PAPER SCIENCE & ENGINEERING
BACCALAUREATE PROGRAM
This program leads to the degree, Bachelor of Science in Paper Science & Engineering
(Accredited by the Engineering Accreditation Commission of ABET)

SCHOOL OF ENGINEERING & APPLIED SCIENCE
MIAMI UNIVERSITY
2009-2010

The mission of the Paper & Chemical Engineering Department is to teach and prepare liberally educated, articulate, and skilled engineers for leadership positions in the pulp and paper and other related industries.

The Paper and Chemical Engineering program provides a broad scientific and engineering education leading to professional entry-level positions in pulp and paper or allied industries. Students learn to apply scientific and engineering principles to the solution of industry problems by following a course sequence emphasizing chemical engineering, chemistry, and paper engineering. This course of study is for students who are interested in science and engineering and also have a desire to develop and interpret experimental data, solve mathematical problems, and apply these skills in an industrial and/or research environment.

The Bachelor of Science in Paper Science and Engineering curriculum is arranged similarly to traditional engineering programs where foundation courses are taken during the first two years, engineering science courses occupy the second and third years, and capstone engineering design and paper science courses are concentrated in the final year. A suggested 4-year curriculum is described on the following pages.

Each student is required to take the Fundamentals of Engineering exam prior to graduation, preferably in the senior year. It is expected that the student will make a "good faith" effort to pass the exam in part because the success at this exam has implications regarding gaining license as a professional engineer. The exam is administrated by the National Council of Examiners for Engineering and Surveying.

The majority of paper and chemical engineering students gain some form of industry experience prior to graduation, whether it be through the five-year co-op program in which students alternate semesters of study with semesters of work in the paper industry, or through summer internships following their sophomore and junior years. Students are also encouraged to become involved with student organizations such as the Miami Chapter of the Technical Association of the Pulp and Paper Industry (TAPPI) and Paper Industry Management Association (PIMA).

The potential job market is broad. Many graduates accept entry-level positions with paper companies as process/project engineers, environmental engineers, production supervisors, or quality control specialists, while others become technical sales or technical service engineers for suppliers of chemicals, computer process control engineers, or research engineers.

PAPER SCIENCE AND ENGINEERING CURRICULUM *
2009-2010

English (9 hours)
- ENG 111 College Composition
- ENG 112 Composition and Literature
- ENG 313 Introduction to Technical Writing

Mathematics & Statistics (16 hours)
- MTH 151 Calculus I
- MTH 251 Calculus II
- MTH 245 Differential Equations for Engineers
- STA 368 Introduction to Statistics

Fine Arts, Humanities, & Social Science (12 hours)
- ECO 201 Principles of Microeconomics
- Miami Plan Humanities
- Miami Plan Fine Arts
- Miami Plan Fine Arts, Humanities, or Social Science

U.S. & World Cultures (6 hours)
- Miami Plan U.S. Cultures
- Miami Plan World Cultures

Natural Science (30 hours)
- PHY 181P The Physical World
- PHY 182P The Physical World
- CHM 141,144 College Chemistry and Lab
- CHM 142,145 College Chemistry and Lab
- CHM 231,231L Organic Chemistry and Lab
- CHM 363,364 Analytical Chemistry and Lab
- Miami Plan Biological Science (MPF IVA)

Thematic Sequence (9 hours)
Liberal Education sequence outside your major focused around a theme. The required chemistry courses fulfill the CHM1 thematic sequence.

Paper Science & Engineering Courses
(56 hours)

1. Engineering Science (13 hours)
   - EAS 101 Computing, Engineering & Society
   - EAS 102 Problem Solving & Design
   - PCE/MME 314 Engineering Thermodynamics
   - PCE/MME 341 Engineering Economics
   - Select one of the following:
     - (i) PCE 219 Statics and Mechanics of Materials
     - (ii) MME 211 Static Modeling of Mechanical Systems

2. Chemical Engineering Courses (19 hours)
   - PCE 204 Material and Energy Balances
   - PCE 311 Unit Operations Laboratory I
   - PCE/MME 313 Fluid Mechanics
   - PCE/MME 403 Heat Transfer
   - PCE 414 Mass Transfer
   - PCE 451 Unit Operations Laboratory II
   - PCE 482 Process Control

3. Paper Courses (25 hours)
   - PCE 201 Principles of Pulp and Paper
   - PCE 202 Pulp and Paper Physics
   - PCE 301 Pulp and Paper Chemistry
   - PCE 404 Papermaking
   - PCE 405 Industrial Environmental Control
   - PCE 415 Chemical Kinetics and Reactor Design
   - PCE 471-472 Engineering Design I, II
   - PCE 490 A Paper Coating
   - PCE 490 B Printing and Converting Processes
   - PCE 490 C Paper Manufacturing
   - PCE 490 D Fundamentals of Corrosion

*Required to take the Fundamentals of Engineering Exam and make a "good faith" effort to pass the exam

SAMPLE CURRICULUM
PAPER SCIENCE AND ENGINEERING
SCHOOL OF ENGINEERING & APPLIED SCIENCE - MIAMI UNIVERSITY
2009-2010

Please consult your adviser before scheduling classes. Actual course offerings may vary.

Freshman Year

First Semester		*Second Semester*	
CHM 141 College Chemistry (MPF IVB)	3	CHM 142 College Chemistry	3
CHM 144 College Chemistry Laboratory (MPF IVB)	2	CHM 145 College Chemistry Laboratory	2
ENG 111 College Composition (MPF I)	3	ENG 112 Composition and Literature (MPF I)	3
MTH 151 Calculus I or 153 Calculus I (MPF V)	5	MTH 251 Calculus II	4
EAS 101 Computing, Engineering & Society	1	EAS 102 Problem Solving & Design	3
Miami Plan Biological Science (MPF IVA)	3		15
	17		
Summer Semester			
PHY 181.P The Physical World (MPF IVB)	4		
	4		

Sophomore Year

First Semester		*Second Semester*	
CHM 231, 231L Organic Chemistry and Lab	4	PCE 204 Materials and Energy Balances	3
PCE 201 Principles of Pulp and Paper	3	PCE 202 Pulp of Paper Physics	3
PCE 219 Statics and Mechanics of Materials **or**		PCE/MME 313 Fluid Mechanics	3
MME 211Static Modeling of Mechanical Systems	3	PCE/MME 314 Engineering Thermodynamics	3
MTH 245 Differential Equations/Engineers	3	ENG 313 Introduction to Technical Writing	3
PHY 182.P The Physical World (MPF IVB)	4		15
	17		

Junior Year

First Semester		*Second Semester*	
ECO 201 Principles of Microeconomics (MPF IIC)	3	PCE 301 Pulp and Paper Chemistry	3
PCE/MME 403 Heat Transfer	3	PCE 311 Unit Operations Laboratory I	2
PCE 404 Papermaking	3	PCE 414 Mass Transfer	3
Miami Plan Humanities Course (MPF IIB)	3	PCE 415 Chemical Kinetics and Reactor Design	3
STA 368 Introduction to Statistics	4	CHM 363 Analytical Chemistry	2
	16	CHM 364 Analytical Chemistry Laboratory	3
			16

Senior Year *

First Semester		*Second Semester*	
PCE/MME 341 Engineering Economics	3	PCE 490 Special Topics	3
PCE 405 Industrial Environmental Control	3	PCE 472 Engineering Design II (MPC)	2
PCE 451 Unit Operations Laboratory II	2	Miami Plan World Culture Course (MPF IIIB)+	3
PCE 471 Engineering Design I (MPC)	1	Miami Plan U.S. Cultures Course (MPF IIIA)	3
Miami Plan Fine Arts Course (MPF IIA)	3	Miami Plan Fine Arts, Humanities, or Social Science Course (MPF II A, B, or C)	3
PCE 482 Process Control	3		14
PCE 490 Special Topics	1		
	16		

The Miami Plan for Liberal Education Foundation (MPF) requirement includes 6 hours of English Composition (ENG 111-112 fulfills this requirement); 12 hours in Fine Arts, Humanities, and Social Science (ECO 201 fulfills 3 hours of Social Science) with a minimum of 3 hours in each; 6 hours in U.S. and World Cultures; 9 hours of Natural Science, including one laboratory course with a minimum of 3 hours in Biological Science and 3 hours in Physical Science (PHY 181-182, and CHM 141-144 more than fulfills the Physical Science requirement;); 3 hours of Mathematics, Formal Reasoning or Technology (MTH 151 fulfills this requirement). **At least one of these foundation courses must provide a historical perspective (H).** The actual order in which you take these courses is up to you. The outline above is just one sample of how the courses might be arranged. You must also complete 12 hours of Focus: Advanced Liberal Learning courses, including 9 hours in an approved Thematic Sequence (MPT) and a 3 hour Senior Capstone Experience (MPC) (PCE 471/472 fulfill this requirement). This sample curriculum assumes the 9-hour Miami Plan Thematic Sequence requirement will be met by CHM 142/145, CHM 231/231L, and CHM 363/364.

***Required to take the Fundamentals of Engineering Exam and make a "good faith" effort to pass the exam.**

PAPER AND CHEMICAL ENGINEERING - COURSE DESCRIPTIONS - 2009-2010
SCHOOL OF ENGINEERING & APPLIED SCIENCE - MIAMI UNIVERSITY

EAS 101 COMPUTING, ENGINEERING & SOCIETY (1) Introduces computing and engineering professions and their role in society. Explores different engineering and computing disciplines, examines ethical and societal issues related to the disciplines and their impact on the world. An active forum for discussion of ideas and issues.

EAS 102 PROBLEM SOLVING AND DESIGN (3) This course introduces an approach to problem solving for computing and engineering students. The students will learn systematic approaches to problem solving. Topics covered include: problem identification, analyzing requirements, research existing and alternative solutions, analyzing solutions quantitatively, synthesizing and evaluating data, prototyping, and testing. Students will also develop their oral and written skills for technical communications. Co-requisite: EAS 101, MTH 151.

PCE 201 PRINCIPLES OF PULP AND PAPER(3) Introduction to the pulping and papermaking. Carry out experiments in paper science. Apply engineering skills to problem solving related to paper and allied industries. Prerequisite: CHM 141 or instructor approval.

PCE 202 PULP AND PAPER PHYSICS (3) Discovery of how pulping, papermaking and converting are utilized to develop required performance properties of products from paper. Conduct laboratory investigations to determine properties of paper made in the laboratory and from the pilot paper machine. Prerequisite: PCE 201 and a grade of C or better in PHY 181 and one of the following: i) PCE 219 or ii) MME 211.

PCE 204 MATERIAL AND ENERGY BALANCES (3) Techniques used to calculate material and energy balances with special emphasis on paper industry applications. Prerequisite: grade of C or better in CHM 142. Co-requisite: PHY 181.

PCE 219 STATICS AND MECHANICS OF MATERIALS (3) This course provides an introduction to the fundamentals of the mechanics of materials for engineering students in Electrical, Chemical, and Paper Engineering. The course stresses statics, mechanics of deformable media, and material behavior. Elements of dynamics, elasticity, and viscoelasticity will be covered. The central theme of the course that binds these subjects together is proper problem formulation in terms of kinematics, constitutive behavior, equilibrium, and compatibility. Prerequisite: EAS 102. Co-requisite: PHY 181.

PCE 244 INTRODUCTION TO ENVIRONMENTAL ENGINEERING (3) Introductory design concepts for the control of water pollution, air pollution, and solid waste will be covered. Environmental legislation will be discussed. Solutions to environmental problems will be investigated, considering technical, economical and ethical aspects of engineering. Prerequisite: CHM 141 or equivalent, MTH 151 or equivalent.

PCE 301 PULP AND PAPER CHEMISTRY (3) Wood chemistry, chemical pulping chemistry and processes, and wet end chemistry. Chemical composition and structure of lignocellulosic wood fibers The unit processes used in chemical pulping and bleaching. Kraft Recovery. Colloidal science of retention, sizing, process and functional additives. Prerequisite: PCE 201 and one of the following: CHM241, or CHM 251, or CHM 231.

PCE 311 UNIT OPERATIONS LABORATORY I (2) Laboratory course; students conduct experiments and do computer simulations in the areas of material and energy balances and fluid dynamics. Emphasizes acquisition of knowledge about instrumentation commonly used in process industries. Both oral and written laboratory reports required. Prerequisite: A grade of C or better in PHY 181 and PCE 204. Co-requisite: PCE/MME 313.

PCE 313 FLUID MECHANICS (3) Fundamentals and application of the mechanics of fluids including properties, statics and dynamics of fluids, dimensional analysis and similitude, steady state flow, and topics in compressible flow. Prerequisites: MTH 251, PHY 181 and PCE 219 or MME 211. Cross-listed with MME 313.

PCE 314 ENGINEERING THERMODYNAMCIS (3) Study of the fundamental principles of thermodynamics. Emphasis placed on engineering applications such as power cycles, refrigeration, and heat transfer systems. Prerequisite: MTH 251, PHY 181. Cross-listed with MME 314.

PCE 320 PROFESSIONAL PRACTICE (0) Students participating in paper science and engineering co-op program register for this course during semesters when they are away from Oxford on work assignment. This enables students to remain in good standing with the university registrar.

PCE 341 ENGINEERING ECONOMICS (3) Engineering economic decisions; break-even and minimum cost analysis; engineering methods of resource allocation; concepts of interest; time evaluation of tactical and strategic alternatives. Prerequisite: ECO 201, MTH 151. Co-requisite: STA 368 or PCE 204. Cross-listed with MME 341.

PCE 403/503 HEAT TRANSFER (3) Continued study of unit operations with emphasis on heat transfer. Study of steady and unsteady conduction, and laminar, turbulent, boiling, and condensing convective heat transfer. Radiation heat transfer, heat exchangers, evaporators, and transfer units. Prerequisites: PCE/MME 313, PCE/MME 314 and MTH 245. Cross-listed with MME 403

PCE404 PAPERMAKING (3) Contemporary paper manufacturing processes with emphasis on the chemical engineering principles. Prerequisite: PCE 313 and PCE 202. Co-requisite: PCE/MME 341.

PCE 405/505 INDUSTRIAL ENVIRONMENTAL CONTROL (3) Survey of environmental issues facing industry and how the industry addresses these issues. In-plant pollution abatement alternatives discussed as well as external treatment. Computer-based modeling applications introduced and applied to problems. Design considerations involved in selecting among alternative pollution control strategies are presented and applied to examples. Prerequisites: PCE/MME 313 and a grade of C or better in PCE 204. Co-requisite: PCE 311.

PCE 412/512 CHEMICAL ENGINEERING THERMODYNAMICS (3) Advanced thermodynamics with emphasis in phase and chemical equilibrium; Thermodynamic relations and application, Properties of ideal and non-ideal one-component and multi-component systems; ideal and non-ideal phase equilibria; phase diagrams; design of equilibrium flash separators; phase equilibria using equation of state; chemical equilibrium; optimum conditions for feasible reaction equilibria. Prerequisite: PCE/MME 314.

PCE414/514 MASS TRANSFER (3) Continued study of unit operations, with emphasis on mass transfer and special problems. Steady and unsteady diffusion, convective mass transfer, absorption, scrubbing, and stripping. Humidification, psychometry, and drying. Multiple effect evaporators, cooling towers, packed towers, and distillation. Prerequisite: PCE/MME 313, PCE/MME 314 and MTH 245, and a grade of C or better in PCE 204.

PCE 415/515 (3) CHEMICAL KINETICS & REACTOR DESIGN
Chemical Kinetics of homogeneous and heterogeneous reactions, kinetic theories, mechanism and modeling, reactor design, design of multiple reactions; temperature and pressure effects. Non-ideal reactors, survey of catalytic and biochemical reaction systems. Prerequisites: PCE/MME 313, 314, MTH 245, and a grade of C or better in PCE 204.

PCE 416 BIOCHEMICAL ENGINEERING (3) this course is an introduction to the fundamental concepts concerning biochemical kinetics and bioreactors. In particular, this course will focus on enzymatic reactions and fermentations using genetically engineered organisms. Biochemical topics include overviews of cell structure, enzyme kinetics and cell growth kinetics. Engineering topics include: immobilization, fermentor design and sterilization processes. Prerequisites: MTH 245, CHM 332 or CHM 432, PCE 415 and a grade of C or better in PCE 204 or by permission of the instructor

PCE/MPC 417 BIOMEDICAL ENGINEERING (3)
This course is an introduction to the fundamental concepts in biomedical engineering with a special focus on chemical engineering applications. In particular, this course will focus on transport phenomena in biological systems, pharmacokinetics and tissue engineering. Engineering topics will also include discussions concerning the design of equipment and materials for, dialysis, oxygenation, artificial organs, and tissue engineering. Prerequisites: MTH 245, PCE 414, and a grade of C or better in PCE 204, or by permission of the instructor.

PCE 441/541 POLLUTION PREVENTION IN ENVIRONEMENTAL MANAGEMENT (3) Provides understanding of how corporations respond to governmental regulation by setting up environmental management systems which employ the principles of pollution prevention. Engineering concepts such as material balances, energy balances, risk assessment, and life cycle assessment have impacted new process designs. In this course a basis for evolution and maturation of pollution prevention as a fundamental methodology to ensure compliance and economic sustainability of industrial processes will be provided. The understanding of the concepts of pollution will be demonstrated by participation in a class project sponsored by industry at one of their facilities. Prerequisite: A grade of C or better in PCE 204 and Junior Standing. Co-requisite: PCE/MME 341.

PCE 442/542 AIR POLLUTION CONTROL (3) This course will introduce students to the formation and control of air pollutants, engineering theories and principles pertaining to the design of air pollution control operations, and environmental legislation. Solutions to environmental problems will be investigated, considering technical, economical and ethical aspects of engineering. Prerequisites: PCE/MME 313, 314, 341, and a grade of C or better in PCE 204.

PCE 450/550 SPECIAL TOPICS (**1-5**; maximum 20)

PCE 451/551 UNIT OPERATIONS LABORATORY II (2) Laboratory course consisting of experiments and computer simulations in topic from the process industries involving heat, mass and momentum transfer, and process control. Both written and oral laboratory reports are required. Prerequisites: PCE/MME 4 03, PCE 414. Co-requisite: PCE 482.

PCE 471, 472 ENGINEERING DESIGN I AND II (1,2) Involves application and synthesis of accumulated knowledge in a major, open-ended, industrial research/design project. Critical elements of the design process and real world constraints (economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability) are considered. Emphasis is placed on oral and written communication skills. Students from different academic backgrounds are assigned to multidisciplinary project teams in order to utilize their varied experiences, knowledge, learning styles, and skills to achieve a successful conclusion to each project. Prerequisite: senior standing, or permission of instructor.

PCE 473/573 CHEMCIAL PROCESS DESIGN (3) this is a project-based course in which chemical engineering technology, process simulation, and economic analysis are used to design chemical processes. The technical and economic aspects of equipment selection and design and alternative methods of operation will be covered. Prerequisites: PCE/MME 341, PCE/MME 403, and a grade of C or better in PCE 204. Co-requisites: PCE 414 and 415.

PCE 482/582 PROCESS CONTROL (3) Study of system dynamics and control schemes used for continuous processes. Block diagrams, steady-state and dynamic response, Laplace transforms, computer simulations and closed loop control. Stability, tuning, and controller synthesis. Prerequisites: PCE/MME 313, 314 and MTH 245.

PCE 490/590A PAPER COATING (1). The course provides an introduction to the coating and surface treatments applied to paper and paperboards to improve functional performance. The materials, processes and equipment used in surface sizing, aqueous pigmented coating and polymer coating/lamination will be covered. Prerequisites: PCE 202 or graduate standing.

PCE 490/590B PRINTING AND CONVERTING PROCESSES (1). The course provides an introduction to conventional and digital printing processes used on paper, films and foils. Converting operations including winding, supercalendering, corrugating and box assembly. Prerequisites: PCE 202 or graduate standing.

PCE 490/590C PAPER MANUFACTURING (1). Provides students with the opportunity to synthesize their accumulated knowledge and skills in paper science, paper engineering, economics, statistical methods, environmental technology, writing, and teamwork fundamentals. Student teams determined the raw materials and processing conditions required to produce paper that matches a sample of "unknown paper". They develop strategies for monitoring and improving team effectiveness continuously. They carry out the engineering, environmental impact, and economic analyses required for a global product development project. And, they lean how to apply high ethical standards to such projects. Prerequisites: PCE 202, PCE 404, or permission of instructor.

PCE 490/590 D FUNDAMENTALS OF CORROSION (1). Principles, mechanisms, and characteristics of corrosion. Corrosion behavior of metals, alloys, plastics and ceramics. Methods of corrosion prevention. Prerequisites: CHM 351 or CHM 361 or graduate standing

PCE 491 INTRODUCTION TO RESEARCH (1-3). Research problems in chemical engineering and paper science selected in consultation with a faculty advisor. Research methodology; design of laboratory experiments and computer simulations; critical analysis of results; technical reports; oral presentations. For grade only. Prerequisites: Permission of instructor, subject to approval of the department chair.