

**ENGINEERING MANAGEMENT
INTERDISCIPLINARY BACCALAUREATE PROGRAM**

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

**SCHOOL OF ENGINEERING & APPLIED SCIENCE
MIAMI UNIVERSITY**

2006-07

For the Manufacturing technical specialty, contact the Department of Manufacturing & Mechanical Engineering, 56 Engineering Building (513-529-0710) or visit our web page <http://www.eas.muohio.edu/mme>. For the Paper Science and Environmental Engineering technical specialties, contact the Department of Paper Science & Engineering, 64 Engineering Building (513-529-0760) or visit our web page <http://www.eas.muohio.edu/pse>.

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.

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
2006-2007

English (9 hours)

ENG 111 College Composition
ENG 112 Composition and Literature
ENG 313 Intro to Technical Writing

**Mathematics/Statistics & Computer Science
(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
MGT 432 Purchasing & Materials Management
MGT 433 Adv Topics in Purchasing/Materials Mgt
Human Resources Track
MGT 303 Human Resources Management
MGT 405 Management-Union Relations Entrepreneurship
Track
BUS 408 Entrepreneurship for Engineers & Scientists
MKT 481 Product Planning & Strategy

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

Engineering Science Courses (22 hours)

EAS 101 Computing, Engineering & Society
EAS 102 Problem Solving & Design
PSE 204 Material and Energy Balances
PSE 219 Static and Mechanics of Materials
MME/PSE 314 Engineering Thermodynamics
MME/PSE 341 Engineering Economics
MME/PSE 313 Fluid Mechanics

Integrative Core Courses (6-9 hours)

EGM/MGT 311 Project Management
Engineering Design Capstone Courses
PSE requires PSE 411
ENV requires PSE 471, 472

**Engineering Specialty Courses (20-21 hours)
(Choose one Technical Specialty area)**

Paper Science & Engineering: 21 hours

PSE 201 Principles of Paper Science & Engineering
PSE 202 Pulp, Paper and Products
PSE 301 Pulping
PSE 311 Unit Operations Laboratory I
PSE 404 Papermaking
PSE 482 Process Control
Choose two of the following five courses:
PSE 403 Heat Transfer
PSE 405 Industrial Environmental Control
PSE 415 Chemical Kinetics & Reactor Design
PSE 425 Surface & Colloid Science of Papermaking
PSE 461 Coating Technology

Environmental Engineering: 17 hours

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

**SAMPLE CURRICULUM
ENGINEERING MANAGEMENT
PAPER SCIENCE TECHNICAL SPECIALTY
2006-07**

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

PSE 201 Principles of Paper Science & Engineering	2
PSE 219 Statics and Mechanics of Materials	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>
	16

Second Semester

PSE 202 Pulp, Paper and Products	2
PSE 204 Materials and Energy Balances	3
ENG 313 Introduction to Technical Writing	3
MME/PSE 313 Fluid Mechanics	3
MME/PSE 314 Engineering Thermodynamics	3
MME/PSE 341 Engineering Economics	<u>3</u>
	17

Third Year

First Semester

PSE 301 Pulping	3
PSE 311 Unit Operations Lab I	2
MKT 291 Principles of Marketing	3
MGT 302 Operations Management	3
STA 368 Introduction to Statistics	<u>4</u>
	15

Second Semester

ECO 202 Prin of Macroeconomics (MPF IIC)	3
Miami Plan Fine Arts Course (MPF IIA)	3
Miami Plan US (MPF IIIA)	3
ACC 221 Intro to Financial Accounting	3
MGT 291 Organ Behavior and Theory	3
Engineering Electives (PSE)	<u>3</u>
	18

Fourth Year

First Semester

Engineering Elective (PSE)	3
PSE 404 Papermaking	3
Miami Plan Thematic Sequence	3
EGM/MGT 311 Project Management	3
Management Track Course	<u>3</u>
	15

Second Semester

COM 135 Public Express/Critical Inq (MPF IIB)	3
Management Track Course	3
Miami Plan World Cultures Course (MPF IIIB)+	3
PSE 411 Advanced Paper Manufacturing (MPC)	3
PSE 482 Process Control	3
Miami Plan Thematic Sequence	<u>3</u>
	18

*** PSE Courses** (select two)

- PSE 403 Heat Transfer
- PSE 405 Industrial Environmental Control
- PSE 425 Surface & Colloid Science of Papermaking
- PSE 461 Coating Technology

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) (PSE 411 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*
2006-07**

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

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
PSE 219 Statics and Mechanics of Materials	3
PSE 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

Junior Year

First Semester

MKT 291 Principles of Marketing	3
MME/PSE 341 Engineering Economics	3
STA 368 Introduction to Statistics	4
MGT 302 Operations Management	3
PSE 311 Unit Operations Laboratory I	<u>2</u>
	15

Senior Year

First Semester

ACC 221 Introduction to Financial Accounting	3
Miami Plan U.S. Cultures Course (MPF IIIA)	3
PSE 405 Industrial Environmental Control	3
PSE 471 Engineering Design I (MPC)	1
EGM/MGT 311 Project Management	3
Miami Plan Thematic Sequence	<u>3</u>
	16

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

Second Semester

ENG 313 Intro to Technical Writing	3
PSE 204 Material & Energy Balances	3
MME/PSE 313 Fluid Mechanics	3
MME/PSE 314 Engineering Thermodynamics	3
Miami Plan Fine Arts Course (MPF IIA)	<u>3</u>
	15

Second Semester

ECO 202 Principles of Macroeconomics (MPF IIC)	3
COM 135 Public Express/Critical Inquiry (MPF IIB)	3
MGT 291 Organizational Behavior and Theory	3
PSE 415 Chemical Kinetics and Reactor Design	3
PSE 441 Pollution Prevention in Environ Mgt	<u>3</u>
	15

Second Semester

Management Track Course	3
Management Track Course	3
PSE 472 Engineering Design II (MPC)	2
PSE 442 Air Pollution Control	3
Miami Plan World Cultures Course (MPF IIIB)+	3
Miami Plan Thematic Sequence	

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) (PSE 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 - 2006-07
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 PAPER SCIENCE AND ENGINEERING (2) 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: EAS 101, 102 or instructor approval.

PCE 202 PULP, PAPER, AND PRODUCTS (2) Discovery of how pulping, papermaking, and converting are utilized to develop the required performance properties of products from paper. Conduct laboratory investigations to determine properties of paper, conduct a paper machine run, and carry out a handsheet study. Prerequisite: PCE 201, or instructor approval.

PCE 204 MATERIAL AND ENERGY BALANCE (3) Techniques used to calculate material and energy balances with special emphasis on paper industry applications. Prerequisite: grade of C- or better in CHM 141, 142, and MTH 151, 251. 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. Prerequisites: PHY 181, EAS 102.

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 PULPING (3) Detailed discussion of mechanical and chemical pulping processes and chemical and engineering principles involved. Prerequisite: CHM 252 or a grade of C- or better in CHM 231 or CHM 251.

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 paper industry. Both oral and written laboratory reports required. Prerequisite: A grade of C- or better in PCE 204. Co-requisite: PCE/MME 313.

PCE 312 UNIT OPERATIONS LABORATORY II (2) Laboratory course consisting of experiments and computer simulations in areas of advanced material and energy balances, heat transfer, pulping, and paper coating. Emphasis on the process control practices of paper industry. Both written and oral laboratory reports required. Prerequisites: a grade of C- or better in PCE 313. Co-requisite: PCE 301, 403.

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, PCE 219 or MME 211 or permission of instructor. 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 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 or PCE 204. Co-requisite: STA 368. 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: grade of C- or better in PCE/MME 313, MTH 245, PCE/MME 314.

PCE404 PAPERMAKING (3) Papermaking process with emphasis on chemical engineering principles involved. Prerequisite: grade of C- or better in PCE 313 and credit for PCE 202. Co-requisite: PCE 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. Prerequisite: A grade of C- or better in PCE 204, PCE/MME 313. Co-requisite: PCE 311.

PCE 411 ADVANCED PAPER MANUFACTURING (3) Provides students with the opportunity to synthesize their accumulated knowledge and skills in paper science, paper engineering, economics, statistical methods, environmental technology, writing, oral presentations, safety, ethical standards, and teamwork fundamentals. Student teams determine the raw materials and processing conditions required to produce paper that matches a sample of "unknown paper." Prerequisite: senior standing and PCE 404, or by permission of the instructor.

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 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, screening, showering, and pump sizing. Prerequisite: grade of C- or better in PCE 403 and MME/PCE 341.

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 204, 313, 314, MTH 245.

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: PCE 204, MTH 245, CHM 332 or by permission of the instructor

PCE 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: PCE 204, MTH 245, PCE 414 or by permission of the instructor

PCE 425/525 SURFACE AND COLLOID SCIENCE OF PAPER MAKING (3) Covers basic concepts associated with papermaking process and properties of paper. Includes descriptions of basic colloid properties of fibers, fines, and other papermaking materials. Prerequisite: grade of C- or better in CHM 231 or CHM 251.

PCE 441/551 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. Prerequisites: PCE 204 and Junior standing Co requisite: PCE/MME 341 is recommended.

PCE 442/552 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 204, 313, 314, and 341.

PCE 461/561 COATING TECHNOLOGY (3) Methods used in coating paper and properties of coating formulation. Prerequisite: PCE 202, PCE 313.

PCE 471, 472 ENGINEERING DESIGN I & II (2,2) 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 (environmental impact, economical and social factors, marketability, ergonomics, safety, aesthetics, and ethics) 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 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 313, 314, 341, 403.

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. Prerequisite: PCE 312 and grade of C- or better in PCE/MME 313, 314 and MTH 245.

PCE 600 GRADUATE SEMINAR (1: maximum 6) Required of all graduate students in the Department of Paper and Chemical Engineering. Student preparation and presentation of lectures on scientific and engineering topics related to thesis research areas. Prerequisite: graduate standing.

PCE 612 CHEMICAL ENGINEERING ANALYSIS (3) Analytical considerations involving the construction and solutions of mathematical models of heat and mass transfer diffusions and convection, mass and energy balance, and simultaneous mass and heat transfer mechanisms relevant to catalysis and chemical reactor design. The analytical methods will cover the modeling of unsteady state engineering problems. Prerequisite: PCE 403, 414 415 (or equivalent) and graduate standing or instructor approval.

PCE 613 FLUID MECHANICS (3) Introduction to unit operations as applied to paper industry with emphasis on fluid mechanics. Designed for graduate student with non-engineering background. Prerequisite: graduate standing.

PCE 620 PAPERMAKING (1-4) Study of papermaking process with emphasis on chemical and engineering principles involved. Students expected to study pertinent technical literature in addition to completing class assignments. Prerequisite: graduate standing and permission of chair.

PCE 621 PAPER PHYSICS (3) Study of the fundamental factors that govern the physical, mechanical, transport, and optical properties of paper. Explore how materials, the papermaking process, and converting impact the performance of paper. Prerequisite: PCE 620, equivalent, or permission of the instructor.

PCE 630 PULPING (1-4) Study of mechanical and chemical pulping processes with emphasis on chemical and engineering principles involved. Prerequisite: graduate standing and permission of chair.

PCE 690 GRADUATE RESEARCH (1-12) Prerequisite: graduate standing and permission of chair.

PCE 700 RESEARCH FOR MASTER'S THESIS (1-16)

PCE 710 INDUSTRIAL PRACTICUM (1-12) Analysis and solution of an industrial problem.