pr. CHEN 7100 or CHEN 7106. Analysis and design of advanced digital control systems for chemical processes. Introduction to computer communications through dynamic data exchange and peripheral linkage. Experimental application of advanced digital control algorithms to chemical processes.

CHEN 8340/8346 PROCESS MODELING AND SIMULATION (3) LEC. 2. LAB. 3. Advances in computer-aided process synthesis, simulation, analysis and optimization including systematic process integration tools for developing and screening potential flow sheets using advanced process simulators.

CHEN 8990 RESEARCH AND DISSERTATION (1-20) DSR. Credit hours to be arranged. Course may be repeated with change in topics.