ABEN 263 —Biological Materials Processing (3 credits) Spring 2021

Classroom portion meets in **ABEN 201** on WF 12:00-12:50 p.m.
Lab meets in the **Pilot Plant** *or* **ABEN 210 cluster** on **T 2:00-4:50 p.m.**
Virtual via Zoom (See folder and link on blackboard).

Instructor and contact information:

Name: Dr. Ewumbua Monono
Office location: ABEN 206
Contact Information: ewumbua.monono@ndsu.edu and Phone: 701-231-7277
Office hours**:** Mondays 10 a.m. – Noon; Thursdays 3-5 p.m.; and by appointment
You may meet in-person or virtually via Zoom

> ***Please remember to wear a face covering during in-person meetings and classes.*** If you need more information about COVID preparedness and plan, go to https://www.ndsu.edu/police_safety/covid_19_preparedness_and_response/

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***:** ABEN 255 *Co-requisite*: ME 221

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:
Processors seek to convert biological materials into products at a profit and in ways that are safe for the consumer and the employee, result in or preserve the desired characteristics of the product, and are compatible with the environment. 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 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)].

B. Apply professional standards for performing and documenting analyses [B, Student outcome 3].
C. Conduct experiments, record data, write reports, and accomplish tasks as a member of a team [A, Student outcome 6; B, Student outcome 5]
D. Program and use dataloggers and PLCs at a basic level [C, Student outcome 2]

Table 1. ABEN program educational objectives and supporting student outcomes. *

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 systems, processing systems, and natural resources and environmental systems affecting the production of food, feed, 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 (a, e)† 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 (c) 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (b)
B	Effectively use professional communication, critical thinking, and interpersonal skills as team leaders and team members. Communicational learning outcomes include student outcomes (3) and (5): 3. an ability to communicate effectively with a range of audiences (g) 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 (d)
C	Responsibly serve the public and their employers by participating in professional development and by maintaining the highest standard of professional 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 (f, h, j) 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies (i)

* 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-2021-2022/ for information on ABET student outcomes 1-7, effective as part of the "Criteria for Accrediting Engineering Programs, 2021-2022."

† ABET student outcomes (a) – (k) from the previous review cycle are included for cross-referencing only. Former student outcome (k) is implied in (1), (2), and (6).

Course Schedule—Classroom Period Component (30 classes total):
Chapters refer to the online textbook mentioned on the next page.

1. Mass balances; units & dimensions (3 classes; Ch. 1 and 2)
2. Thermal energy balances (3 classes; Ch. 3)
3. Mechanical energy balances applied to fluid system (2 classes; Ch. 4)
4. Viscosity, flow props of fluids, fluid friction (3 classes; Ch. 5 and 6)
5. Pumps and fans, pressure drop in processes (1 class; Ch. 7)
6. Properties and use of steam & evaporator analysis (4 classes; Ch. 8 and 9)
7. Steady state heat transfer by conduction & convection; Thermal properties of biological materials (4 classes; Ch. 10 and 11)
8. Heat exchangers, predict convection, cylindrical walls (4 classes; Ch. 12 and 13)
9. Introduction to Dataloggers and PLCs (3 classes; Ch. 14 and 15)
10. Integration of process principles: evaporator example (1.5 classes; Ch 16)
11. Course assessment, evaluation, and review (1.5 classes)

Course Schedule—Laboratory Period Component by Week:

1. Course introduction; course pre-test (**Jan. 12, 2 p.m.** in Pilot Plant)
2. Quality evaluation of canola seed, seed cleaning & tempering (**Jan. 19** in Pilot Plant)
3. Mass balance for screw pressing of canola oil (**Jan. 26** in Pilot Plant)
4. Spreadsheet software for data analysis (**Feb 2, 2 p.m.** in ABEN 210 cluster)
5. **1st test** (**Feb. 9, 2-3:30 p.m.** in ABEN 215; bring calculator & paper)
6. Fluid properties of soup concentrates and biodiesel (**Feb. 16** in Pilot Plant)
7. Guest speaker from American Crystal Sugar (**Feb. 23, 2 p.m.**)
8. Thermal energy balance on evaporator (**Mar. 2** in Pilot Plant)
9. **2nd test** (**Mar. 9, 2-3:30 p.m.** in ABEN 215; bring calculator & paper)
10. Mid-course review & assessment (**Mar. 23**, **2 p.m.** in ABEN 210 cluster)
11. Guest speaker, TBD (**Mar. 30, 2 p.m.**)
12. Double pipe heat exchanger (**Apr. 6** in Pilot Plant)
13. **3rd test** (**Apr. 13, 2-3:30 p.m.** in ABEN 215; bring calculator & paper)
14. Dataloggers and "Hot Box" event (**Apr. 20** in ABEN 210 cluster)
15. Programmable logic controllers in processing (**Apr. 27** in ABEN 210 cluster)

Makeup for weather-related postponement of lab or class (**May 4**)

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. 9, Mar. 9, Apr. 13**
Final exam	100	**May 10**, **1 - 3 p.m.**
Graded problem sets	80	
Lab quizzes/worksheets/reports	170	
Professional practice/notebook	50	Notebook due on **Apr. 16**
Total	**700**	

Letter grades assigned as follows: A=90-100%; B=80-89%; C=70-79%; D=60-69%; F< 60%.

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.*** Be generous with space. 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. Underline your final answers.

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***. Please assist with cleanup.

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 mostly face-to-face, especially the labs. When needed, students are also able to participate virtually in synchronous or asynchronous discussions and activities and submit assignments virtually. *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. If you attend classes or lab or exams virtually, you are required to have both **video and audio capabilities.** This will enable you to interact with your teammate(s) attending in-person.

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.*

Students with Special Needs and/or Circumstances: 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 as soon as possible. The instructor may ask for verification and that, plus other assistance, can be requested from Disability Services in NDSU Library Suite 17 (231-8463). http://www.ndsu.edu/disabilityservices/.

Veterans or military personnel with special circumstances or who are activated are encouraged to notify the instructor as early as possible.

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.

Honor Pledge in the College of Engineering: "On my honor I will not give nor receive unauthorized assistance in completing assignments and work submitted for review or assessment. Furthermore, I understand the requirements in the College of Engineering Honor System and accept the responsibility I have to complete all my work with complete integrity. Students who are suspected of academic dishonesty may not withdraw from the course in which dishonesty is suspected while the case is under review by the Honor Commission (NDSU Policy 335, 5b)." *http://www.ndsu.edu/coe/undergraduate_students/honor_code/*

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