CBEMS 40A PROCESS ENGINEERING CALCULATIONS

Catalog Data: **CBEMS 40A Process Engineering Calculations (Credit Units: 5)**
Overview of methodology for the formulation and solution of material and energy balances, applied to chemical process systems. Introduction to dimensional analysis, stoichiometric mass balances, phase equilibrium, and the first law of thermodynamics. Prerequisites: Math2B, Chemistry 1C, Physics 7A. (Design Unit: 0)

Textbook: *Elementary Principles of Chemical Processes*, R.M. Felder and R.W. Rousseau, 3rd Edition, Wiley, New York, 2000.

Reference: *Perry's Chemical Engineers Handbook*, R.H. Perry and D.W. Green Eds. 7th Edition, McGraw-Hill, New York, 1997.

Coordinator: Andrew J. Putnam

Course Objectives: This course emphasizes the application of the laws of conservation of mass and energy to the chemical process industries. It also introduces the engineering approach to problem solving. This approach involves breaking down a process into manageable components, establishing relationships between known and unknown quantities, organization of the information required to determine unknowns, and re-assembly of the individual components into a complete description of the process.

Course Outcomes: Students are able to:
Convert quantities from one set of units to their equivalent in any other dimensionally consistent units, using conversion factor tables.
Calculate the weight of an object of known mass in any dimensionally consistent units.
Calculate the density of a liquid or solid species, in any dimensionally consistent units, from knowledge of its specific gravity.
Calculate the weight fractions and of each species present in a mixture of known mole fractions, and visa versa.
Express a pressure, given in head of fluid, to its equivalent, expressed as force per unit area, and visa versa.
Given a process description, draw and fully label a flowchart, choose a convenient basis, perform degrees-of-freedom analysis, and calculate the required process variables for the overall system.
Calculate the feed rate of air for a combustion reaction, given the fuel composition and percent excess air.
Apply the ideal gas law to determine any of the four quantities: a) temperature, b) pressure, c) mole number, or d) volume, when the other three are given.
Estimate the vapor pressure of pure, non-aqueous substances at a specified temperature, or the boiling point at a specified pressure, using: a) the Antoine equation, b) the Cox chart, or c) the Clausius-Clapeyron equation.
Estimate the vapor pressure of pure water at a specified temperature, or the boiling point at a specified pressure, using the steam tables.

Prerequisites by Topics: Dimensional analysis, process variable definitions, chemical stoichiometry, basic thermodynamics

Lecture Topics:
Units, dimensions
Material balances
Recycle, bypass, purge
Material balances on reacting systems
Combustion processes
Elementary phase equilibrium
Staged separations - extraction
Energy balances - non-reactive and reactive systems
Enthalpy contributions - sensible heats, latent heats, heats of reaction
Combined mass and energy balances
Basic process synthesis based on economic, environmental, and safety considerations.

Class Schedule: Each class meets 4 hours per week for 10 weeks.

Computer Usage: Students are required to use basic computer skills to solve short design problems (Homework).

Laboratory Projects:

Professional Component: Contributes toward the Chemical Engineering Major design experience.

Relationship to Program Outcomes:

ChE This course relates to Program Outcomes 1, 3, 5, 10, 11, and 13 as stated at: http://www.eng.uci.edu/dept/objective_chemical

MSE This course relates to Program Outcomes 1 and 2 as stated at: http://www.eng.uci.edu/dept/objective_materials_science

Design Content Description:

Approach: N/A
Lectures: N/A
Laboratory Portion: N/A

Grading Criteria:

Homework:	15%
Quizzes :	20%
Midterm Exam:	30%
Final Exam:	35%
	100%

Estimated ABET Category Content:
Mathematics and Basic Science: 0 credit units or 0%
Engineering Science: 5 credit units or 100%
Engineering Design: 0 credit unit or 0%

Prepared by: **Andrew J. Putnam** **Date:** **June 2005**

CEP Approved: Fall 2002