B.4. Professional Component

The major topics discussed in this section are:

- B.4.1. Description Of Curriculum
- B.4.2. Auburn University's Core Curriculum
- B.4.3. Bachelor Of Chemical Engineering Curriculum
- B.4.4. Relationship Of Program Educational Outcomes To Courses
- B.4.5. Program Specializations
- B.4.6. Discussion Of The Design Experience
- B.4.7. Professional And Engineering Electives
- B.4.8. Discussion Of Curriculum Changes To Become Effective Fall 2004
- B.4.9 Student Development In Engineering Practice

B.4.1. Description Of Curriculum

The basic-level curriculum for the chemical engineering program is listed in Table I-1 (Appendix I). This table lists the courses in the program in the order in which they are taken, and are classified in the appropriate categories to indicate how the program meets Criteria 4 and 8.

The curriculum requires forty-two hours of Mathematics and Basic Sciences which exceeds the ABET requirement of 32. These hours can be broken down into mathematics and basic science. The mathematics sequence (fifteen hours) includes: calculus, vector calculus, multivariable calculus, and linear differential equations. The basic sciences sequence (twenty-seven hours) includes general, organic and physical chemistry including four required laboratories, engineering physics and a physical science technical elective.

The curriculum requires fifty-three hours of Engineering Topics which exceeds the ABET requirement of 48. The curriculum contains twenty-seven courses focused on engineering topics including twenty-three chemical engineering courses, two engineering science courses, one computer science course and one electrical engineering course. The program places strong emphasis on laboratory training and provides extensive design experiences (as described below).

The General Education component is well focused and complements the technical component, to best achieve the program educational outcomes and program objectives of the chemical engineering program, and to be consistent with the academic philosophy of the university. These courses comprise the Auburn University Core Curriculum that is required of all students. Because of the importance of the core in providing coverage of many non-technical aspects of our program educational outcomes, we present a brief description of the rationale employed in developing, establishing and implementing the Auburn University Core Curriculum.

B.4.2. Auburn University's Core Curriculum

The general purpose of the Auburn University Core Curriculum is to foster the development of educated citizens. This purpose leads to three goals:

- First, the Core Curriculum seeks to assure that all graduates of Auburn University are competent in critical reading, writing, mathematics, and information literacy.
- Second, the Core Curriculum seeks to assure that all graduates of Auburn University develop analytical skills that allow them to discern significant issues and events; ask appropriate questions; approach problems; gather, synthesize and interpret information; critically analyze established positions; and use knowledge creatively for the enhancement of society.
- Finally, the Core Curriculum seeks to assure that all graduates of Auburn University possess an educated appreciation of the natural world, of human life, and of the interaction between them, especially through technology. Emphasis falls on human behavior, history and social organization, encouraging students to understand and appreciate both their own cultural traditions and the great diversity of other human cultures and experiences. The Core Curriculum also encourages inquiry into moral and aesthetic values and into ideas and their consequences.

To accomplish these goals, Auburn University's Core Curriculum provides a shared learning experience to all Auburn undergraduates based on the principles of coherence and integration. Coherence is achieved by course sequences and by providing connections among courses. Integration is accomplished through interdisciplinary courses.

B.4.3. Bachelor Of Chemical Engineering Curriculum

The Department of Chemical Engineering offers a Bachelor of Chemical Engineering degree (BCHEN). The curriculum followed is designed to meet the education requirement of ABET and the engineering profession. The Engineering Accreditation Commission of ABET has accredited the program since 1950. Since the last ABET visit the BCHEN program has undergone a major restructuring as the university changed from a quarter-based format to a semester-based format. The program and curriculum have also undergone additional modifications due to the assessment based-process of continuous improvement. A large number of significant changes will become effective Fall 2004, again due to improvements and action plans derived from our assessment and improvement processes. These will be discussed separately below and are not part of the data provided in Table I-1.

The curriculum model currently in effect is presented in the Table 4-1

Table 4-1 Curriculum Model for Bachelor of Chemical Engineering (2003-04)

Freshman	Fall	Spring	Course	Fall	Spring
ENGL	1100	1120	English Composition I & II	3	3
CHEM	1110	1120	General Chemistry I & II	3	3
CHEM	1111	1121	General Chemistry Lab I & II	1	1
MATH	1610	1620	Calculus I & II	4	4
			Core History I & II	3	3
ENGR		1100	Engineering Orientation		0
ENGR	1110		Introduction to Engineering	2	
COMP		1200	Computer Science		2
			TOTAL	**16**	**16**

Sophomore	Fall	Spring	Course	Fall	Spring
CHEN	2100		Principles of Chemical Engineering	3	
CHEN	2101		Principles of Chemical Engineering Lab	1	
CHEN		2610	Transport I		3
PHYS	1600		Engineering Physics I	3	
PHYS	1601		Engineering Physics I Lab	1	
ENGL		2200	Great Books I		3
ENGR		2010	Thermodynamics		3
CHEM	2070	2080	Organic Chemistry I & II	3	3
CHEM	2071		Organic Chemistry Lab I	1	
MATH	2630		Multivariate Calculus	4	
MATH		2650	Differential Equations		3
			TOTAL	**16**	**15**

Junior	Fall	Spring	Summer	Course	Fall	Spring	Summer
ENGL	2210			Great Books II	3		
ELEC		3810		Electrical Engineering		3	
CHEM		6070		Physical Chemistry I		3	
CHEM		6071		Physical Chemistry Lab		1	
CHEN	3370			Phase & Reaction Equil	3		
CHEN	3620			Transport II	3		
CHEN	3650			Applied ChE Analysis	3		
CHEN		3660		ChE Separations		3	
CHEN	3700			Chemical Reaction Engineering	3		
CHEN		3820		ChE Lab I		2	
				CHEN Technical Elective l		2	
PSYC			2010	Psychology and Culture			3
ECON			2020	Microeconomics			3
CHEN			4860	ChE Lab II			2
				Core Fine Arts			3
				TOTAL	**15**	**14**	**11**

Senior	Fall	Spring	Course	Fall	Spring
CHEN		4160	Process Dynamics		4
CHEN	4450		Process Economics	2	
CHEN	6170		Digital Process Control	3	
CHEN	6460		Process Sim, Syn & Design	3	
CHEN		6470	Process Design Practice		2
CHEN	6650		Hazardous Materials Mngt	2	
CHEN		6651	Process Engr Safety Lab		1
			CHEN Technical Elective 2		2
			CHEN Technical Elective 3		2
			Elective		3
			Physical Science Elective	4	
PHIL		1040	Business Ethics		3
			TOTAL	**14**	**17**

Electives, Technical Electives, Physical Science Electives: See adviser for approved course listing.

B.4.4. Relationship Of Program Educational Outcomes To Courses

Table 4-2 shows the relationship fashion in which courses taken in the major relate to achieving program educational outcomes. It also includes all courses offered by the department as technical electives. Each outcome that receives significant attention is rated as either being introductory in nature (indicated by an "open square" ☐), receiving strong coverage to develop the outcome (indicated by a "filled square" ■) or being employed or reinforced significantly in the course (indicated by a "filled diamond" ◆).

Table 4-2 Mapping of Program Eduational Outcomes vs Courses

☐ Coverage is Introductory or Preparatory

■ Strong Coverage to Develop Outcome

◆ Significant Coverage to Reinforce or Employ Outcome

	reqd / elective course	course type	1 apply math, science, engineering	2 identify formulate solve engineering problems	3 design conduct experiments, analyze interprete data	4 use technical skills modern engr tools	5 design to meet needs	6 understand professional ethical responsibility	7 knowledge of contemporary issues	8 effective written communication	9 effective oral communication	10 function on a multidisciplinary team	11 life-long learning
CHEN 2100 Principles of Chemical Engineering	reqd	che	■	■		☐	☐	☐	☐	☐		☐	☐
CHEN 2101 Principles of Chemical Engineering Lab	reqd	che	■	■		☐	☐	☐	☐	☐		☐	☐
CHEN 2610 Transport I	reqd	che	■	■			☐			☐	☐	☐	☐
CHEN 3090 Pulp and Paper Technology	elect	pp	■						■	■			
CHEN 3100 Chemical Engineering Processes	elect	che	■	■			■	☐	■				☐
CHEN 3370 Phase and Reaction Equilibria	reqd	che	■	◆		■							
CHEN 3410 Creativity and Critical Thinking in Engineering	elect	che		■	■		■			■	■	■	☐
CHEN 3620 Transport II	reqd	che	■	■			☐			☐		☐	☐
CHEN 3650 Chemical Engineering Analysis	reqd	che	■	◆	■	■	■					◆	☐
CHEN 3660 Chemical Engineering Separations	reqd	che	■	◆			■						
CHEN 3700 Chemical Reaction Engineering	reqd	che	■	◆		■	■						
CHEN 3820 Chemical Engineering Lab I	reqd	che	■	◆	☐	■	☐	☐	■	■	☐	■	☐
CHEN 4100 Pulp and Paper Processing Laboratory	elect	pp	■		■				■	■		■	
CHEN 4160 Process Dynamics and Control	reqd	che	■	■		◆	■		☐	◆	◆	■	■
CHEN 4450 Process Economics and Design	reqd	che	■	◆			■		■	■	■	■	☐
CHEN 4560 Pulp and Paper Process Simulation	elect	pp	■	◆		■	■		■	■	■	■	
CHEN 4570 Pulp and Paper Process Design	elect	pp	◆	◆		◆	■	◆	◆	◆	◆	◆	■

CHEN 4750	Nuclear Chemical Engineering	elect	che	■				■	■	■				
CHEN 4860	Chemical Engineering Laboratory II	reqd	che	■	◆	■	■	□	□	■	■	■	■	□
CHEN 4880	Pulp and Paper Engineering Laboratory	elect	pp	■	■	■	■				■	■	■	
CHEN 4900	Independent Study	elect	spec	◆	◆						◆			
CHEN 4970	Special Topics in Chemical Engineering	elect	spec	◆	◆		◆				◆			
CHEN 4980	Undergraduate Research	elect	spec	◆	◆	◆	◆				◆	◆		
CHEN 4997	Honors Thesis	elect	spec	◆	◆	◆	◆				◆	◆		
CHEN 6110	Pulp and Paper Engineering	elect	pp	■	■		■			■				
CHEN 6120	Surface and Colloid Science of Papermaking	elect	pp	■	■					◆	■	■		◆
CHEN 6170	Digital Process Control	reqd	che	■	◆		■	■						
CHEN 6400	Molecular Engineering	elect	che	◆	◆	■	■	■			□	□	■	
CHEN 6410	MacroMolecular Engineering	elect	che	◆	◆	■	■	◆		□	■	■	■	
CHEN 6420	Polymer Chemical Engineering	elect	che	◆	◆	■	■	◆		□	■	■	■	
CHEN 6430	Business Aspect of Chemical Engineering	elect	che	■	■			■	■	■	■	■		
CHEN 6440	Electrochemical Engineering	elect	che	■										
CHEN 6460	Process Simulation Synthesis and Optimization	reqd	che	■	◆		■	■		■	■	■	■	
CHEN 6470	Process Design Practice	reqd	che	■	◆		◆	◆	◆	◆	◆	◆	◆	◆
CHEN 6630	Introductory Transport Phenemena	elect	che	■	■		■							□
CHEN 6650	Hazardous Materials Management and Engineering	reqd	che	■	◆		■	■	■	■				
CHEN 6651	Process Safety Management and Engineering	reqd	che	■	◆	■		■	■	■	◆			■
CHEN 6660	Multimedia Waste Reduction	elect	che	■				■		■				
CHEN 6670	Pollution Prevention Engineering	elect	che	■	■			■		■				
CHEN 6680	Energy Conversion and Conservation in Chemical Processes	elect	che	■			■	■		■				
CHEN 6700	Advanced Separation Processes	elect	che	◆	◆	■	■	◆	□	■	■	■	■	
CHEN 6800	Biochemical Engineering	elect	che	■	■		◆	◆			◆			
CHEN 6810	Biomedical Engineering	elect	che	■	◆		■		■	◆	■			◆
CHEN 6820	Advanced Topics in Environmental Biotechnology	elect	che	■			■			■	■			
ENGR 1110	Introduction to Engineering	reqd	eng	□	□		□	□	□	□	□	□	□	□

ENGR 2010 Thermodynamics	reqd	eng	■	☐							☐	
ENGR 2200 Introduction to Thermodynamics, Fluids and Heat	serv	eng	■	■								
COMP 1200 Intro Engr Computations	reqd	comp	■			■						
ELEC 3810 Electrical Engineering	reqd	ee	■									
ENGR 1100 Engr Orientation	reqd	eng	☐	☐		☐	☐	☐	☐			☐	☐
PHYS 1600/1 Engr Physics I	reqd	phy	■									
CHEM1110/1 Gen Chem I	reqd	sci	■									
CHEM1120/1 Gen Chem II	reqd	sci	■									
CHEM 2070/1 Org Chem II	reqd	sci	■									
CHEM 2080 Org Chem II	reqd	sci	■									
CHEM6070/1 Phy Chem I	reqd	sci	■									
PSE Physical Science Elect	reqd	sci	■									
MATH 1610 Calculus I	reqd	math	■									
MATH 1620 Calculus II	reqd	math	■									
MATH 2630 Multivariable Calculcus	reqd	math	■									
MATH 2650 Differential Equations	reqd	math	■									
ECON 2020 Microeconomics	reqd	univ							■			
ENGL 1100 English Comp I	reqd	univ								■		
ENGL 1120 English Comp II	reqd	univ								■		
ENGL 2200 Great Books I	reqd	univ								■		
ENGL 2210 Great Books II	reqd	univ								■		
HIS Core History I	reqd	univ						■	■	■		■
HIS Core History II	reqd	univ						■	■	■		■
FAC Fine Arts Core	reqd	univ						■	■			■
PHIL 1040 Business Ethics	reqd	univ						■	■			■
PSYC 2010 Psychology	reqd	univ							■			■

Notation	Legend
che	chemical engineering (general)
pp	pulp and paper specialization
math	required math
sci	required science
univ	university core
spec	special undergraduate
serv	service course
grad	graduate
comp	computer science
ee	electrical engineering
phy	physics

B.4.5. Program Specializations

In addition to the basic-level curriculum, the department currently offers six program specializations that are constructed by careful selection of technical elective courses to provide specialized knowledge, classroom experiences and professional advising. These program specializations are informal and non-binding so that students may change from a program specialization back to the standard curriculum model without loss of credit. The fashion in which elective courses are employed in each specialization is shown in Table 4-3.

Table 4-3 Relationship of Program Specializations To Base-Level Curriculum

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.

Courses Taken in the Specialization Replacing Elective Content	Elective Content Replaced and Other Substitutions
BIOL 3200, BCHE 6180, CHEN 6800, CHEM 2081 and Biochemical Engineering Technical Elective (3 hours).	Technical Elective 1, 2, 3, the Elective, and the Physical Science Elective.

Computer Control Chemical Engineering Specialization

Chemical engineers with expertise in the application of computer-aided process control, computer-aided process systems and advanced technology are highly sought after by all process industries. The program specialization provides appropriate courses for an individual with interests in computer control.

Courses Taken in the Specialization Replacing Elective Content	Elective Content Replaced and Other Substitutions
CHEN 4970, CHEM 6130, 6131 and Computer Control in CHEN Technical Elective (7 hours).	Technical Elective 1, 2, 3, the Elective, and the Physical Science Elective

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 which 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.

Courses Taken in the Specialization Replacing Elective Content	Elective Content Replaced and Other Substitutions
CIVL 4210, Environmental CHEN Technical Elective, CHEM 6130, CHEM 6131 and CHEN 6670.	Technical Elective 1, 2, 3, the Elective, and the Physical Science Elective

Pre-Medicine Chemical Engineering Specialization

This specialization provides the necessary preparation for students wanting to do graduate work in biomedical engineering and, when completed, provides a regular chemical engineering degree while simultaneously meeting pre-medicine requirements.

Pre-Medicine Chemical Engineering Specialization (cont)

Courses Taken in the Specialization Replacing Elective Content	Elective Content Replaced and Other Substitutions
CHEM 2081, BIOL 1020, BIOL 1030, Pre-Med/Biomed Engineering Physical Science Elective and Pre-Med/Biomed Engineering Technical Elective.	Technical Elective 1, 2, 3, the Elective, the Physical Science Elective and CHEM 6071.

Pulp and Paper Chemical Engineering Specialization

This specialization prepares students for challenging and rewarding technical careers in the pulp and paper and numerous allied industries, which service the paper industry. The industry is capable of sustainable development with a renewable raw material base, recyclable products and processing technology able to achieve energy self-sufficiency and environmental compatibility. Entry-level positions for students successfully completing this specialization include process engineering, project engineering, environmental engineering, product development, technical service, sales and marketing.

Courses Taken in the Specialization Replacing Elective Content	Elective Content Replaced and Other Substitutions
CHEN 3090, CHEN 4100, CHEN 6110, CHEN 4560, CHEN 4570, FOPR 4780.	Technical Elective 1, 2, 3, the Elective, the Physical Science Elective, CHEN 6470, and CHEM 6071.

Technical Service Specialization

This specialization prepares students for careers in technical service to the paper, chemical, petroleum, plastics and allied industries. This program specialization provides appropriate courses for individuals interested in technical service, product engineering, engineering consulting and technical sales.

Courses Taken in the Specialization Replacing Elective Content	Elective Content Replaced and Other Substitutions
CHEN 3090, CHEN 6420, CHEN 6120, and Technical Service Technical Elective (6 hours).	Technical Elective 1, 2, 3, the Elective, the Physical Science Elective, and CHEM 6071

B.4.6. Discussion Of The Design Experience

The design experience is well integrated in the curriculum beginning with elementary design principles being introduced in ENGR 1110 Introduction to Engineering (CHEN) and CHEN 2100 Principles of Chemical Engineering culminating in a capstone design experience in CHEN 6470 Process Design Practice employing commercial process simulation software.

In the second year students are introduced to parametric analyses and to solving problems with multiple solutions using spreadsheet software to solve complex material and energy balance problems. The need for making decisions among many alternatives with safety, economic and societal issues as concerns is introduced in this course. Recent assessment data presented at our Spring 2004 Faculty Retreat has lead to the faculty approving employing our commercial simulation software in our "chemical engineering fundamentals courses" as soon as the Ross Hall renovation is completed and new computing resources are available. Homework problems and classroom discussions in CHEN 2610 Transport I and CHEN 3620 Transport II also focus on open-ended problems and their systematic solution. Several group projects are undertaken in these courses to reinforce teaming and related skills.

In the third year, courses in CHEN 3660 CHEN Separations and CHEN 3700 Chemical Reaction Engineering both have significant design content. In these courses students are required to use creativity in developing solutions for open-ended problems and become aware of various constraining factors and alternatives that must be considered. For example, homework assignments deal with designing specific separation and reaction systems to meet design parameters.

B.4.7. Capstone Design Experience

The senior design sequence starts with CHEN 4450 Process Economics, CHEN 6651 Process Engineering Safety Lab, and CHEN 6460 Process Simulation, Synthesis and Design. These courses provides an integrated breadth and depth coverage of design-related problems. The objective of this sequence is to enable the students to experience the various issues of process design, synthesis, simulation and optimization while recognizing important design issues such as safety, environmental acceptability, sustainability and operability. Based on preliminary flowsheet information or literature (patent) search, the students learn to systematically generate process alternatives and screen these based on techno-economic criteria. Students also learn how to improve performance of existing facilities and undertake retrofitting analyses. Student learn how to target design performance and develop optimum strategies for cost reduction, yield enhancement, debottle-necking, resource conversion, energy reduction, and pollution prevention. Computer simulation is subsequently used to validate the developed designs.

In the capstone design course, CHEN 6470 Process Design Practice, a comprehensive design problem is assigned to a team of three or four students. Students must draw upon their previous knowledge and use the tools available to them to synthesize various process configurations. The students take these preliminary solutions and develop final process plans via screening, further simulation, process integration, risk analysis, and environmental and economic optimization. Final results are presented to peers, faculty and industry both orally and in written form with particular attention to engineering standards and realistic constraints. A significant amount of assessment data is generated from the student's performance in these courses using available

rubrics as well as course surveys. At the time of the ABET visit, examples of final design reports as well as the rubrics used to critique these reports will be available for inspection. Generally the design projects focus on development of a complete plant design given specific product requirements.

The overall goal is to distribute the process of learning to design chemical engineering processes, products, and systems throughout the curriculum in a continuous process.

B.4.8. Professional And Engineering Electives

The chemical engineering curriculum includes 6 credits of advanced chemistry electives, 6 technical electives and 3 credits of general electives. As previously discussed, the department provides several program specializations to provide an in-depth experience for those interested in specialization in a current area. For those students who do not wish to specialize the department allows a broad variety of approved electives. Table 4-4 details the current technical elective and physical science elective courses:

Table 4-4 Technical Electives and Physical Science Electives

The following list provides approved courses that meet the requirements for Technical Electives

Students pursuing a program specialization must select electives in accordance with the particular program specialization requirements. This information is available from the Academic Advisor.

Engineering Courses

Chemical Engineering	CHEN-3090 PULP AND PAPER TECHNOLOGY CHEN-3100 CHEMICAL ENGINEERING PROCESS CHEN-4100 PULP AND PAPER PROCESSING LAB CHEN-4560 PULP & PAPER PROCESS SIMULATION CHEN-4900 INDEPENDENT STUDY CHEN-4970 SPECIAL TOPICS IN CHEMICAL ENG CHEN-4980 UNDERGRADUATE RESEARCH CHEN-6120 SURFACE/COLLOID SCI OF PAPERMKG CHEN-6420 POLYMER CHEMICAL ENGINEERING CHEN-6430 BUSINESS ASPECTS OF CHEMICAL ENG CHEN-6440 ELECTROCHEMICAL ENGINEERING CHEN-6630 INTRODUCTORY TRANSPORT PHENOMENA CHEN-6670 POLLUTION PREVENTION ENGINEERING CHEN-6700 ADVANCED SEPARATION PROCESSES CHEN-6800 BIOCHEMICAL ENGINEERING CHEN-6810 BIOMEDICAL ENGINEERING
Biosystems Engineering	BSEN-3240 THERMAL PROCESS OPS IN BIOSYS BSEN-4230 WASTE MNGT & UTIL ENG BIOSYSTEMS BSEN-6550 PRINCIPLES OF FOOD ENGR TECH
Civil Engineering	CIVL-4210 ENVIRONMENTAL ENGINEERING II CIVL-6240 AIR POLLUTION
Computer Science and Software Engineering	COMP-2000 NETWORK PROGRAM W/HTML AND JAVA COMP-2200 FUNDAMENTALS OF COMP SCIENCE I COMP-3000 OBJECT ORIENTED PROG ENG & SCI
Engineering	ENGR-1200 GRAPHICAL COMMUNICATION & DESIGN ENGR-2050 STATICS ENGR-2070 MECHANICS OF MATERIALS
Electrical Engineering	ELEC-2020 ELECTRICAL ENGINEERING LAB II ELEC-2010 ELECTRICAL ENGINEERING LAB I ELEC-2110 ELECTRIC CIRCUIT ANALYSIS ELEC-2120 LINEAR SIGNALS & SYSTEMS ANLYS ELEC-2200 DIGITAL LOGIC CIRCUITS ELEC-2210 DIGITAL ELECTRONICS ELEC-2220 COMPUTER SYSTEMS ELEC-3500 CONTROL SYSTEMS ELEC-3820 INDUSTRIAL INSTRUMENTATION
Industrial and Systems Engineering	INSY-3020 OCCUPATIONAL SAFETY & ERGONOMICS INSY-4330 STAT QUALITY DESIGN & CONTROL INSY-6010 SAFETY ENGINEERING I INSY-6380 RELIABILITY ENGINEERING
Material Engineering	MATL-3100 ENG. MATERIALS - METALS MATL-3200 ENGINEERING MATERIALS - POLYMERS MATL-3300 ENG MATERIALS CERAMICS

	MATL-4500 MATERIALS PROPERTIES & SELECTION MATL-3201 POLYMER & COMPOSITES LABORATORY MATL-6100 THERMODYN OF MATERIALS SYSTEMS MATL-6600 CORROSION
Mechanical Engineering	MECH-4310 HEATING, VENTILATING, AC & REFRG MECH-4320 APPLIED CFD AND HEAT TRANSFER MECH-6120 COMBUSTION
Statistics	STAT-3010 STATS FOR ENGINEERS & SCIENTISTS STAT-3600 PROBABILITY & STATISTICS I STAT-3610 PROBABILITY & STATISTICS II
Textile Engineering	TXEN-3400 INTRO TO DYEING & FINISHING TXEN-6100 FABRICS FOR PAPER MAKING TXEN-6310 STRUCTURE & PROPERTIES POLYMERS TXEN-6410 PHYSICAL CHEMISTRY OF DYEING TXEN-6510 POLYMER CHEMISTRY TXTN-3310 STRUCTURE & PROPERTIES OF FIBERS

Science Courses

Biology	BIOL-1020 PRINCIPLES OF BIOLOGY BIOL-1030 ORGANISMAL BIOLOGY BIOL-3000 GENETICS BIOL-3200 GENERAL MICROBIOLOGY BIOL-4100 CELL BIOLOGY BIOL-4101 CELL BIOLOGY LABORATORY BIOL-4220 INTRODUCTORY MOLECULAR GENETICS BIOL-4400 CLINICAL PHYSIOLOGY
Chemistry	CHEM-6080 PHYSICAL CHEMISTRY II CHEM-6081 PHYSICAL CHEMISTRY II LABORATORY CHEM-6100 INORGANIC CHEMISTRY I CHEM-6101 INORGANIC CHEMISTRY LABORATORY I CHEM-6130 INSTRUMENTAL ANALYSIS CHEM-6131 INSTRUMENTAL ANALYSIS LAB
Biochemistry	BCHE-6180 BIOCHEMISTRY I BCHE-6181 BIOCHEMISTRY I LABORATORY
Forest Products	FOPR-4780 WOOD CHEMISTRY FOPR-6210 PRIMARY WOOD PROCESSING TECH
Geology	GEOL-2100 ENVIRONMENTAL GEOLOGY
Mathematics	MATH-2660 TOPICS IN LINEAR ALGEBRA
Physics	PHYS-1510 GENERAL PHYSICS II PHYS-1610 ENGINEERING PHYSICS II PHYS-2200 INTRO QUANT PHYSICS & RELATIVITY

Other Courses Allowed As Technical Elective

Economics	ECON-2030 PRIN OF MACROECONOMICS ECON-3020 INTERMEDIATE MICROECONOMICS
English	ENGL-3040 TECHNICAL WRITING ENGL-3080 BUSINESS WRITING ENGL-4000 ADVANCED COMPOSITION
Finance	ACCT-2110 PRINCIPLES OF FINANCIAL ACCT FINC-3610 PRINCIPLES OF BUSINESS FINANCE
Management	MNGT-3090 ANALYSIS & DESIGN OF BUSINESS IS

	MNGT-3100 PRINCIPLES OF MANAGEMENT MNGT-3140 INTRO TO MIS MNGT-3250 INTRO TO ENTERPRISE OPER SYSTEMS MNGT-4140 ENTREPRENEURSHIP MNGT-4740 QUALITY MANAGEMENT SYSTEMS MNGT-4890 STRATEGIC ENVIRONMENTAL MNGT

The following list provides approved courses that meet the 4-semester credit hour **Physical Science Elective** requirement. Both the lecture and laboratory course must be taken.

Physical Science Elective

Biochemistry	BCHE-6180 BIOCHEMISTRY I BCHE-6181 BIOCHEMISTRY I LABORATORY
Chemistry	CHEM-6080 PHYSICAL CHEMISTRY II CHEM-6081 PHYSICAL CHEMISTRY II LABORATORY CHEM-6100 INORGANIC CHEMISTRY I CHEM-6101 INORGANIC CHEMISTRY LABORATORY I CHEM-6130 INSTRUMENTAL ANALYSIS CHEM-6131 INSTRUMENTAL ANALYSIS LAB
Physics	PHYS-1510 GENERAL PHYSICS II PHYS-1511 GENERAL PHYSICS II LAB PHYS-1610 ENGINEERING PHYSICS II PHYS-1611 ENGINEERING PHYSICS II LAB
Chemical Engineering	CHEN-6120 SURFACE/COLLOID SCI OF PAPERMKG

B.4.9. Discussion Of Curriculum Changes To Become Effective Fall 2004

Based on the last two years of assessment data and action plans, a major revision of the curriculum was proposed to improve the program to become effective Fall 2004. The major changes are outlined in Table 4-5. The curriculum model that becomes effective Fall 2004 is provided in Table 4-6.

Table 4-5 Changes in Bachelor of Chemical Engineering Program (2004-05)

Implementation of Progress Assessment Courses: The Department of Chemical Engineering was approved to offer a two-course sequence called Progress Assessment I and II to measure subject matter retention and student proficiency in August 2003. The object of these courses (CHEN2@@0 and CHEN3@@0)) is to measure (for assessment purposes) and to certify the student's retention of essential chemical engineering knowledge. In this proposal we request the prerequisite for CHEN4470 Process Design Practice be changed to allow the use of the progress assessment courses to be fully implemented beginning Fall 2004. The changes requested for CHEN4470 Process Design Practice (including the change in prerequisite) are to be effective Fall 2004. However, students taking CHEN4470 in the spring 2005 semester will be allowed to substitute CHEN 2@@0 in place of the CHEN 3@@0 prerequisite (to allow for sufficient time to pass the Progress Assessment exam). In the department's Pulp and Paper Specialization the course that is equivalent to CHEN4470 is CHEN4570 Pulp and Paper Process Design. The prerequisites for this course are similarly revised to allow for the use of the Progress Assessment courses. The other changes to CHEN 4470 and CHEN 4570 are discussed in item (d) below.

Standardization of Technical Electives: During the "quarter to semester" conversion, the department converted most of its existing technical elective openings to a two-credit hour format and similarly offered many of its technical elective courses as two-credit hour courses. This has proved to be unsatisfactory for a number of reasons including difficulties in arranging for the department's program specialization plans as well as it being difficult to clearly demonstrate (for accreditation purposes) how these program specializations relate to the chemical engineering program. In addition, it was very difficult for students to locate appropriate 2-hour courses to fill these elective openings since many engineering, science and math courses are offered in a three-hour format. In this request, the department is converting all technical elective openings in the program plan to a three-hour format and changing all technical elective courses to a three-hour format as well. This uniformity will make course choices for the student much easier as well as allowing the department to clearly demonstrate that our program specializations are simply formed by appropriate selection of technical electives.

Addition of CHEN 3600 Computer-Aided Chemical Engineering: Recent assessments prepared for our upcoming accreditation point to a deficiency in the area of computer-applications and software proficiency in solving chemical engineering problems. This partly came about because two courses previously offered under the quarter plan were eliminated to decrease the number of hours in the program. The currently taken COMP1200 does not provide sufficient exposure to the required computer language skills, to important numerical methods and to software applications in the area of chemical engineering, therefore the department is seeking to offer a new course entitled Computer-Aided Chemical Engineering to provide necessary instruction in programming specifically applied to the area of chemical engineering. This course will be taken in addition to the COMP 1200 Computer Science course.

Rearrangements and Consolidations: Our departmental assessment process has revealed that several of the courses in the current curriculum would be more effectively taught if combined. The CHEN2100 Principles of Chemical Engineering and CHEN2101 Principles of Chemical Engineering Lab are being combined into a single course CHEN 2100 Principles of Chemical Engineering to provide more uniform instruction. Similarly, the currently offered CHEN4651 (previously CHEN6651) Process Safety Lab is being combined with CHEN4450 Process Economics to form a more valuable CHEN4450 Process Economics & Safety course. This corrects an accreditation issue that our seniors were involved in their senior process design practice project without having completed their safety course. The two-course process design sequence (CHEN 4460 and CHEN 4470) is being modified to shift an hour from the CHEN 4460 Process Simulation and Optimization course to the CHEN 4470 Process Design Practice course. This is consistent with the workload and time expectations in the CHEN 4470 course. Coverage in CHEN 4460 is reduced to accomplish this. In the program's Pulp and Paper Specialization the course equivalent to CHEN 4460 is CHEN 4560 Pulp and Paper Process Simulation. The prerequisites for this course are being adjusted to be similar to those of CHEN 4460. The content and of the course CHEN 4570 Pulp and Paper Process Design is being modified to keep it equivalent to the main programs CHEN 4470 Process Design Practice course.

Other changes involve moving courses (to provide a better balance and timeliness of content):

Move ELEC3810 Electrical Engineering from Junior(Fall) to Junior(Summer)
Move Core Fine Arts from Junior(Summer) to Senior(Spring)
Move PHIL1040 Business Ethics from Senior(Spring) to Junior(Summer)
Move PSYC1000 Psychology and Culture from Junior(Summer) to Senior(Spring) and designate as Core Social Science Group 1

Adjustment to Balance Total Hours: With the addition of the CHEN3600 Computer-Aided Chemical Engineering course (needed in order to remedy accreditation concerns as indicated by our departmental assessment data) and with the conversion of three two-hour technical electives to three-hour technical electives, the department has carefully analyzed the remaining courses to identify how to maintain the program at its current size. This requires removing (from the program as required courses) CHEN4160 Process Dynamics and CHEN5650 (previously CHEN6650) Hazardous Materials Management. Both of these courses are retained in the curriculum as technical elective courses and are taken by students in several of the department's program specializations. Some small portion of the content of these courses has been moved to other required courses in the curriculum.

Narrative Changes: Along with the changes in the structure of the program, the department seeks to revise the program narrative including the narratives for the program specializations. One of the current specializations (Technical Service) is being dropped for lack of participation and the Pulp and Paper Chemical Engineering specialization is being renamed Pulp, Paper and Bio-resources Engineering to recognize important changes in the industry.

Table 4-6 Curriculum Model for Bachelor of Chemical Engineering (2004-05)

Freshman	Fall	Spring	Course	Fall	Spring
ENGL	1100	1120	English Composition I & II	3	3
CHEM	1110	1120	General Chemistry I & II	3	3
CHEM	1111	1121	General Chemistry Lab I & II	1	1
MATH	1610	1620	Calculus I & II	4	4
			Core History I & II	3	3
ENGR		1100	Engineering Orientation		0
ENGR	1110		Introduction to Engineering	2	
COMP		1200	Computer Science		2
			TOTAL	**16**	**16**

Sophomore	Fall	Spring	Course	Fall	Spring
CHEN		2@@0	Progress Assessment I		0
CHEN	2100		Principles of Chemical Engineering	4	
CHEN		2610	Transport I		3
PHYS	1600		Engineering Physics I	3	
PHYS	1601		Engineering Physics I Lab	1	
ENGL		2200	Great Books I		3
ENGR		2010	Thermodynamics		3
CHEM	2070	2080	Organic Chemistry I & II	3	3
CHEM	2071		Organic Chemistry Lab I	1	
MATH	2630		Multivariate Calculus	4	
MATH		2650	Differential Equations		3
			TOTAL	**16**	**15**

Junior	Fall	Spring	Summer	Course	Fall	Spring	Summer
CHEN		2@@0		Progress Assessment I		0	
ENGL	2210			Great Books II	3		
CHEN	3600			Computer-Aided Chemical Engineering	3		
CHEM		4070		Physical Chemistry I		3	
CHEM		4071		Physical Chemistry Lab		1	
CHEN	3370			Phase & Reaction Equil	3		
CHEN	3620			Transport II	3		
CHEN		3650		Applied ChE Analysis		3	
CHEN		3660		ChE Separations		3	
CHEN	3700			Chemical Reaction Engineering	3		
CHEN		3820		ChE Lab I		2	
				CHEN Technical Elective I		3	
ELEC		3810		Electrical Engineering		3	
				Core Social Science Group 2			3
CHEN			4860	ChE Lab II			2
PHIL			1040	Business Ethics			3
				Core Fine Arts			3
				TOTAL	**15**	**15**	**11**

Senior	Fall	Spring	Course	Fall	Spring
CHEN		4170	Digital Process Control		3
CHEN	4450		Process Economics and Safety	3	
CHEN	4460		Process Simulation and Optimization	2	
CHEN		4470	Process Design Practice		3
			CHEN Technical Elective II	3	
			CHEN Technical Elective III		3
			CHEN Technical Elective IV		3
			Physical Science Elective	4	
			Core Social Science Group 1		3
PHIL		1040	Core Fine Arts	3	
			TOTAL	**15**	**15**

Technical Electives, Physical Science Electives: See adviser for approved course listing.

B.4.10. Student Development In Engineering Practice

Classroom Activities

The program provides students with an understanding of the ethical, social, economic, and safety considerations that occur in engineering practice. This is done by individual instructors in relation to the technical material that is being taught in various courses as well as a required course in PHIL 1040 Business Ethics, taught by the philosophy department. This covers a wide range of professional ethics associated with industrial practice.

In CHEN 2010, Principles of Chemical Engineering students are introduced to the opportunities for the chemical engineer in the various process industries. The traditional functions that chemical engineers serve in petroleum refining, petrochemical operations, pulp and paper manufacture, and power generation are reviewed. In addition, the student is informed about opportunities in developing industries, such as space technology, ceramics, electronics, materials, biotechnology, and biomedical engineering. The responsibility of the professional engineer for safe and socially responsible operations is emphasized.

Professional ethics is discussed in CHEN 3820 Chemical Engineering Lab I. The need for professional honesty in obtaining and analyzing performance and design data on equipment is stressed. Laboratory safety is also stressed in the laboratory courses, CHEN 3820 and CHEN 4860 Chemical Engineering Lab II. A document prepared by the department, "Guidelines for Safety in the Chemical Engineering Laboratories," is distributed to the students who are required to acknowledge having read it before they do any experiments. Moreover, the students are observed throughout the course to ensure that all safety precautions are observed. The guidelines include rules to be observed, precautions to be taken, and emergency action procedures. In CHEN 4860, a detailed process hazard review (PHR) is performed by the students; teams of students give a written and oral presentation of the safety hazards, procedures, evacuation, and chemical disposal. In other courses, as technical material is discussed, it is emphasized that the student, upon graduation, will be responsible for the safety of the employees he or she supervises. It behooves the student, therefore, to recognize any dangers that are involved.

Chemical safety is a major thrust area in CHEN 6651 Process Engineering Safety Lab. Important topics such as statistical representation of accidents and hazards (toxicology, exposure pathways, and dose-response models), industrial hygiene, toxic release and dispersion models, fires and explosions, and hazard and operability (HAZOP) analysis are covered. It is pointed out

that if adequate information is not available to assess risks to health and safety in a process design, the concerns should be documented and a request made for more laboratory, pilot plant, or toxicity information. The need for back-up controls and, where possible, fail-safe designs and operating procedures are discussed and examples are used such as runaway chemical reactions, plugged vent lines, unexpected polymerization in columns, over-pressuring units, heavy organic vapor clouds, contaminants causing unexpected decomposition, and poison gas accumulation. It is stressed that the goal of plant design and operation must be to meet health and safety standards and economic goals. In addition, speakers from industry are invited to present typical industrial approaches to process and equipment safety. The course also addresses several actual industrial accidents, accounts for causes and effects, and outlines steps that can prevent similar disasters.

The importance of reliable process control and its influence on plant safety and economics are discussed in CHEN 6170 Digital Process Control. It is stressed that in order to maintain a safe operating environment that is also economically optimal, automatic control systems should be designed to perform well, not only under ideal conditions, but when several plant components or instrumentations have failed. Methods for design and implementation of such reliable control systems are discussed in the courses. A case study of distillation column control is given as a term project to familiarize students with realistic control problems and the effect of failures and other non-ideal factors on the closed-loop performance.

In CHEN 6650 Hazardous Materials Management students become familiar with safety regulations, environmental treatment approaches, handling techniques and disposal methods for hazardous or potentially hazardous materials.

The social and economic aspects of engineering practice are covered in CHEN 4450 Process Economics. Speakers from industry serve as role models, talking about a variety of subjects: their careers, professional development, technical processes, and influence of governmental regulations on engineering decisions. In the subsequent 10-15 minute question and answer period, the students ask about the environmental and social issues that are involved. Students learn how to apply several methods for cost estimation, depreciation, and profitability. The economic, social, and environmental implications of the design process are also emphasized.

Technical, Professional, and Honor Societies Membership

Auburn University has student chapters of the American Institute Of Chemical Engineers (AIChE) and the Technical Association of the Pulp and Paper Industry (TAPPI). Dr. Y.Y. Lee is the faculty advisor for AIChE, and Dr. Gopal Krishnagopalan is the faculty advisor for TAPPI.

The AIChE chapter holds four-six general meetings per semester, and one officer's planning meeting per semester. Most meetings include guest speakers from industry, government, and universities. Traditionally, two Auburn faculty members are asked to present discussions of their research. One meeting had a panel discussion with five of our graduate students for the undergraduates to learn about graduate school opportunities.

About ten AIChE undergraduate student members participated in the Regional AIChE Student Conference. Three students presented research papers in the conference competition. The presenters' preparation and practice talks before the student chapter and before the research groups provided an opportunity for close interactions between faculty, graduate students, and undergraduate students. The department provides travel expenses for the students who present

papers. The chapter president participated in the AIChE National Student Conference.

The AIChE Chapter is heavily involved with planning and hosting of the department participation in E-Day during National Engineers Week. Several hundred high school students from around the state visit the college of engineering. The AIChE undergraduates work with graduate students and faculty to set up and present six research displays and demonstrations. The students also serve as department laboratory guides and they are available to discuss chemical engineering opportunities with visitors.

There are three national honoraries open to our students: Omega Chi Epsilon (ChE), Tau Beta Pi (Engineering), and Phi Kappa Phi (University-wide). Omega Chi Epsilon initiates deserving juniors and seniors, recognizing scholarship and service in chemical engineering. It makes available graduate school information from other schools and members of the honorary assist on Engineering Day at Auburn to discuss chemical engineering as a professional college field of study.

In addition to bringing industrial representatives to the AIChE meetings, the AIChE student chapter arranges visits to industrial and governmental facilities.

Students in the Pulp and Paper program specialization visit one mill each year. Students in the Pulp and Paper program specialization also participate in the Annual Meeting of the Pulp and Paper Research and Education Center where they interact closely with more than 100 industrial representatives at meetings, committees, and a scholarship dinner held in the students' honor.

Students are encouraged to become National members of the AIChE. About 70 students are members this year. Students are also encouraged to participate in the local Professional Section of the AIChE. Approximately 20 students attended the Central Alabama Section Meeting called "Student Night" where several awards are normally given.

Students meet company representatives through two job fairs and through company information sessions organized by the Auburn University Placement Office.

Students are encouraged to participate in industrial, co-op, and summer internship programs. More than half of this year's graduating class has industrial experience with 44% reporting on the senior exit interview that they had participated in the co-op program.

The student chapter president of TAPPI attends executive meetings of the local TAPPI section. The technical and business sessions of the local section, which take place bimonthly, are open to students, affording them the opportunity to interact with technical people from the paper industry. Usually these meetings are followed by a plant visit. The local section makes donations to the student chapter.