APPENDIX A – COURSE SYLLABI

Chemistry
Mathematics
Physics
Paper Science and Engineering

NOTE: The typeface size may vary on the syllabi to allow a one-page presentation of the required elements.

CHEM 115: General and Inorganic Chemistry
Required
Catalog Description
Laws and principles of chemistry including atomic and molecular structure, review of stoichiometry, descriptive inorganic chemistry of the representative and transition elements, chemical equilibria, electrochemistry, thermodynamics, and chemical kinetics.

Prerequisites
One yr high school chemistry grade C or better; Math 118 or con reg or cons chemistry chair; or placement in 119 or higher.

Textbook
Moore, Stanitski, Jurs. Chemistry: the Molecular Science 2nd ed.; Thomson Learning Inc.: Belmont, CA, 2005.

Course Learning Outcomes (from syllabus as distributed to students)
Learn the chemistry fundamentals that you need for success in later science classes
Understand the importance of chemical measurements (significant figures; units; calculations) in recording and reporting experimental data
Understand the important models and concepts used by chemists to describe atoms, molecules and chemical reactions
Learn the general concepts of physical, inorganic, organic, and analytical chemistry and biochemistry
Develop the ability to apply the fundamental concepts to problems in biochemistry, engineering, geochemistry, materials science, environmental science, medicine, forensic science and other related fields
Develop an appreciation for the many ways that chemistry affects your daily lives

Topics Covered
The Nature of Chemistry
Atoms and Elements
Chemical Compounds
Quantities of Reactants and Products
Chemical Reactions
Energy and Chemical Reactions
Electron Configurations; Periodic Table
Covalent Bonding
Molecular Structures
Gases and the Atmosphere

Course Schedule
3 hours lecture, 1 hour discussion, 3 hours lab per week

Contribution to ABET Criterion 5
This course contributes to the math and basic sciences component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data

Description Prepared by:
Karyn Biasca
6/25/08

CHEM 116: General and Inorganic Chemistry
Required
Catalog Description
Laws and principles of chemistry including chemical equilibria, electrochemistry, thermodynamics, and chemical kinetics covered this semester.

Prerequisites
CHEM 115

Textbook
Moore, Stanitski, Jurs Chemistry: the Molecular Science 2nd ed.; Thomson Learning Inc.: Belmont, CA, 2005.

Course Learning Outcomes (from syllabus as distributed to students)
Learn the chemistry fundamentals that you need for success in later science classes
Understand the importance of chemical measurements (significant figures; units; calculations) in recording and reporting experimental data
Understand the important models and concepts used by chemists to describe atoms, molecules and chemical reactions
Learn the general concepts of physical, inorganic, organic, and analytical chemistry and biochemistry
Develop the ability to apply the fundamental concepts to problems in biochemistry, engineering, geochemistry, materials science, environmental science, medicine, forensic science and other related fields
Develop an appreciation for the many ways that chemistry affects your daily lives

Topics Covered
Liquids, Solids and Materials
Fuels, Organic Chemicals and Polymers
The Chemistry of Solutes and Solutions
Chemical Kinetics: Rates of Reactions
Chemical Equilibrium
Thermodynamics: Directionality of Chemical Reactions
Acids and Bases
Additional Aqueous Equilibria
Electrochemistry and Its Applications

Course Schedule
3 hours lecture, 1 hour discussion, 3 hours lab per week

Contribution to ABET Criterion 5
This course contributes to the math and basic sciences component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data

Description Prepared by:
Karyn Biasca
6/25/08

CHEM 248: Quantitative Analysis
Required
Catalog Description
Theory and methods of quantitative chemical analysis including effects of chemical equilibria on quantitative separations, titration curves, polyprotic acids and buffers, and oxidation-reduction processes.

Prerequisites
CHEM 116

Textbook

Quantitative Chemical Analysis, 7th Ed. , by Daniel C. Harris

Laboratory Manual: Quantitative Analysis Experiments

Course Learning Outcomes (from syllabus as distributed to students)

Introduce students to techniques of quantitative analysis.

Topics Covered

Statistics and data analysis, acid-base equilibrium, gravimetric analysis, complexation reactions, spectroscopy, electrochemistry, and chromatography

Course Schedule
2 hours lecture, 6 hours lab per week

Contribution to ABET Criterion 5
This course contributes to the math and basic sciences component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data

Description Prepared by:
Karyn Biasca
6/25/08

CHEM 325: Organic Chemistry
Required
Catalog Description
Structure, conformation, stereochemistry, properties and reactions of organic compounds. Structure-property relationships and reaction mechanisms and their application in the study of a broad range of representative functional groups and compounds including carbohydrates, polymers, amino acids and proteins. Retrosynthetic analysis and spectroscopic characterization of organic modules.

Prerequisites
116

Textbook
"Organic Chemistry", Eighth Edition by T. W. Graham Solomons and Craig B. Fryhle, John Wiley & Sons, 2004

Course Learning Outcomes (from syllabus as distributed to students)
Students will describe the structure and function of simple organic molecules and explain the importance of stereochemistry.
Students will propose products and reasonable mechanisms for chemical reactions based on a fundamental understanding of organic chemistry.
Students will propose synthesis of simple molecules.
Students will use spectral data to identify organic compounds.
Students will safely prepare and characterize organic compounds and appropriately document and present their laboratory work.

Topics Covered
This first semester of organic chemistry will serve as an introduction to organic structure and function beginning with Lewis structures, resonance forms, atomic orbitals and molecular orbitals. Students will learn how different properties, such as boiling point, melting point, and acidity can arise from different organic functional groups. We will study the conformations of linear alkanes, cycloalkanes, and the stereochemistry of organic molecules to better understand the three-dimensionality of organic molecules. Students will learn how to identify molecules using modern instrumentation such as gas chromatographs (GC) as well as infrared (IR) and nuclear magnetic resonance (NMR) spectrometers. Finally, students will be shown how organic structure relates to reactivity in substitution, elimination and addition reactions. The semester will end with a brief introduction to free radical chemistry.

Course Schedule
3 hours lecture, 3 hours lab per week

Contribution to ABET Criterion 5
This course contributes to the math and basic sciences component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data

Description Prepared by:
Karyn Biasca
6/25/08

CHEM 326: Organic Chemistry
Required
Catalog Description
Continuation of 325

Prerequisites
CHEM 325

Textbook
"Organic Chemistry", Eighth Edition by T. W. Graham Solomons and Craig B. Fryhle, John Wiley & Sons, 2004

Course Learning Outcomes (from syllabus as distributed to students)
Students will propose reasonable mechanisms for chemical reactions based on a fundamental understanding of organic chemistry.
Students will propose synthesis of simple molecules and include the use of protecting groups as necessary.
Students will describe the structure and function of simple bioorganic molecules.
Students will demonstrate the ability to read aspects of organic chemistry in scientific journals.
Students will learn to use MacSpartan for HOMO/LUMO calculations.
Students will safely prepare and characterize organic compounds and appropriately document and present their laboratory work.

Topics Covered
Students will build upon what they have learned in Chem 325 to understand the reactivity of alcohols and ethers. Then, for the first time, students will be introduced to the reactivity of carbonyl compounds and the idea of reactions initiated by anion reactivity rather than cation reactivity. This concept will reappear in discussions of the Wittig reaction, Aldol reactions, Michael additions, and a host of other reactions. Students will also learn about the reactivity and properties of aromatic rings and other conjugated systems. Finally, students will be introduced to the role of organic chemistry in natural systems such as carbohydrates, lipids and amino acids..

Course Schedule
3 hours lecture, 3 hours lab per week

Contribution to ABET Criterion 5
This course contributes to the math and basic sciences component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data

Description Prepared by:
Karyn Biasca
6/25/08

CHEM 335: Physical Chemistry
Required
Catalog Description
Laws and principles of physical chemistry including atomic and molecular structure, thermodynamics, kinetics.

Prerequisites
326, MATH 222, PHYS 250

Textbook

Ball, David W., Physical Chemistry, Brooks/Cole , Pacific Grove, CA, 2003.

Laboratory Text. Garland, Nibler and Shoemaker, Experiments In Physical Chemistry 7th, McGraw-Hill, New York, 2003.

Course Learning Outcomes (from syllabus as distributed to students)
None listed on syllabi

Topics Covered
Chem 335 will cover thermodynamics and kinetics. Laboratory work will illustrate physical chemistry principles including thermochemical and electrochemical measurements, kinetics, and bulk properties of matter.

Course Schedule
3 hours lecture, 3 hours lab per week

Contribution to ABET Criterion 5
This course contributes to the math and basic sciences component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data

Description Prepared by:
Karyn Biasca
6/25/08

MATH 120: Analytic Geometry and Calculus I
Required
Catalog Description
Analytic geometry of the plane; differentiation and integration of algebraic functions with some applications.

Prerequisites
118 and 119 or suitable placement score

Textbook
Calculus: Early Transcendentals, 5th ed. by James Stewart

Course Learning Outcomes (from syllabus as distributed to students)
To gain a basic understanding of the topics in Chapters 1 – 5 of the text.
To be able to think and communicate better mathematically through the study of calculus.

Topics Covered
Functions and Models (REVIEW MATERIAL)
Limits and Derivatives
Differentiation Rules
Applications of Differentiation
Integrals

Course Schedule
4 hours lecture per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering

Description Prepared by:
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6/24/08

MATH 121: Analytic Geometry and Calculus II
Required
Catalog Description
Analytic geometry of the plane continued; differentiation and integration of transcendental functions; integration techniques; differential equations; infinite series; additional applications.

Prerequisites
120

Textbook
Calculus: Early Transcendentals, 5th ed. by James Stewart

Course Learning Outcomes (from syllabus as distributed to students)
To gain a basic understanding of the topics in Chapters 6 – 9 and 11 of the text.
To be able to think and communicate better mathematically through the study of calculus.

Topics Covered
Applications of integration
Techniques of integration
Further applications of integration
Differentiation
Infinite sequences and series

Course Schedule
4 hours lecture per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering

Description Prepared by:
Karyn Biasca
6/24/08

MATH 222: Analytic Geometry and Calculus III
Required
Catalog Description
Introduction to solid analytic geometry; differentiation of functions of several variables; multiple integrals; parametric equations and vectors; applications.

Prerequisites
121

Textbook
Calculus: Early Transcendentals, 5th ed. by James Stewart

Course Learning Outcomes (from syllabus as distributed to students)
To gain a basic understanding of the topics in Chapters 10 and 12-15 of the text.

Topics Covered
Parametric equations and polar coordinates
Vectors and the geometry of space
Vector functions
Partial derivatives
Multiple integrals

Course Schedule
4 hours lecture per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering

Description Prepared by:
Karyn Biasca
6/24/08

MATH 320: Differential Equations
Required
Catalog Description
Introduction to ordinary differential equations of the first and second order; linear equations with constant coefficients; solution in series; numerical approximations; Laplace transforms; system of ordinary equations; selected applications.

Prerequisites
222

Textbook
Zill, A First Course in Differential Equations, 9e

Course Learning Outcomes (from syllabus as distributed to students)
None listed in syllabus.

Topics Covered
Review of first-order separable and linear ordinary differential equations from second-semester calculus.
Related applications: Mixing problems, population growth, logistic model
Exact differential equations, with integrating factors.
Miscellaneous first-order techniques: Substitution, homogenous equations, Bernoulli equations, first-order Euler.
Second-order homogeneous equations with constant coefficients.
Second-order nonhomogeneous equations with constant coefficients, theory and solution form.
Using the Method of Variation of Parameters for constructing particular solutions to nonhomogeneous equations.
Using the Method of Undetermined Coefficients for constructing particular solutions to nonhomogeneous equations.
Generalization to higher-order equations with constant coefficients and the method of elimination for systems.
Related applications: Two-stage cascade reactions, spring problems, electrical networks.
Laplace transforms of products of polynomials and exponential functions.
Laplace transforms of products including Heavyside and Dirac Delta Functions.
The convolution integral.
Series methods.

Course Schedule
3 hours lecture per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering

Description Prepared by:
Karyn Biasca
6/24/08

PHYS 150: University Physics I
Required
Catalog Description
Mechanics, heat, and sound.

Prerequisites
MATH 120

Textbook
Principles of Physics by Serway & Jewett

Course Learning Outcomes (from syllabus as distributed to students)
The goals of this course are to (a) understand the conceptual framework underpinning that branch of physics known as classical mechanics, (b) apply fundamental principles of physics to the solution of practical problems, and (c) develop laboratory techniques useful to science and engineering disciplines.

Topics Covered
Introduction and Vectors
1 Dimensional Motion
2 Dimensional Motion
Newton's Laws of Motion
Applications of Newton's Laws
The Concept of Energy
Potential Energy
Momentum and Collisions
Rotational Motion
Rotational Motion
Gravity, Orbits, and Hydrogen
Fluid Mechanics
Oscillatory Motion
Mechanical Waves
Standing Waves

Course Schedule
3 hours lecture, 1 hour discussion, 3 hours lab per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering

Description Prepared by:
Karyn Biasca
6/24/08

PHYS 250: University Physics II
Required
Catalog Description
Electricity, magnetism, and optics.

Prerequisites
150, MATH 121

Textbook
Principles of Physics by Serway & Jewett
Lab manual

Course Learning Outcomes (from syllabus as distributed to students)
1. Make a connection between the conceptual, mathematical, and experimental aspects of physics. This means you will be able to
   - Solve problems using both numbers and/or variables
   - Design Simple experiments and prove they work
   - Analyze and Interpret Data taken from experiments or given to you.
2. Explain the ideas of physics to each other using words and relationships
3. Describe how physics applies to various useful devices in the world around us, including both common and scientific devices..

Topics Covered
Electric Force, Electric Field, Electric Potential and Electric Circuits
Magneitic Forces and Fields, Faraday's Law and Lenz's Law
Reflection, Refraction, Image Formation, and Interference
Temperature, Heat, Internal Energy and Entropy

Course Schedule
3 hours lecture, 1 hour discussion, 3 hours lab per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering

Description Prepared by:
Karyn Biasca
6/24/08

PAPR 103: Paper, Society and the Environment
Elective
Catalog Description
Study lifecycle of paper; raw materials; manufacturing; economic impact on society, recycling and sustainability; alternative disposal methods; impact on environment; policy and politics of pulp and paper industry.

Prerequisites
None

Textbook
Online readings

Course Learning Outcomes (from syllabus as distributed to students)
1) Knowledge of the history of paper in society
2) Understanding of the basic principles of economics
3) Learn how principles of economics affect manufacturing industries such as the paper industry
4) Acquire a rudimentary understanding of pulp and paper processes
5) Learn the life cycle of paper
6) Understand environmental and economic challenges facing the paper industry
7) Learn how environmental policy is created through interactions between government, industry, and environmental groups

Topics Covered
Critical thinking and environmental policy
Environmental policy and the paper industry
Environmental activism and the paper industry
Introduction to economic principles
History of paper and use by society
Current use of paper and consumer products by society
Forest management – practical and economic considerations
Pulp and paper manufacture and economic implications
Paper recovery and the recycling process
Economics of recycling vs. virgin paper
Past paper industry environmental challenges and solutions
Current paper industry environmental challenges
Climate change
Life cycle analysis
Sustainability

Course Schedule
Lecture, 3 hrs/week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Karyn Biasca
6/3/08

PAPR 105: Freshman Forum
Not Required
Catalog Description
Orientation to technical and professional aspects of paper and allied industries; presentations by students, faculty, and guest lecturers.

Prerequisites
None

Textbook
None

Course Learning Outcomes (from syllabus as distributed to students)
Introduction to the pulp and paper industry

Topics Covered
Pulp and Paper Industry Careers
Orientation to College
Commercial Facility Tours
Simple Engineering Design Project

Course Schedule
One 50 minute lecture per week. Commercial facility tours are done in local mills to accommodate the 50 minute period.

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(c) the ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) the ability to function on multi-disciplinary teams
(e) the ability to identify, formulate, and solve engineering problems
(f) the understanding of professional and ethical responsibility
(j) a knowledge of contemporary issues
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Description Prepared by:
Don Guay
6/4/08

PAPR 210: Pulp and Paper Laboratory Methods
Required
Catalog Description
Laboratory methods in pulp, paper, and nonfibrous testing; microscopic techniques; emphasis on statistical analysis of data.

Prerequisites
CHEM 116 or CHEM 106

Textbook
Course laboratory descriptions, test methods, and key documents are located in a D2L webpage which all students enrolled in PAPR 210 have access to.

Course Learning Outcomes (from syllabus as distributed to students)
This course is not the type of lab course that you will experience in chemistry, physics, or biology. Getting the "right" answer is neither the objective nor the requirement for a good grade. Your goal is to become familiar with the important laboratory techniques and testing procedures used in the pulp and paper industry. This course is the first of two writing emphasis courses you will take in Paper Science. So naturally, the intent is to have you develop excellent written communication skills.

You will use a "Mill" memo format for your writing. This format will give you experience with the way things are actually written on the job. This course will not require you to spend hours in the library to write a theory section. You will write a research paper when you are a junior in Paper Science. In this course, you will acquire a skill that you will use in your coop, summer job, and actual working experience.

You will work hard in this course. You will experience frustration because you are learning a new skill. Paper Science takes its writing-emphasis program seriously. I expect you to work on your own. You can get a good grade in this course if you follow these simple rules. In this course, I will recognize and reward the amount of work that everyone will have done when assigning the grades.

Organization is a vital key when undertaking laboratory projects. This class requires the purchase of a laboratory notebook for entering all data generated during each lab. I expect you to read each laboratory exercise in advance of coming to class each week. To demonstrate this, you must prepare blank data tables in your laboratory notebook each week before any testing begins. Record all data in permanent ink when performing each lab. This may seem like a silly detail, but permanent ink is a requirement in virtually every research lab in the pulp and paper industry.

Topics Covered
Technical Writing, Proper Research Notebook Usage, Data Analysis, Pulping Chemistry, Papermaking, Optical Paper Testing Procedures, Mechanical Paper Testing Procedures, Physical Paper Testing Procedures

Course Schedule
One 50 minute lecture per week and one 4 hour laboratory exercise per week. Lecture time is reserved for discussing technical writing skills, data analysis, and the upcoming laboratory exercise. During the laboratory session, students are split into groups to complete the tasks outline in lab procedures.

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data
(d) the ability to function on multi-disciplinary teams
(g) the ability to communicate effectively
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Don Guay
6/4/08

PAPR 215: Introduction to Process Engineering Calculations
Required
Catalog Description

Basic principles and techniques of engineering problem formulation and solution; material and energy balances, including chemical reactions and studies of advanced systems; thermodynamic properties and engineering data information management; introduction to computer modeling and simulation; applications to pulp and papermaking process engineering.

Prerequisites
Chem 116, PAPR 210

Textbook
Elementary Principles of Chemical Processes, Felder and Rousseau, Third Edition

Course Learning Outcomes (from syllabus as distributed to students)

Your objective, as a successful student in this course, is to become proficient at solving material and energy balance problems. When you are a proficient problem solver, you are able to:

- read and understand problem statements
- correctly draw and label a process flow diagram
- perform scientific and engineering calculations correctly
- determine physical properties of process streams
- recognize the problem type
- devise appropriate solution strategies, recognize dead ends (and use an alternate strategy) and
- find a correct answer to the problem ON YOUR OWN.

Topics Covered
Chapters 1-9 of Felder and Rousseau
Material balances procedures on steady-state systems, with and without chemical reactions.
Energy balance procedures on steady-state systems, with and without chemical reactions.

Course Schedule
Classroom: 4 hrs per week.

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
This course contributes to program outcomes:
(a): the ability to apply knowledge of mathematics, science, and engineering
(c): the ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d): the ability to function on multi-disciplinary teams
(f): the understanding of professional and ethical responsibility
(j): a knowledge of contemporary issues
(k): the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l): knowledge of the science and technology used in the paper industry

Description Prepared by:
Karyn Biasca
6/3/08

PAPR 314: Engineering Statistical Design and Analysis
Required
Catalog Description
Statistical methods for design, analysis and improvement of engineering experimentation and process operation: experimental design, regression analysis, modeling, analysis of variance, and evolutionary operation.

Prerequisites
Junior standing in Paper Science and Engineering

Textbook
D.C. Montgomery, Runger, G.C., and Hubele, N.F, Engineering Statistics, John Wiley & Sons, Inc., Second Edition, 2001.

Course Learning Outcomes (from syllabus as distributed to students)
This course will cover engineering statistics. By the end of the course you will be expected design and conduct experiments and analyze and interpret data. The application of statistics is vital in a large variety of engineering projects. You will become familiar with the statistics functions in Excel and statistical software including Minitab and SPC XL. We will also cover the basics of lean/six sigma which is used by a good number of manufacturers to improve economic performance.

Topics Covered
Basic Statistics
Experimental Design
Hypothesis Testing
Analysis of Variance
Regression
Control Charts
Lean/Six Sigma Manufacturing Methodology

Course Schedule
Three 50 minute lectures per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data
(e) the ability to identify, formulate, and solve engineering problems
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Description Prepared by:
Don Guay
6/4/08

PAPR 320: Fluid Mechanics and Hydraulics
Required
Catalog Description
Properties of fluids; momentum transport phenomena; laminar and turbulent flow; measurement and control of flow; fluid machinery; engineering calculations and design; economic factors.

Prerequisites
PAPR 215, MATH 222, PHYS 150

Textbooks
W.L. McCabe, Smith, J.C., and Harriot, P., Unit Operations of Chemical Engineering, McGraw-Hill, 7th Edition, 2005.
Heald, C. C. ed., Cameron Hydraulic Data, Flowserve, 19th Edition, 2002.

Course Learning Outcomes (from syllabus as distributed to students)
Your objective in this class is to learn the basic concepts and theory of fluids and fluid flow and their applications to typical pulp and paper industry processes.

Topics Covered
Fluid Statics
Fluid Flow
Basic Equations of Fluid Flow
Incompressible Flow
Compressible Flow
Transportation and Metering of Fluids
Agitation and Mixing of Liquids

Course Schedule
Three 50 minute lectures per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(d) the ability to function on multi-disciplinary teams
(e) the ability to identify, formulate, and solve engineering problems
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Don Guay
6/4/08

PAPR 326: Heat Transfer Operations
Required
Catalog Description
Fundamental heat transfer mechanisms: conduction, convection, and radiation; heat transfer coefficients; heat exchange equipment; evaporation and evaporator systems; drying; economic factors; applications specific to pulp and paper processes; study of field operations.

Prerequisites
PAPR 320

Textbooks
W.L. McCabe, Smith, J.C., and Harriot, P., Unit Operations of Chemical Engineering, McGraw-Hill, 7th Edition, 2005.
Heald, C. C. ed., Cameron Hydraulic Data, Flowserve, 19th Edition, 2002.

Course Learning Outcomes (from syllabus as distributed to students)
This course will cover heat transfer. As engineers, you will be concerned with the efficient use of heat at some point during your career. Heat transfer will build upon your knowledge of math and science as an application of energy usage. At the end of this course you will be expected to design systems and identify and solve engineering problems related to the transfer of energy in the form of heat. We will design and analyze the performance of a heat exchanger.

Topics Covered
Heat Transfer by Conduction
Principles of Heat Flow in Fluids
Heat Transfer to Fluids Without Phase Change
Heat Transfer to Fluids With Phase Change
Heat-Exchange Equipment
Evaporation

Course Schedule
Three 50 minute lectures per week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(c) the ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(e) the ability to identify, formulate, and solve engineering problems
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Don Guay
6/4/08

PAPR 350: Wood and Pulping Technology
Required
Catalog Description
Cellulose, hemicelluloses, lignin, wood extractives, wood and fiber microstructure; commercial pulping and bleaching processes. Effective use of technical literature and presentation of information. 3 hrs lec, 3 hrs lab/disc per wk; field trips to commercial operations.

Prerequisites
PAPR 215 and CHEM 326

Textbooks
Eero Sjostrom, Wood Chemistry Fundamentals and Applications, Acedemic Press, 2nd Edition, 1981.
Hiroki Nanko, Alan Button, Dave Hillman, The World of Market Pulp, WOMP, 2005.

Course Learning Outcomes (from syllabus as distributed to students)
Your objective in this class is to learn wood chemistry and structure, pulping and bleaching chemistry, and commercial pulping and bleaching processes. Students are required to complete 2 writing assignments. This is a writing emphasis class so a significant portion of your grade will depend on these writing assignments. Each written assignment will also require an oral presentation. Both reports must follow the Paper Science writing style manual.

Topics Covered
Wood Chemistry
Forest Management
Woodyard Operations
Pulp Manufacturing
Pulp Bleaching
Technical Writing

Course Schedule
Three 50 minute lectures per week and one 3 hour laboratory exercise per week. Pulp mill field trips are accomplished during the scheduled laboratory period.

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(e) the ability to identify, formulate, and solve engineering problems
(g) the ability to communicate effectively
(i) a recognition of the need for, and the ability to engage in life-long learning
(j) a knowledge of contemporary issues
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Don Guay
6/4/08

PAPR 355: Paper and Fiber Physics
Required
Catalog Description
Fiber structure and properties; interfiber bonding; mechanical optical, chemical properties of paper; interrelations between structure, sheet formation, consolidation factors, and ultimate properties. Effective use of literature and presentation of information.

Prerequisites
PAPR 350

Textbook
The textbook for this course is “Introduction to Pulp and Paper Properties”, which is available as an e-book in the course folder. You may make one paper copy of this book.

Course Learning Outcomes (from syllabus as distributed to students)
This “Paper and Fiber Physics” course has two goals: first, to have you understand the papermaking process from the fundamental unit of paper, the fiber, to the completed paper product; second, to have you understand the strength and physical performance of paper as a hydrogen bond dominated material.

Topics Covered
Strength of materials
Fiber properties (dimensions, strength and bonding)
Formation of paper
The structure of paper
Physical properties
Mechanical properties
Optical properties

Course Schedule
Lecture, 3 hrs/week, lab 4 hrs/week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(b) the ability to design and conduct experiments, as well as to analyze and interpret data
(d) the ability to function on multi-disciplinary teams
(g) the ability to communicate effectively
(i) a recognition of the need for, and the ability to engage in life-long learning
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Gerard Ring
6/3/08

PAPR 365: Colloid and Surface Phenomena
Required
Catalog Description
Principles of colloid and surface chemistry; electrokinetic and base exchange phenomena; thermodynamics of interfacial systems; adsorption; applications to coatings, flocculation, fillers, and wet end additives.

Prerequisites
CHEM 335

Textbook
Swanson, J.W., Colloid Chemistry of Papermaking Materials, ed. G.J.F. Ring. 2003, Atlanta: TAPPI Press. 278.

Course Learning Outcomes (from syllabus as distributed to students)
The goal of this course is to understand the chemistry of the papermaking process and paper products by studying such topics as electrokinetic and base exchange phenomena; the thermodynamics of interfacial systems; adsorption; coating technology; flocculation, fillers, and wet end additives.

Topics Covered
Surface energy and surface tension
Adsorption and swelling -- general
Sorption and swelling of cellulosic materials in water and other media
Surface area of cellulose and cellulosic materials
The role of swelling and shrinkage in the bonding between cellulose fibers in papermaking
The base-exchange and electrokinetic properties of cellulose fibers
Flocculation in papermaking systems
Interactions between pulp fibers and other materials in the papermaking system -- wet end additives
Internal sizing of papers and paperboard
Sorption and retention of high molecular weight compounds on fibers and their effects on paper properties -- wet end additives
Pitch troubles in papermaking
Foam in papermaking systems
Additives which affect optical and printing properties of paper and paperboard

Course Schedule
Lecture 3 hrs/week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(i) a recognition of the need for, and the ability to engage in life-long learning
(j) a knowledge of contemporary issues
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Gerard Ring
6/3/08

PAPR: 385. Systems Engineering and Simulation
Required
Catalog Description
Modeling and simulation of pulp and papermaking systems; computer systems analysis; commercially available simulation hardware and software; model building for engineering systems; industrial case histories and economic systems optimization.

Prerequisites
PAPR 215, 350

Textbooks
Elementary Principles of Chemical Processes, Felder and Rousseau
Introduction to Process Simulation, TAPPI

Course Learning Outcomes (from syllabus as distributed to students)
When you complete this course, you should be able to:

- analyze process systems and determine how best to simulate their operation
- prepare a simulation of the process that accurately predicts the operation of that system
- use the simulation to answer "what if" questions about the system
- present your findings in a written or oral report

Topics Covered
Energy balances on systems with chemical reactions (review)
Process simulations using Excel
Process simulations using WinGEMS

Course Schedule
Lecture, 3 hrs/week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(d) the ability to function on multi-disciplinary teams
(e) the ability to identify, formulate, and solve engineering problems
(j) a knowledge of contemporary issues
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Karyn Biasca
6/3/08

PAPR 410: Leadership Practicum
Not Required
Catalog Description
Develop leadership and supervisory skills; instruction in laboratory safety.

Prerequisites
Senior standing in Paper Science and Engineering

Textbook
None

Course Learning Outcomes (from syllabus as distributed to students)
Develop leadership and supervisory skills; instruction in laboratory safety.

Topics Covered
Supervisory Skills
Technical Writing Critiques

Course Schedule

One 4 hour laboratory exercise per week during PAPR 210 lab period

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(g) the ability to communicate effectively
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Don Guay
6/4/08

PAPR 430: Mass Transfer Operations
Required
Catalog Description
Fundamental concepts; mass transfer coefficients; gas absorption; filtration; extraction; pulp washing systems; sedimentation; cooling, humidification, air conditioning; drying; applications specific to pulp and paper processes; study of field operations.

Prerequisites
PAPR 326

Textbook
"Unit Operations in Chemical Engineering", McCabe, Smith and Harriott, 7th ed.
Various readings distributed by instructor

Course Learning Outcomes (from syllabus as distributed to students)
Your objectives as a successful student in this course are to:

- perform design calculations for cooling towers
- determine the differences in drying behavior of the major pulp types used in the paper industry
- analyze the performance of a paper machine dryer section, identify the limitations of the equipment and propose solutions to the problems
- build and use WinGEMS simulations of brown stock washing systems to analyze the washing process
- analyze the mass transfer performance of an existing gas absorption system and predict the impact of changes in equipment and/or operating procedures
- analyze the performance of sedimentation equipment
- write reports on your activities

Topics Covered
Principles of Diffusion and Mass Transfer (Chapter 17)
Gas Absorption (Chapter 18)
Humidification (Chapter 19)
Paper Drying (Chapter 24 plus additional materials provided by Dr. B)
Filtration/Brown Stock Washing(some of Chapter 29 plus additional provided by Dr. B)
Sedimentation (more of Chapter 29 plus additional materials provided by Dr. B)

Course Schedule
Lecture, 3 hrs/week, mill tours

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(c) the ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(e) the ability to identify, formulate, and solve engineering problems
(i) a recognition of the need for, and the ability to engage in life-long learning
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Karyn Biasca
6/3/08

PAPR 440: Industrial Thermodynamics and Kinetics
Required
Catalog Description
Thermo-dynamic properties; energy and entropy balances; thermodynamics of energy conversion: combustion, steam, vapor power cycles; energy recovery systems; chemical kinetics and reaction engineering; economic and environmental factors; applications to pulp and paper processes; field trips.

Prerequisites
PAPR 326, CHEM 335

Textbook
Introductory Chemical Engineering Thermodynamics, Elliott, J. R. and Lira, C. T. (1999).

Course Learning Outcomes (from syllabus as distributed to students)
Paper 440 is an engineering course aimed at giving senior students in Paper Science a knowledge and capability in Chemical Engineering process design. Chemical Engineering process design capability may be described as the ability to solve problems and to create designs related to the manufacture of products. Ingenuity and problem solving ability are therefore required as well as a scientific and mathematical background.
PAPR 440 has a thermodynamics base and uses the laws of thermodynamics for mass and energy balances, for devising processes which are more energy efficient, for predicting the behavior of pure substances and solutions, for phase and chemical reaction equilibria, and for process kinetics.
At first you will be acquainted with the basic principles and techniques involved in chemical engineering thermodynamics. By the end of the course, however, you will be able to perform complex analysis and calculations for complex industrial processes.

Topics Covered
The scope of thermodynamics.
Ideal behavior of gases and liquids.
Departures from the ideal state.
Heat capacity, latent heat, and heats of reaction.
The analysis of heat engines
Entropy and the second law.
Analysis of homogeneous phases.
Thermodynamic analysis of multiphase systems
Flow of compressible fluids.
Production of power from heat.
Refrigeration systems.
Fundamental property relations.
Fugacity and excess properties.
Vapor-liquid equilibrium data and applications.

Course Schedule
Lecture 4 hrs/week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(e) the ability to identify, formulate, and solve engineering problems
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Description Prepared by:
Gerard Ring
6/3/08

PAPR 445: Coating and Converting Operations
Not Required
Catalog Description

Pigment coating materials/processes; converting operations including laminating, corrugating, extrusion and hot melt coating; functional coatings; presentations by staff/guest lecturers.

Prerequisites
Senior standing in Paper Science and Engineering

Textbook
The Coating Processes, Walter, J. C. (ed.)
Other readings supplied by instructor

Course Learning Outcomes
Students will become familiar with a variety of operations used to convert paper into end products. Students will be able to identify operations used to produce different grades of paper. Students will have the knowledge to assist with troubleshooting converting equipment.

Topics Covered
Specific topics will include coating, calendaring, sheeting, printing, and corrugating. Other topics of interest to the class may be included as time permits.

Course Schedule
Classroom: 3 hrs per week. Students will lead some of the classroom discussions on course material.

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5. This is the only course dealing specifically with the conversion of paper into useful end products.

Relationship to Program Outcomes
This course contributes to ABET outcome (l): knowledge of the science and technology used in the paper industry

Description Prepared by:
Karyn Biasca
6/3/08

PAPR 460: Process Dynamics and Control
Required
Catalog Description
Dynamic model formulation and solution, using Laplace transform, analog, and digital computing techniques; control theories, strategies, and equipment; controller tuning; applications to pulp/paper processes; field trips.

Prerequisites
PAPR 215, MATH 320

Textbook
"Principles of Automatic Process Control," Smith and Corripio
"Elementary Principles of Chemical Processes," Felder and Rousseau (for reference)
Readings and handouts distributed by instructor

Course Learning Outcomes (from syllabus as distributed to students)
Your objectives as a successful student in this course are to:

- analyze the time dependent behavior of simple systems
- create block diagrams for open and closed loop systems
- describe instruments used for measurement and control in the pulp and paper industry
- create spreadsheet simulations of simple systems, and use these to predict system behavior
- identify sources of non-ideal behavior of real systems
- report on your activities (oral and written)

Topics Covered
Introduction to Process Control
Mathematics of Process Control
First Order Systems
Control Systems
Controller Tuning and Process Identification
Applications in Mill Operations

Course Schedule
Lecture, 3 hrs/week, mill tours

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(e) the ability to identify, formulate, and solve engineering problems
(i) a recognition of the need for, and the ability to engage in life-long learning
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Karyn Biasca
6/3/08

PAPR 475: Paper Machine Operations
Required
Catalog Description
Hydrodynamics of fibrous suspensions; dynamics of sheet formation and water removal; fundamentals of pressing; analysis of drying process in terms of heat and mass transfer; engineering calculations performed on full scale production paper machines; field trips to paper mills and affiliated industries.

Prerequisites
PAPR 355

Textbook
Course notebook by instructor

Course Learning Outcomes (from syllabus as distributed to students)
PAPR 475 will acquaint you with the detailed operations of a paper machine. You will study the operation of the department's paper machine and learn the necessary procedures to start, operate and shut it down safely.
This course will consist of many point-earning activities. The number of points accumulated relative to the total points will determine your grade in this course. Special activities may be announced throughout the semester.

Topics Covered
Stock White Water Systems
Roll Headboxes and Their Approach Flow
Hydraulic Headboxes
Fourdrinier Papermaking
Twin-Wire And Multiple-Wire Formation And Drainage
Multiply Forming
Press Operations
Paper Drying
Surface Sizing
Yankee Dryers
Winding
Calendering
Miscellaneous Topics

Course Schedule
Lecture 3 hrs/week, lab 4 hrs/week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(d) the ability to function on multi-disciplinary teams
(f) the understanding of professional and ethical responsibility
(g) the ability to communicate effectively
(i) a recognition of the need for, and the ability to engage in life-long learning
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Gerard Ring
6/3/08

PAPR 484: Engineering Design I
Required
Catalog Description
Engineering economics; interest and economic equivalence; methods of comparing project and investment alternatives. Ethical and professional issues in engineering. Basic principles of process design.

Prerequisites
Senior standing in Paper Science and Engineering

Textbook
Plant Design and Economics for Chemical Engineers, Peters, Timmerhaus, West (5^{th} ed.)

Course Learning Outcomes (from syllabus as distributed to students)
1) Perform time value of money calculations.
2) Perform equipment cost estimates.
3) Identify and describe ethical issues in industrial environments.
4) Develop process options that address specified project goals while working within project constraints.
5) Write a project proposal that describes process options (including costs), explains advantages and disadvantages of each option and addresses safety issues.

Topics Covered
Engineering economics
Engineering ethics
Oral and written project presentation strategies

Course Schedule
Lecture/lab, 3 hrs/week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data
(c) the ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) the ability to function on multi-disciplinary teams
(e) the ability to identify, formulate, and solve engineering problems
(f) the understanding of professional and ethical responsibility
(g) the ability to communicate effectively
(i) a recognition of the need for, and the ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Karyn Biasca
6/3/08

PAPR 486: Engineering Design Project
Required
Catalog Description
Engineering economics; interest and economic equivalence; methods of comparing project and investment alternatives. Individual student project includes project definition, equipment selection and sizing, capital and operating cost estimation, economic evaluation and justification; oral and written presentations.

Prerequisites
Senior standing in Paper Science and Engineering

Textbook
Plant Design and Economics for Chemical Engineers, Peters, Timmerhaus, West (5th ed.)

Course Learning Outcomes (from syllabus as distributed to students)
Complete design work and install equipment as specified in PAPR 484 Final Report
Perform economic analysis of project
Verify that project requirements have been met

Topics Covered
Engineering economics
Oral and written project presentation strategies

Course Schedule
Lecture/lab, 3 hrs/week

Contribution to ABET Criterion 5
This course contributes to the engineering topics component of Criterion 5.

Relationship to Program Outcomes
(a) the ability to apply knowledge of mathematics, science, and engineering
(b) the ability to design and conduct experiments, as well as to analyze and interpret data
(c) the ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) the ability to function on multi-disciplinary teams
(e) the ability to identify, formulate, and solve engineering problems
(f) the understanding of professional and ethical responsibility
(g) the ability to communicate effectively
(i) a recognition of the need for, and the ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) knowledge of the science and technology used in the paper industry

Description Prepared by:
Karyn Biasca
6/3/08