

**ENGINEERING MANAGEMENT  
INTERDISCIPLINARY BACCALAUREATE PROGRAM**

The program leads to the degree, Bachelor of Science in Engineering, with a major in Engineering Management

**SCHOOL OF ENGINEERING & APPLIED SCIENCE  
MIAMI UNIVERSITY  
2009-2010**

For the Paper Science and Environmental Engineering technical specialties, contact the Department of Paper & Chemical Engineering, Engineering Building, room 64 (513-529-0760) or visit our web page <http://www.eas.muohio.edu/PCE>.

Many of today's highly competitive global businesses involve technology and require people that have a solid technical background coupled with business and liberal education. Engineering management offers an interdisciplinary approach to address complexities in today's workplace. This program provides a broad academic background, including engineering, business, science, mathematics, and the liberal arts.

Industry recognizes the importance of an interdisciplinary education for management and sales in businesses involved with sophisticated technology. Through the engineering management program you will have both the business and technical background to manage and understand technical aspects of industry. You will develop the engineering and business expertise, social awareness, and cultural perspective necessary to address technological problems in their larger organizational and societal contexts. You will have the opportunity to enhance your interpersonal skills both inside and outside the classroom.

The engineering management curriculum consists of an engineering and business core complemented by a concentration in one of the following technical specialties: Environmental Engineering, Manufacturing Engineering, or Paper Science & Engineering. The environmental engineering technical specialty concentrates on understanding biological engineering and economic solutions to pollution problems and pollution prevention. The manufacturing engineering technical specialty is based on a combination of traditional electrical and mechanical engineering with an emphasis on manufacturing a high quality, cost-competitive product. The paper science and engineering technical specialty emphasizes chemistry, chemical engineering, and paper engineering.

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.

Opportunities are available to obtain valuable work experience and financial assistance through participation in the co-op or internship programs. This professional experience before graduation makes students more valuable to prospective employers. The co-op program, which takes five years to complete, and internship program are optional programs for all technical specialties. Students may also choose to work with their professors on research projects (REU – Research Experience for Undergraduates). This program provides for financial assistance to conduct research.

As a graduate you will be qualified to fill entry level positions that require high levels of interaction with the business functions of operations, purchasing and procurement, personnel, accounting or marketing. Examples of such positions include technical sales and service, production line supervision, quality control, and environmental protection with responsibility for pollution abatement and regulatory implementation programs.

**ENGINEERING MANAGEMENT CURRICULUM \*\***  
**Paper Science & Environment Science Specialties**  
**2009-2010**

**English (9 hours)**

ENG 111 College Composition  
ENG 112 Composition and Literature  
ENG 313 Intro 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\*  
ECO 202 Principles of Macroeconomics\*  
Miami Plan Fine Arts Elective  
COM 135 Public Express/Critical Inquiry  
(COM 136 or 231 may be substituted for COM 135 for the major but they do not fulfill the humanities requirement.)

**U.S. and World Cultures (6 hours)**

Miami Plan World Cultures Elective  
Miami Plan U.S. Cultures Elective

**Natural Science (25 hours)**

CHM 141,144 College Chemistry and Lab  
CHM 142,145 College Chemistry II  
CHM 231 Fundamentals of Organic Chemistry  
PHY 181, 182 The Physical World  
Miami Plan Biological Science Elective

**Thematic Sequence (9 hours)**

Liberal Education sequence outside your major, focused around a theme.

**Remaining Business Core Courses\* (18 hours)**

ACC 221 Introduction to Financial Accounting  
MGT 291 Organizational Behavior and Theory  
MGT 302 Operations Management  
MKT 291 Principles of Marketing  
MGT Tracks (select one track):  
Materials Management Track  
MKT 431 Logistics Management  
MGT 432 Purchasing and Materials Management  
Operations Management Track  
MGT 451 Operations Planning & Scheduling  
MGT 453 Productivity Improvement  
Purchasing/Procurement Track  
MIS 303 Enterprise Systems  
MGT 432 Purchasing & Materials Management  
Human Resources Track  
MGT 303 Human Resources Management  
MGT 405 Labor Relations & Conflict Management  
Entrepreneurship Track  
ESP 467 Entrepreneurship: New Ventures  
ESP 481 Technology, Products, and Ventures

\*ECO 201,202 under Social Science are also Business Core

**Engineering Science Courses (19 hours)**

EAS 101 Computing, Engineering & Society  
EAS 102 Problem Solving & Design  
PCE 204 Material and Energy Balances  
PCE/MME 314 Engineering Thermodynamics  
PCE/MME 341 Engineering Economics  
PCE/MME 313 Fluid Mechanics

Choose one of the following:

- (i) PCE 219 Static and Mechanics of Materials
- (ii) MME 211 Static Modeling of Mechanical Systems

**Integrative Core Courses (6 hours)**

EGM/MGT 311 Project Management  
Engineering Design Capstone Courses  
PCE 471, 472

**Engineering Specialty Courses (17-21 hours)**  
**(Choose one Technical Specialty area)**

Paper Science & Engineering: 21 hours

PCE 201 Principles of Pulp and Paper  
PCE 202 Pulp and Paper Physics  
PCE 301 Pulp and Paper Chemistry  
PCE 311 Unit Operations Laboratory I  
PCE 404 Papermaking  
PCE 482 Process Control  
PCE 490 Special Topics (1)

Choose one courses:

PCE 405 Industrial Environmental Control  
PCE 490 Special Topics (3)

Environmental Engineering: 17 hours

PCE 244 Intro to Environmental Engineering  
PCE 311 Unit Operations Lab I  
PCE 405 Industrial Environmental Control  
PCE 415 Chemical Kinetics & Reactor Design  
PCE 441 Pollution Prevention in Environmental Mgt  
PCE 442 Air Pollution Control

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

**SAMPLE CURRICULUM  
ENGINEERING MANAGEMENT  
PAPER SCIENCE TECHNICAL SPECIALTY \***

**2009-2010**

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

**First Year**

First Semester

CHM 141 College Chemistry (MPF IVB)	3
CHM 144 College Chemistry Laboratory (MPF IVB)	2
ENG 111 College Composition (MPF I)	3
MTH 151 Calculus I or 153 Calculus I (MPF V)	5
EAS 101 Computing, Engineering & Society	1
Miami Plan Biological Science (MPF IVA)	<u>3</u>
	17

Second Semester

CHM 142 College Chemistry	3
CHM 145 College Chemistry Laboratory	2
ENG 112 Composition and Literature (MPF I)	3
MTH 251 Calculus II	4
EAS 102 Problem Solving & Design	<u>3</u>
	15

Summer Semester

PHY 181.P The Physical World (MPF IVB)	4
ECO 201 Principles of Microeconomics (MPF IIC)	<u>3</u>
	7

**Second Year**

First Semester

PCE 201 Principles of Pulp and Paper	3
PCE 219 Statics and Mechanics of Materials <b>or</b> MME 211 Static Modeling of Mechanical Systems	3
CHM 231 Organic Chemistry and Lab	4
MTH 245 Differential Equations/Engineers	3
PHY 182.P The Physical World (MPF IVB)	<u>4</u>
	17

Second Semester

PCE 202 Pulp and Paper Physics	3
PCE 204 Materials and Energy Balances	3
PCE/MME 313 Fluid Mechanics	3
PCE/MME 314 Engineering Thermodynamics	3
STA 368 Introduction to Statistics	<u>4</u>
	16

**Third Year**

First Semester

Miami Plan US (MPF IIIA)	3
ENG 313 Introduction to Technical Writing	3
MKT 291 Principles of Marketing	3
MGT 302 Operations Management	3
PCE/MME 341 Engineering Economics	<u>3</u>
	15

Second Semester

ECO 202 Principles of Macroeconomics (MPF IIC)	3
Miami Plan Fine Arts Course (MPF IIA)	3
PCE 301 Pulp and Paper Chemistry	3
PCE 311 Unit Operations Lab I	2
ACC 221 Intro to Financial Accounting	3
MGT 291 Organ Behavior and Theory	<u>3</u>
	17

**Fourth Year \***

First Semester

PCE 490 Special Topic	1
PCE 404 Papermaking	3
Miami Plan Thematic Sequence	3
EGM/MGT 311 Project Management	3
Management Track Course	3
PCE 471 Engineering Design I	1
PCE 482 Process Control	<u>3</u>
	18

Second Semester

COM 135 Public Express/Critical Inq (MPF IIB)	3
Management Track Course	3
Miami Plan World Cultures Course (MPF IIIB)+	3
PCE 472 Engineering Design II	2
Engineering Elective (PCE)	3
Miami Plan Thematic Sequence	<u>3</u>
	17

**PCE Courses** (select one)

- PCE 405 Industrial Environmental Control
- PCE 490 Special Topics

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 with a minimum of 3 hours in each (COM 135 fulfills 3 hours of the humanities requirement; ECO 201, 202 fulfills 6 hours of the social science requirement); 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, 142, 144, 145 more than fulfill the Physical Science requirement); 3 hours of Mathematics, Formal Reasoning or Technology (MTH 151 fulfill 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 fulfills this capstone requirement).

This sample curriculum lists 6 hours of the 9-hour thematic sequence requirement. It is assumed that the first 3 hours are utilized as a Miami Plan foundation requirement. Selection of some thematic sequences may reduce overall number of hours required from that shown above. Minimum of 128 hours is required for degree completion.

**SAMPLE CURRICULUM  
ENGINEERING MANAGEMENT  
ENVIRONMENTAL ENGINEERING TECHNICAL SPECIALTY \***

**2009-2010**

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

**First Year**

First Semester

CHM 141 College Chemistry (MPF IVB)	3
CHM 144 College Chemistry Laboratory (MPF IVB)	2
ENG 111 College Composition (MPF I)	3
MTH 151 Calculus I or 153 Calculus I (MPF V)	5
EAS 101 Computing, Engineering & Society	1
Miami Plan Biological Science (MPF IVA)	<u>3</u>
	17

Second Semester

CHM 142 College Chemistry	3
CHM 145 College Chemistry Laboratory	2
ENG 112 Composition and Literature (MPF I)	3
MTH 251 Calculus II	4
EAS 102 Problem Solving & Design	<u>3</u>
	15

Summer Semester

PHY 181.P The Physical World (MPF IVB)	4
ECO 201 Principles of Microeconomics (MPF IIC)	<u>3</u>
	7

**Sophomore Year**

First Semester

CHM 231 Organic Chemistry and Lab	4
PCE 219 Statics and Mechanics of Materials <b>or</b> MME 211 Static Modeling of Mechanical Systems	3
PCE 244 Introduction to Environmental Engineering	3
MTH 245 Differential Equations for Engineers	3
PHY 182.P The Physical World (MPF IVB)	<u>4</u>
	17

Second Semester

PCE 204 Material & Energy Balances	3
PCE/MME 313 Fluid Mechanics	3
PCE/MME 341 Engineering Economics	3
STA 368 Introduction to Statistics	4
PCE/MME 314 Engineering Thermodynamics	<u>3</u>
	16

**Junior Year**

First Semester

ECO 202 Principles of Macroeconomics (MPF IIC)	3
ENG 313 Intro to Technical Writing	3
MKT 291 Principles of Marketing	3
MGT 302 Operations Management	3
Miami Plan Fine Arts Course (MPF IIA)	<u>3</u>
	15

Second Semester

COM 135 Public Express/Critical Inquiry (MPF IIB)	3
MGT 291 Organizational Behavior and Theory	3
PCE 311 Unit Operations Laboratory I	2
PCE 415 Chemical Kinetics and Reactor Design	3
PCE 441 Pollution Prevention in Environ Mgt	<u>3</u>
	14

**Senior Year \***

First Semester

ACC 221 Introduction to Financial Accounting	3
Miami Plan U.S. Cultures Course (MPF IIIA)	3
PCE 405 Industrial Environmental Control	3
PCE 471 Engineering Design I (MPC)	1
EGM/MGT 311 Project Management	3
Miami Plan Thematic Sequence	<u>3</u>
	17

Second Semester

Management Track Course	3
Management Track Course	3
PCE 472 Engineering Design II (MPC)	2
PCE 442 Air Pollution Control	3
Miami Plan World Cultures Course (MPF IIIB)+	3
Miami Plan Thematic Sequence	<u>3</u>
	17

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 with a minimum of 3 hours in each (COM 135 fulfills 3 hours of the humanities requirement; ECO 201, 202 fulfills 6 hours of the social science requirement); 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, 142, 144, 145 more than fulfill the Physical Science requirement; BOT 131 fills the biological science requirement); 3 hours of Mathematics, Formal Reasoning or Technology (MTH 151 fulfill 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 fulfills this capstone requirement).

This sample curriculum lists 6 hours of the 9-hour thematic sequence requirement. It is assumed that the first 3 hours are utilized as a Miami Plan foundation requirement. Selection of some thematic sequences may reduce overall number of hours required from that shown above. Minimum of 128 hours is required for degree completion.

**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 THERMODYNAMICS (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, psychrometry, 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 ENVIRONMENTAL 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 403, 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 CHEMICAL 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 learn 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.