TO: The Faculty of the College of Engineering

FROM: The School of Agricultural and Biological Engineering

RE Change to an Existing Course ABE 201 from 3 credit hours to 4 credit hours by addition of a laboratory.

The faculty of the School of Agricultural and Biological Engineering has approved the following changes to ABE 201. This action is now submitted to the Engineering Faculty with a recommendation for approval.

From: ABE 20100 – Thermodynamics in Biological Systems I
Sem. 1, Class 3, Cr. 3
Prerequisite**:** CHM 11600, or equivalent

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.

To: ABE 20100 – Thermodynamics in Biological Systems I
Sem 1, Class 3, Lab 1, Cr. 4
Prequisite: CHM 11600 or equivalent

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 of conservation of energy to biological systems, energy conversion systems, and the environmental impacts of energy production. Concepts of entropy and process efficiency, development of engineering problem solving skills via MathCad and Matlab software. The laboratory emphasizes the combining of technical engineering skills with development of professional skills by means of computer and laboratory exercises including two extensive projects that result in a biological product design.

Reason: The addition of a laboratory will enable students to gain experience with applying basic science, math and engineering skills to a "real world" task. The National Academy of Engineers has observed that, because of emerging trends such as globalization, engineers are being looked to as leaders and managers. Technical competency alone will be insufficient. The College of Engineering at Purdue has established the following vision for its future engineering graduates: *Purdue Engineers will be prepared for leadership roles in responding to the global*

file
Approved
by ABE

technological, economic, and societal challenges of the 21st century. The addition of a laboratory to this course will help to better prepare our students to meet these challenges. In accordance with the College of Engineering's "Engineer of 2020" initiative, the goal of this course is to combine technical engineering skill development with other transferable professional skills not traditionally emphasized in engineering. For the past 3 years, the laboratory portion of the class has been taught separately from ABE 20100 as a 1 credit hour course, ABE 49500 Select topics in Agricultural and Biological Engineering. Approximately 50% of the students in ABE 20100 have participated in the separate laboratory course each semester it has been offered. The results have been positive and the Biological Engineering faculty felt it was time to incorporate the laboratory content into ABE 20100 to reach all of the students. The laboratory will be taught using project based spiral learning principles. It will use projects to introduce topics, often before the theory is taught. Students will work together to reinforce previous experiences and seek out new knowledge to solve tasks. Just-in-time lectures and learning modules will provide the necessary technical instruction. As noted above, professional skill training and leadership development are a focus of the laboratory.

Bernard A. Engel
Professor and Head
Agricultural and Biological Engineering Department

Date: February 15, 2011

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE

ECC Minutes #13

Date 3/9/2011

Chairman ECC R. Cipra

Office of the Registrar
FORM 40 REV. 10/10

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

Document – Fall 2010-11

DEPARTMENT: Agricultural and Biological Engineering EFFECTIVE SESSION: Spring 2011

STRUCTIONS: Please check the items below which describe the purpose of this request.

- [ ] 1. New course with supporting documents
- [ ] 2. Add existing course offered at another campus
- [ ] 3. Expiration of a course
- [ ] 4. Change in course number
- [ ] 5. Change in course title
- [x] 6. Change in course credit/type
- [ ] 7. Change in course attributes (department head signature only)
- [x] 8. Change in instructional hours
- [x] 9. Change in course description
- [ ] 10. Change in course requisites/restrictions
- [ ] 11. Change in semesters offered (department head signature only)
- [ ] 12. Transfer from one department to another

	PROPOSED	EXISTING
Subject Abbreviation	ABE	ABE
Course Number	20100	20100

Long Title: Thermodynamics in Biological Systems I

Short Title: Thermo in Biological Systems I

Abbreviated title will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY)

TERMS OFFERED — Check All That Apply: [x] Fall [ ] Spring [ ] Summer

CAMPUS(ES) INVOLVED: [ ] Calumet [ ] Cont Ed [ ] Ft. Wayne [ ] Indianapolis [ ] N. Central [ ] Tech Statewide [x] W. Lafayette

CREDIT TYPE
1. Fixed Credit: Cr. Hrs. 4
2. Variable Credit Range:
   Minimum Cr. Hrs
   (Check One) To [ ] Or [ ]
   Maximum Cr. Hrs
3. Equivalent Credit: Yes [ ] No [ ]

COURSE ATTRIBUTES: Check All That Apply
1. Pass/Not Pass Only [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ]
   Maximum Repeatable Credit: [ ]
4. Credit by Examination [ ]
5. Special Fees [ ]
6 Registration Approval Type: Department [ ] Instructor [ ]
7 Variable Title [ ]
8 Honors [ ]
9 Full Time Privilege [ ]
10 Off Campus Experience [ ]

Schedule Type	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated
Lecture	50	3 ~~4~~	15	
Recitation				
Presentation				
Laboratory	150 ~~120~~	1	15	
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses:

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):

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 bio-processing. 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. Prerequisites: CHM 116

*COURSE LEARNING OUTCOMES

See Attached

Calumet Department Head	Date	Calumet School Dean	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date
Indianapolis Department Head	Date	Indianapolis School Dean	Date
North Central Faculty Senate Chair	Date	Vice Chancellor for Academic Affairs	Date
[signature] West Lafayette Department Head	11/10/10 Date	[signature] West Lafayette College/School Dean	12/3/10 Date

[signature] 12/16/10 West Lafayette Registrar Date

OFFICE OF THE REGISTRAR

12/16/10

Supporting Documentation

COURSE ACRONYM AND NUMBER: ABE 20100

COURSE TITLE: Thermodynamics in Biological Systems I

COURSE CREDITS AND INSTRUCTIONAL TYPE: Sem. 1. Class 3, lab 1, cr. 4.

COURSE 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 bio-processing. 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.

A. Justification:

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. The laboratory focuses upon application of science and engineering principles (especially thermodynamics and material/energy balances), development of team and project management skills, and engineering design of a biological product.

B. Level of Course:

95% anticipated enrollment of lower division students. (freshmen and sophomores)
5% anticipated enrollment of upper division students. (juniors and seniors)
0% anticipated enrollment of graduate students.

C. Prerequisites: CHM 11600

D. Name of Instructor: Nathan S. Mosier

E. Course Objectives:
Students will be able to:
1. Understand and apply thermodynamic principles to biological systems and processing of biological materials.
2. Understand and solve steady-state mass and energy balances for reacting and non-reacting processes including multiple unit operations emphasizing living systems and bioprocessing.
3. Solve engineering problems using computer programs such as MathCad, Matlab, and MS Excel
4. Apply engineering science (with emphasis on thermodynamics), biological science, and biochemistry to design a bioproduct, e.g. food, that meets economic and performance constraints

E1. Course Outline of Topics/Syllabus:

Week	Lecture	Lab
1	Introduction, dimensions/units, material properties (density, temperature, pressure, etc.)	NUTRITION, UNITS CONVERSION FOR CALCULATION OF COMPOSITIONS OF BIOLOGICAL MATERIALS
2	First Law of Thermodynamics, material balances, degrees of freedom analysis. Material balances for bioprocesses with multiple unit operations and recycle.	FOOD CHEMISTRY/ BIOMOLECULES - Ingredient Functionality/ Structure-Function Relationships
3	(cont)	PROCESS FLOW DIAGRAMS - software tools
4	Material balances with chemical reactions, respiration (without energy balance), TCA Cycle (without energy balance). Material balances with chemical equilibrium, pH and buffer equilibrium, pKa and myoglobin/O2 equilibrium.	FOOD COMPOSITION CALCULATIONS - software tools
5	(cont)	PRODUCT DEVELOPMENT PROCESS – Mass Balance Calculations
6	Gas and vapor characterization. ideal gas mixtures/ideal solutions, Raoult's Law; phase diagrams; dew point and bubble point calculations; multi-component systems; Henry's law; Lewis Randall rule.	LEADERSHIP, TEAMWORK, & COMMUNICATION - Developing Personal Strengths - Brainstorming Techniques
7	(cont)	MARKET RESEARCH & MARKETING AND PILOT PLANT TOUR (Smith) - Databases for market trends - Information for processing/pricing

Week	Lecture	Lab
8	Fall Break	FALL BREAK - No Class
9	Introduction to energy balances. Quantifying energy, state properties, enthalpy, isothermal systems, adiabatic systems, tables of thermodynamic properties.	PROCESS ENERGY BALANCES
10	Energy balances continued. Sensible heat and heat capacities. Estimating heat capacities of biological materials, phase changes and latent heat, phase diagrams, psychrometrics.	PRODUCT PROPERTIES
11	Energy balances on reactive systems. Heat of reaction, heat of formation.	PRODUCT PRODUCTION LAB
12	(Cont)	PRODUCT PRODUCTION LAB
13	Second Law of Thermodynamics, Entropy	ENTROPY IN PROCESS DESIGN
14	(Cont)	THANKSGIVING - No Lab
15	Irreversibility and Intro to Cycles	POSTER PREP - Comp Lab
16	(Cont)	FINAL PRESENTATION

E2. Method of Evaluation or Assessment:
The student's final grade will be based on a combination of individual homework, group homework, lab reports, and exam scores.

A = 90%
B = 80-89%
C = 70-79%
D = 60-69%
F = <60%

Specific percentages of final grade represented by each facet follows:

Midterm Exam 1	100 pts
Midterm Exam 2	100 pts
Midterm Exam 3	100 pts
Final Exam	200 pts
Individual Homework	250 pts
Team Homework	250 pts
Lab Assignments	200 pts
Team Evaluations	50 pts
Reverse Engineering Project	150 pts
Product Development Project	250 pts

Total	**1650 pts**

The two laboratory projects each consist of multiple assignments that focus on the application of mass/energy balances and thermodynamics from the course lectures while also integrating food/biochemistry, food science, team work, engineering design, product development, and communication skills. Weekly labs are structured to provide resources, practical experiences, and instruction on key topics and skills needed to complete the tasks for the projects.

Team Reverse Engineering of Food Product

- Critically evaluate food label for provided product (energy bar) to identify the function provided by each ingredient
- Reverse engineer the formula for the needed ingredients to make the product with the constraints of meeting the ingredient and nutrition descriptions on the food label (software use – Tech Wizard)
- Develop process flow diagram(s) for a likely manufacturing process to produce this product at industrial scale
- Suggest product improvements and revisions
- Use software tool (Tech Wizard) to develop a FDA compliant Nutrition Label for the product after suggested improvements
- Complete a written final report that summaries the project that will also be evaluated for readability (spelling and grammar), appearance, and neatness.

Team Product Development Project

- Develop 5 potential concepts/prototypes that meet the product nutritional constraints for a "healthy, on-the-go food product" as provided by the instructor
- Develop a project development timeline that lists deliverables (assignments to be completed as outlined by the instructor) as well as milestones developed by your team
- Complete marketing research/analysis for your product and justify rationale for developing your product in this product area
- Refine your concept to one product using evaluation criteria developed from marketing analysis and other criteria as developed by the team
- Develop product formula, including "grocery list" for prototype development labs
- Make prototype product and revise formula to meet product criteria (nutrition, taste, consumer convenience, etc.)
- Develop a sensory (tasting) evaluation plan, execute it, analyze the results, and write a report evaluating your product with regard to consumer satisfaction.
- Document revisions to your formula and provide updated Nutrition Labels for each iteration in your product development
- For your final product:
    - Complete mass and energy balances and process flow diagram for commercial-scale product production process
    - Develop an FDA compliant Nutrition Label
    - Evaluate potential food safety and shelf-stability concerns for the product
    - Determine key Quality Standards for manufacture of the product
    - Complete a SWOT analysis of your final product
- Complete a written report that summarizes the efforts of your team product development and includes section for each project deliverable. Report will also be evaluated for readability (spelling and grammar), appearance, and neatness

- Present your product (with examples to try) and your overall project in the class poster symposium.

F. Reading List/Textbook:

"Thermodynamics in Biological Systems I" Course Handouts
Felder, Richard M. and Rousseau, Ronald W. Elementary Principles of Chemical Processes. John Wiley & Sons ISBN 0-471-53478-1
StrengthsFinder 2.0 by Tom Rath (ISBN: 978-1-59562-015-6)

G. Impact on Learning Outcomes:

Program Outcomes

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

Lecture

1. Analyze problems and use a systematic approach to problem solving in the engineering of biological systems (PO 2,3,4)
2. Develop mass balances for systems with and without biochemical reactions for in vivo and in vitro biological systems (PO 2,3,6)
3. Characterize the properties of solids, liquids, and gases common to biological systems (PO 2)
4. Estimate gas/vapor properties using gas laws (PO 2, 3)
5. Understanding the relationships between pressure, partial pressure, and humidity (PO 2)
6. Apply the basic thermodynamic concepts to quantify phase and chemical equilibrium parameters for food and biological systems (PO 1, 2, 9)
7. Use models to predict the physical behavior of materials at equilibrium in multi-component, multi-phase systems (PO 1, 2, 4, 5, 6, 9)
8. Use computational software to solve problems in biological systems (PO 6)

Lab

1. Students will be able to apply science and math skills to develop a new product and the processes required to transform the input materials into the final product. (PO 3)
2. Students will be able to apply engineering fundamentals and analytical skills, specifically mass and energy balances and thermodynamics, to product & process development projects (PO 4, 5)
3. Students will be able to communicate technical information, oral and written (PO 9)
4. Students will develop leadership and teamwork skills through personal awareness and reflection, and team experiences (PO 10)
5. Students will develop an innovative and a strong work ethic through new product development (PO 12)
6. Students will have increased awareness of ethical responsibility through evaluating case studies and classroom discussion (PO 7, 11)
7. Students will be more curious and persistent learners through self-directed team projects (PO 12)