Engineering Faculty Document No. 28-03
January, 2004

TO: Engineering Faculty

FROM: The Faculty of Agricultural and Biological Engineering

RE: New Undergraduate Course

The faculty of the Department of Agricultural and Biological Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ABE 201 – Thermodynamics in Biological Systems I

Sem. 1, Class 3, cr. 3.

Prerequisite: CHM 116, or equivalent and Co-requisites: BIO 295E, BIO 295F

Thermodynamic principles associated with biological systems and processing of biological materials. Emphasis on the first law of thermodynamics. Fundamentals of steady-state mass and energy balances for reacting and non-reacting processes including multiple unit operations emphasizing living systems and bioprocessing. Applications of the first law conservation of energy to biological systems, energy conversion systems, and the environmental impacts of energy production. Development of engineering problem solving skills via MathCad and MatLab software.

Reasons:

A background in thermodynamic principles is essential to understanding biological and biochemical processes. This course is the first in a consecutive two course series in biological thermodynamics.

Vince F. Bralts
Head, Department of Agricultural and Biological Engineering

ABE 201 – Thermodynamics in Biological Systems I

Sem. 1, Class 3, cr. 3.

Prerequisites
CHM 116, MA 166 or equivalent.

Corequisites
BIO 295E, BIO 295F or permission of instructor

Description
Thermodynamic principles associated with biological systems and processing of biological materials. Emphasis on the first law of thermodynamics. Fundamentals of steady-state mass and energy balances for reacting and non-reacting processes including multiple unit operations emphasizing living systems and bioprocessing. Applications of the first law conservation of energy to biological systems, energy conversion systems, and the environmental impacts of energy production. Development of engineering problem solving skills via MathCad and MatLab software.

Textbook and/or other required material

Felder, Richard M. and Rousseau, Ronald W. *Elementary Principles of Chemical Processes*. John Wiley & Sons ISBN 0-471-53478-1

"Thermodynamics in Biological Systems I" Course Handouts

Course Learning Objectives:
Successful completion of this thermodynamics in biological systems course will enable students to:

1. Analyze problems and use a systematic approach to problem solving in the engineering of biological systems
2. Develop mass balances for systems with and without biochemical reactions for *in vivo* and *in vitro* biological systems
3. Characterize the properties of solids, liquids, and gases common to biological systems
4. Estimate gas/vapor properties using gas laws
5. Understanding the relationships between pressure, partial pressure, and humidity
6. Apply the basic thermodynamic concepts to quantify phase and chemical equilibrium parameters for food and biological systems
7. Use models to predict the physical behavior of materials at equilibrium in multicomponent, multiphase systems
8. Use computational software to solve problems in biological systems

Course Outline

Week

1-2	Introduction, dimensions/units, material properties (density, temperature, pressure, etc.)
3-4	First Law of Thermodynamics, material balances, degrees of freedom analysis. Material balances for bioprocesses with multiple unit operations and recycle.
5-6	Material balances with chemical reactions, respiration (without energy balance), glycolysis-glucogenesis (without energy balance). Material balances with chemical equilibrium, pH and buffer equilibrium, pKa and hemoglobin/O2 equilibrium.
7-8	Gas and vapor characterization. ideal gas mixtures/ideal solutions, Raoults Law; phase diagrams; dew point and bubble point calculations; multicomponent systems; Henry's law; Lewis Randall rule.
9-10	Introduction to energy balances. Quantifying energy, state properties, enthalpy, isothermal systems, adiabatic systems, tables of thermodynamic properties.
11-12	Energy balances continued. Sensible heat and heat capacities. Estimating heat capacities of biological materials, phase changes and latent heat, phase diagrams, psychometrics.
13-14	Energy balances on reactive systems. Heat of reaction, heat of formation.
15	Cycles and transduction of energy. Refrigeration cycles, Carnot engines.