ABEN/CFS 263 —Biological Materials Processing (3 credits) Spring 2025

Classroom portion meets in **Peltier 1200** on **WF 12:00-12:50 p.m.**
Lab meets in the **Peltier 1338** *or* **Ladd 201** on **T 2:00-4:50 p.m.**

Instructor and contact information:

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Office hours**:** Mondays 10 a.m. – Noon; Thursdays 3-5 p.m.; and by appointment

Bulletin Description of Course:
Quantitative analysis of processing systems for food, biofuels and bioproducts using principles of mass and energy balances, fluid flow, steam properties, and heat and mass transfer. Includes 3 hour lab.

*Prerequisite***:** Math 146 or higher

Required and Recommended Student Resources:

Textbook: Biological Materials Processing: Process Engineering for Food, Biofuels & Bioproducts, 7th edition v2 & v3, 2020, and freely available through the Blackboard course site.

Other required resources: electronic calculator, lab notebook, safety glasses or goggles, protection for your clothes in lab such as a lab coat or apron

Recommended resources:
Fundamentals of Engineering Reference Handbook (FERH), available as a free download from http://ncees.org/exams/study-materials/download-fe-supplied-reference-handbook/

Introduction to Food Engineering, 5th edition, by Singh & Heldman, Academic Press, 2013

Course Objectives:
Process scientists and engineers must be able to quantify relationships between process parameters—such as temperatures and flow rates—and product quality, yield and cost. This requires an understanding of the underlying principles and methods of formulating and using equations that model these relationships, also, an understanding of rheological and thermal properties.

Therefore, students completing this course should be able to:

A. Analyze processes for food and biological materials using one or more of (1) mass, component and thermal energy balances, with correct use of units and conversions; (2) mechanical energy balances applied to fluid systems; (3) properties of process steam, especially through use of steam tables; and (4) principles of steady state heat transfer, including heat transfer resistances in series [A, Student outcome 1 (Table 1); Student outcome d (Table 2)].
B. Apply professional standards for performing and documenting analyses [B, Student outcome 3 (Table 1); Student outcome a (Table 2)].
C. Conduct experiments, record data, write reports, and accomplish tasks as a member of a team [A, Student outcome 6; B, Student outcome 5 (Table 1); Student outcome a, e (Table 2)]
D. Program and use dataloggers and PLCs at a basic level [C, Student outcome 2 (Table 1); Student outcome d (Table 2)]

Table 1. ABEN program educational objectives and supporting student outcomes [(1)].

Graduates are expected to have established themselves as practicing engineers who, within a few years of graduation:	
A	Successfully address emerging engineering challenges in the design or evaluation of machine, processing, environmental, and natural resources systems that affect the production of food, feed, fuel, and other biobased products. Technical learning outcomes include student outcomes (1), (2), and (6): 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics 2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
B	Effectively use professional communication, critical thinking, and interpersonal skills as team leaders and members. Communicational learning outcomes include student outcomes (3) and (5): 3. an ability to communicate effectively with a range of audiences 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
C	Responsibly serve the public and their employers by participating in and promoting professional development, while maintaining the highest standard of professional engineering ethics. Contextual learning outcomes include student outcomes (4) and (7): 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

[(1)] See https://www.ndsu.edu/aben/about/abet_accredited/ for the current ABEN program educational objectives. See https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2024-2025/#GC3 for information on ABET student outcomes 1-7, effective as part of the "Criteria for Accrediting Engineering Programs, 2024 – 2025."

Table 2. Student outcomes for the Food Science (FS) B.S. program.

The following six Student Outcomes* describe the competency, knowledge, communication, professional and leadership skills that FS students are expected to have by the time of graduation: These six outcomes are more amenable to a changing society and broad based compared the previous outcomes.	
(a) To demonstrate the ability to communicate within the food system community through the use of knowledge and understanding of food science concepts and the skillful use of relevant and credible sources.	(d) To be able to evaluate and use scientific knowledge to solve problems relative to the food system.
(b) To recognize and understand the societal basis for rapidly changing food patterns or food choices in the United States and the importance of the global community in shaping these changes.	(e) To apply scientific methodology in the creation of a food product.
(c) To demonstrate knowledge of the food system.	(f) To comprehend and demonstrate ethical behavior and civic responsibility in the context of being a professional food scientist.

* See https://www.ift.org/community/educators/ift-undergraduate-program-approval

Evaluation Procedures and Criteria:

Graded assignments and their relative contribution to your grade are tentatively as follows:

Tests (3, each 100 points)	300 points	**Feb. 11, Mar. 18, Apr. 15**
Final exam	100	**May 13**
Graded problem sets	80	
Lab quizzes/worksheets/reports	180	
Professional practice/notebook	40	Notebook due on **Apr. 16**
Total	**700**	

Letter grades assigned as follows: A=90-100%; B=80-89.9%; C=70-79.9%; D=60-69.9%; F< 60%. The grade will be rounded to one decimal place.
A *mid-term grade* will be posted at Spring Break which will be based on the first two tests and other graded assignments from the first half of the semester.

Lectures and Labs Schedule – ***schedule may change due to unforeseen circumstances***

Wk	**Dates**	**Tuesday Lab**	**Wednesday class**	**Friday class**
1	**1**/14,15,17	Course Intro & Syllabus **Peltier 1200**	Ch. 1: Mass Balances	Ch. 1: Mass Balances
2	**1**/21,22,24	Quality Assessment of a Grain, **Peltier 1338**	Ch. 1: Mass Balances	Ch. 2: Units & Dimension
3	**1**/28,29,31	Mass Balance on a Screw Press, **Peltier 1338**	Ch 3: Thermal Energy Balances	Ch 3: Thermal Energy Balances
4	**2**/4,5,7	Spreadsheet Software for Lab Data Analysis, **Ladd 201**	Ch 3: Thermal Energy Balances	Ch 4: Mechanical Energy Balances
5	**2**/11,12,14	**Test 1**, **Peltier 1200**	Ch 4: Mechanical Energy Balances	Ch 5: Viscosity
6	**2**/18,18.21	Fluid Properties Measurement, **Peltier 1338**	Ch 5: Viscosity	Ch 6: Fluid Friction
7	**2**/25,26,28	Field Trip, **American Crystal Sugar, Moorhead MN**	Ch 6: Fluid Friction	Ch 8: Properties and Use of Steam
8	**3**/4,5,7	Thermal Energy Balance on a Evaporator, **Peltier 1338**	Ch 9: Evaporator Analysis	Ch 9: Estimating Heat Capacity (Cp)
9	**3/10 - 3/14**	**SPRING BREAK**		
10	**3**/18,19,21	**Test 2**, **Peltier 1200**	Ch 7: Pumps	Ch 10: Heat Transfer Conduction
11	**3**/25,26,28	Mid-course Review and Assessment**, Peltier 1200**	Ch 10: Heat Transfer Conduction	Ch 11: Steady State HT Convection
12	**4**/1,2,4	Field Trip, **Simplot, Grand Forks, ND**	Ch 11: Predicting h	Ch 12: Double Pipe Heat Exchangers (DPHX)
13	**4**/8,9,11	DPHX lab, **Peltier 1338**	Ch 12: Analysis of DPHX	Ch 12: Analysis of DPHX
14	**4**/15,16,18	**Test 3**, **Peltier 1200**	Ch 14: Dataloggers	**Good Friday Holiday**
15	**4**/22,23,25	Datalogger and "Hot Box", **Ladd 201**	Ch 13: Heat Exchangers through a Cylindrical Wall	Ch 13: Heat Exchangers through a Cylindrical Wall
16	**4**/29,30; **5**/2	Makeup for Weather-related Postponement	No Class	Ch 15: Programmable Logic Controllers (PLCs)
17	**5**/6,7,9	Programmable Logic Controllers, **Ladd 201**	PLC Review	Course Assessment & Review
18	5/12 -5/16	**FINAL EXAM, Tuesday May 13th, 10:30 am - 12:30 pm**		

Problem Sets and Professional Standards (please follow format on p. 10 of online textbook)

Working the problems is the best way to master the material in this course. You may work in a small group, particularly if you have limited time and find the problems frustrating. While students are encouraged to share ideas on solving problems and compare final answers, *the work you submit should still be essentially your own* -- not a solution you copied from someone else.

Professional standards apply to all work in this course. ***The foremost expectation is to clearly communicate the method used to solve the problem.*** Students with good penmanship may complete problem sets *in pencil* on *only one side* of lined or grid 8-1/2” x 11” notepad paper (not spiral-bound paper); otherwise, use a word processor and then print on standard printer paper. Concisely *summarize* the **GIVEN** information, briefly state what you are asked to **FIND**, and then give a clear, organized, logical **SOLUTION** to the problem. ***Clearly communicate the method for solving the problem.*** <u>Be generous with space</u>. Show correct units throughout your solution, especially in the final answer. Round off your final answers. Professional practice is to show no more than 2-3 significant figures in the final answers, unless the accuracy of the data warrants more; please round your answers accordingly. <u>Underline your final answers.</u>

You typically have one week to complete assigned problem sets. If you cannot meet that deadline, assignments are *sometimes* accepted with advance permission up to 3 days late (10% deduction per day, based on maximum possible score). Problem sets may not be returned in advance of the corresponding test. Thus, *photocopy your answers and compare them to the posted solution key* to ensure that you are using correct procedures.

Laboratory Exercises:

Students will be able to download the lab guide by the Friday before the corresponding lab exercise is performed. The lab exercise will usually be conducted by separate teams of 2-3 students, with teams usually working at separate parts of the period. For some exercises, teams will share data with one another. Please study the lab guide for 30 to 60 min prior to reporting to lab to perform the exercise. You will usually be quizzed on the lab guide when you arrive to perform the exercise. Please make it a habit to record your original data in a neat and orderly way directly into a *bound lab notebook* (avoid using photocopies of data); *this is due by* ***April 16***.

7 Marks of Professionalism in the Lab

1. Lab guide is carefully studied before the lab period, and consulted as needed during the lab.
2. Work is performed safely according to precautions, e.g., with eye protection if needed.
3. Questions are asked and constructive suggestions offered, where needed to perform experiments safely and accurately, and to help discern relevance of the lab to the course.
4. Experiments are repeated, to the extent that time and resources allow.
5. Your team’s data are recorded neatly *in ink* directly into a bound notebook.
6. Behavior towards others is courteous and helpful; use of humor is graceful.
7. Equipment and facilities are treated with respect, and assistance with clean-up is volunteered.

What should be entered into the lab notebook?

1. Title of experiment (title used in lab guide)
2. Your name and date of lab exercise, and your lab partner names
3. Brief statement of objective(s) of lab exercise
4. Simple, labeled sketch of lab apparatus, where appropriate
5. Complete record of relevant data *with units*, organized in a table where appropriate
6. Record departures from the lab guide procedure, and observations made

Please write ***in black or dark blue ink*** and use *only the front side* of each notebook sheet.

Professional Practice: Participation and Attendance
According to NDSU Policy 333 (www.ndsu.edu/fileadmin/policy/333.pdf), attendance in classes is expected. In this course students should participate in the course, especially the labs. *Attendance is incorporated into the professional practice component of your course grade,* through punctuality, class discussions, volunteering answers to questions, asking constructive questions, and by helping to create a spirit of cooperation within the class.

Please also note: *Students who exceed two unexcused absence for the semester should provide documentation of a valid excuse for all absences, such as from an advisor of an NDSU student organization, to avoid a grade penalty of at most 2 points per unexcused absence.*

Americans with Disabilities Act for Students with Special Needs: Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Center for Accessibility and Disability Services (www.ndsu.edu/disabilityservices)

Veterans: Veteran or military personnel with special circumstances or who are activated are encouraged to notify the instructor as soon as possible and are encouraged to provide Activation Orders.

Family Educational Rights and Privacy Act (FERPA): Your personally identifiable information and educational records as hey relate to this course are subject to FERPA.

Academic Honesty: The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.

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