**BMED 2110 Conservation Principles in Biomedical Engineering**

**Credit:** 1-6-3

**Prerequisite(s):** CHEM 1211K and MATH 1552

**Catalog Description**

Study of material and energy balances applied to problems in biomedical engineering

**Text**

Bioengineering Fundamentals, Saterbak, McIntire, and San, Pearson Prentice (2007)

**Objectives**

This course introduces you to the engineering approach to problem solving. By applying principles of mass and energy conservation, this course prepares you to analyze and solve problems involving complex biological systems. Problem solving includes breaking a system down into its components, establishing the relationships between known and unknown system variables, assembling the information needed to solve for the unknowns, then obtaining the solution.

**Outcomes**

By the end of the course you should be able to:

1. Know the basics of conducting engineering calculations (Student Outcome 1)
   1. Convert quantities from one set of units to another quickly and accurately
   2. Define, calculate, and estimate system and material properties such as fluid density, flow rate, chemical composition variables (mass and mole fractions, concentrations), fluid pressure, temperature, enthalpy, entropy, work, and heat capacity
   3. Draw and label process flowcharts from verbal process descriptions
2. Comprehend concepts and principles of mass and energy conservation (Student Outcome 1)
   1. Identify principles in restated form
   2. Describe examples of the principles
   3. State hypotheses that are in harmony with the principles
   4. Distinguish between correct and incorrect interpretations of the principles
3. Apply these concepts and principles to the analysis of biological systems (Outcome 1)
   1. Write and solve material and energy balance equations for ‘single-unit’ and ‘multi-unit’ systems, systems with multi-component streams, systems with reactive processes, and dynamic systems
   2. Calculate internal energy and enthalpy changes for fluids that undergo specified changes in temperature, pressure, phase, and chemical composition and incorporate the results of these calculations into system material and energy calculations

**Topical Outline**

1. Introduction to Engineering Calculations
   1. Units and dimensions
   2. Force and weight
   3. Pressure and temperature
   4. Mass, moles and molecular weight
   5. Concentration
   6. Kinetic, potential and internal energy
   7. The chemical equation and stoichiometry
   8. Basis of calculations
2. Introduction to Conservations Principles
   1. Accounting versus conservation equations
   2. Algebraic balances
   3. Differential balances
   4. Integral balances
3. Introduction to Mass Balances
   1. The mass balance
   2. Program of analysis of mass balance problems
   3. Solving problems that do not involve reactions
   4. Solving problems that do involve reactions
   5. Solving problems that involve multiple subsystems
   6. Solving transient mass balance
4. Degree-of-Freedom Analysis
   1. Counting the number of variables, equations and specifications
   2. Determine if a problem is under, over, or correctly specified
   3. Determine the order in which calculations must be performed in order to obtain a solution
5. Gasses, Vapors, Liquids and Solids
   1. Ideal gas law calculations
   2. Vapor pressure and liquids
   3. Vapor-liquid equilibria
   4. Saturation, partial saturation and humidity
   5. Mass balances that involve condensation and vaporization
6. Introduction to Energy Balances
   1. Concepts and units
   2. The general energy balance
   3. Application of the general energy balance to systems without reactions occurring
   4. Application of the general energy balance to systems with reactions occurring
7. Solving Simultaneous Mass and Energy Balances
   1. Analyzing degrees of freedom in a steady-state process
   2. Solving mass and energy balances at steady-state
   3. Unsteady-state mass and energy balances