

TRANSPORT PROCESSES IN BIOLOGICAL & ENVIRONMENTAL SYSTEMS (ABEN 444/644) COURSE SYLLABUS

BASIC INFORMATION

Number of credits: 3

Meeting place and time: MWF 12:00-12:50 p.m. @ ABEN 208

Term and year: Spring 2022

Instructor's name: Zhulu Lin

Office location: ABEN 104

Office hours: Monday and Thursday 1:00-2:00 p.m. or by appointment

Contact information: Zhulu.Lin@ndsu.edu/231-7118

Zoom Meeting Link: <https://ndsu.zoom.us/j/2999001994>

BULLETIN DESCRIPTION

Topics covered include modes and equations of energy and mass transport processes, transport properties of biomaterials and porous media, formulations of and solutions to energy and mass transfer problems, and engineering design considerations.

PREREQUISITES

Before taking this course, students should have already completed the following courses:

- MATH 266 – Introduction to Differential Equations
- CE 309 – Fluid Mechanics or ME 352 – Fluid Dynamics, and
- ABEN 263 – Biomaterials Processing

ABEN EDUCATIONAL OBJECTIVES AND ABET STUDENT OUTCOMES

Educational Objective 1: Graduates are expected to have established themselves as practicing engineers who, within a few years of graduation, 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.

This objective addresses the following ABET student outcomes:

- ABET-(1): an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- ABET-(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.

COURSE OBJECTIVES

After completing this course, students should be able to

1. Understand the principles and the impacts of energy and mass transport processes as they are applied in a biological or environmental context. [ABET–(1)]
2. Define transport problems; develop the governing equations; describe the appropriate material properties, initial conditions, and boundary conditions; and develop analytical and/or numerical solutions. [ABET– (1)]

3. Design a heat or mass transfer process to produce solutions that meet specified needs in biological, environmental, or agricultural systems.
4. (Graduate students only) Analyze real-world heat or mass transfer processes in biological, environmental, or agricultural systems.

REQUIRED STUDENT RESOURCES

Required textbook: Datta, A.K. (2017) Heat and Mass Transfer: A Biological Context (2nd Edition), CRC Press, Boca Raton, FL. Or Datta, A.K. (2002). Biological and Bioenvironmental Heat and Mass Transfer. New York: Marcel Dekker.

References (optional): Incropera, F. P., and D. P. DeWitt (2007). Fundamentals of Heat and Mass Transfer, 6th Edition. John Wiley & Sons: New York.

Logan, B.E. (2012). Environmental Transport Processes, 2nd Edition. John Wiley & Sons: Hoboken, New Jersey.

Other Resources: A regularly checked e-mail account, data storage devices, and a calculator are required. Departmental computers are available in ABEN Rooms 217 and 222 to complete homework assignments.

COURSE SCHEDULE/OUTLINE/CALENDAR OF EVENTS

Wk	Day	Date	Topics	Readings	HW	Tests
1	W	1/13	Introduction & Pre-test			
	F	1/14	Equilibrium, energy conservation, and temperature in environment	Chapter 1		
2	M	1/17	MLK Jr. Day (no class, office closed)			
	W	1/19	Modes of heat transfer (Conduction, convection, & radiation)	Chapter 2		
	F	1/21	Equation and boundary conditions of heat transfer (Derivation of heat transfer governing equation and three types of boundary conditions)	Chapter 3	HW1	
3	M	1/24				
	W	1/26	Conduction heat transfer: steady-state (SS) (1-D SS heat transfer applications: insulation materials, R-values, fins, bio-heat transfer)	Chapter 4		
	F	1/28				
4	M	1/31				
	W	2/2				
	F	2/4			HW2	
5	M	2/7	Conduction heat transfer: unsteady-state (USS) (1-D USS heat transfer applications: incubation, food sterilization, burial depths of water mains in soils)	Chapter 5		
	W	2/9				

	F	2/11				
6	M	2/14				
	W	2/16			HW3	
	F	2/18	Mid-term Exam 1			Exam
7	M	2/21	President's Day (no class, office closed)			
	W	2/23	Convection heat transfer (Calculations of convective coefficient in different flow regimes and geometries, wind chill)	Chapter 6		
	F	2/25				
8	M	2/28				
	W	3/2				
	F	3/4	Heat transfer with change of phase (Freezing process of water and biomaterials, evaporations)	Chapter 7		
9	M	3/7				
	W	3/9				
	F	3/11			Design	
10	M	3/14				
	W	3/16	Spring Break Week			
	F	3/18				
11	M	3/21	Radiative heat transfer (Electromagnetic spectrum and photosynthesis, thermal radiation)	Chapter 8		
	W	3/23			HW4	
	F	3/25	Equilibrium, mass conservation, and kinetics (Psychrometric chart, food preservation, half-life of pesticides in environment)	Chapter 9		
12	M	3/28				
	W	3/30	Modes of mass transfer (Molecular and capillary diffusion, dispersion, convection, and flow through porous media)	Chapter 10		
	F	4/1	Mid-term Exam 2			Exam
13	M	4/4				
	W	4/6				
	F	4/8	Equations and boundary conditions of mass transfer (Derivation of mass transfer governing equation and three types of boundary conditions)	Chapter 11		
14	M	4/11	Diffusion mass transfer: steady-state (1-D SS mass transfer applications: contaminant and oxygen transfer through biofilms)	Chapter 12		

	W	4/13				
	F	4/15	Recess (no class, offices closed)			
	M	4/18	Recess (no class, offices open)			
15	W	4/20			HW5	
	F	4/22	Diffusion mass transfer: unsteady-state (1-D USS mass transfer applications: wood drying, food preservation, oxygen diffusion in silage and composting piles)	Chapter 13		
16	M	4/25				
	W	4/27				
	F	4/29	Convection mass transfer (1-D convective mass transfer applications: pollutant discharge/spills into surface waters and soils, mulching, calculations of convective mass transfer coefficients)	Chapter 14		
17	M	5/2				
	W	5/4			HW6	
	F	5/6	Graduate student term paper presentation			
18	W	5/11	Final Exam (10:30 p.m. - 12:30 p.m.)			Final

* Except for examination dates (<https://www.ndsu.edu/registrar/dates/finals/#c467382>), the above course schedule is subject to change.

EVALUATION PROCEDURES AND GRADING CRITERIA

While the assignment submission policy for this course is outlined below, please note that I will be flexible regarding deadlines for students who are experiencing illness or other challenges related to COVID-19. Please contact me as early as possible if you think you may not be able to complete an assignment or participate in the course due to illness. Do not come to class if you are sick. You can view the Yuja lecture recordings afterward.

Assignment Policy: In this course Blackboard will be used for assignment submission for all students. Due dates for the homework and the term paper will be given with the assignments. Late assignments will be accepted with a 10% penalty per NDSU class day. Assignments must be submitted in hardcopy before 5 p.m. to be credited to the day it is received. Late assignments will not be accepted after solutions are posted/handed out/discussed or after 3 NDSU class days from the date they are due.

Exam Policy: Missed exams will receive zero points unless missed for a valid justification and the instructor is notified prior to the date and time of the exam. Valid justification is a statement indicating illness, obituary notice (death in family or loved one), or co-curricular activities. For such justified reasons, a make-up exam may be given at a mutually acceptable time or the weight of the missed mid-term exam will be shifted to the final exam. Extracurricular activities, weddings, vacations, hunting and fishing trips, work, dentist's appointments, and undocumented car-related incidents are examples of unjustifiable reasons for missing the scheduled dates and times for exams. The instructor reserves the right to determine whether the excuse is legitimate or not.

Grading Policy: All students (undergraduate and graduate) will have to complete the following five categories of work in this course: homework assignments, quizzes, two midterm exams, one process design project, and one final exam.

Graduate students will be required to write a term paper in addition to the above course work. The term paper should cover a transport phenomenon and its solution. Each such paper will be subject to approval from the instructor to ensure appropriate scope and content. A detailed guideline on how to complete the term paper will be provided separately. The requirements for term papers include a written report and an in-class oral presentation.

The possible points which can be earned for all work categories are listed in the table below. Each student's final letter grade in the course will be determined by the percentage of the total earned points over the total possible points using the following grading scale: $A \geq 90\%$, $80\% \leq B < 90\%$, $70\% \leq C < 80\%$, $60\% \leq D < 70\%$, $F < 60\%$.

Work category	Points	
	Undergraduate students	Graduate students
Homework (6)	150	150
Class participation & quizzes (5)	50	50
Mid-term exams (2)	200	200
Process design project (1)	50	50
Final exam	150	150
Term paper (1)	N/A	100
Total	600	700

ATTENDANCE POLICY AND COVID-19 ACCOMMODATION

In accordance with NDSU Policy 333 (<http://www.ndsu.edu/fileadmin/policy/333.pdf>), class attendance and participation are expected at all regularly scheduled class times as they are critical to every student's success in this course. Students are expected to attend every class and remain in class for the duration of the session. Although students are expected to participate in the course face-to-face (see below for face covering policy), when needed students are able to view the recording of the class afterward.

If you are unable to attend class at the regularly scheduled time due to illness, contact the instructor prior to the class meeting time for alternate arrangements, including recordings of class sessions and accommodations needed for assignments.

GUIDANCE REGARDING CLASSROOM MANAGEMENT AND MASKS

NDSU has implemented a mask requirement for all classroom settings whether such classes are credit, non-credit, training sessions, etc. Faculty members who are able to maintain social distance from students may remove their masks during the class for purposes of being more easily heard. Medical exemptions for mask wearing can only come from Disability Services (701-231-8463). Students asking for a medical exemption should be directed to that office. This guidance can be found [here](#).

1. Faculty should set clear expectations about the required use of masks in their classes. In the event that the faculty member has not been strictly enforcing the mask requirement to date,

the faculty member should indicate that, starting with the next class meeting, the policy will be strictly enforced.

2. In the event that one or more students do not wear a mask to a class, the faculty member should remind the student(s) of the mask requirement and indicate that the student(s) must comply.
3. It is optional but recommended that the faculty member offer non-complying student(s) a mask (a limited supply is available from Central Stores).
4. If a student continues to violate the mask requirement after being directed to comply, the faculty member may ask the student to leave the class. The faculty member is not required to either provide an alternative learning method or provide make-up opportunities for any missed class requirements.
5. In the event that a student is asked to leave the class on three or more occasions, the faculty member should contact her/his chair to discuss further action(s). A possible action may be an administrative drop of the class, but this will only be used after a meeting between the student and the chair. This meeting is intended to discuss the situation and gain compliance for mask wearing by the student.
6. If the student is disruptive in class beyond non-compliance on mask wearing, the faculty member should file a Concern and Complaint form with the Dean of Student's Office to determine if a violation of the Code of Student Conduct occurred. The form can be found [here](#).

AMERICAN DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT

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 Disability Services Office as soon as possible. Assistance is also available from Disability Services in 212 Ceres Hall (231-8463). <http://www.ndsu.edu/disabilityservices/>

APPROVED ACADEMIC HONESTY STATEMENT

"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."

All work in this course must be completed in a manner consistent with NDSU Policy, Section 335: Code of Academic Responsibility and Conduct <https://www.ndsu.edu/fileadmin/policy/335.pdf>.

VETERANS AND MILITARY PERSONNEL

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

ADDITIONAL RESOURCES FOR STUDENTS

As a member of the NDSU community, resources are available for you should you need help in dealing with adverse reactions to things happening in the world today. A variety of resources are listed below. For students on campus and remotely (telehealth):

- Counseling Services: 701-231-7671; <https://www.ndsu.edu/counseling/>

- Disability Services: 701-231-8463; <https://www.ndsu.edu/disabilityservices/>
- Student Health Service: 701-231-7331; <https://www.ndsu.edu/studenthealthservice/>
- Dean of Students Office: 701-231-7701; <https://www.ndsu.edu/deanofstudents/>

In a crisis or emergency situation:

- Call University Police: 701-231-8998
- Call 9-1-1
- Go to a Hospital Emergency Room
- Go to Prairie St. Johns for a Needs Assessment: 701-476-7216 (510 4th St. S.)
- Call the FirstLink Help Line: 1-800-273- TALK (8255) or 2-1-1
- Call Rape and Abuse Crisis Center: 701-293-7273

IMPORTANT DATES

January 17	Martin Luther King Jr. Holiday (no class, offices closed)
January 20	Last day to add classes via Campus Connection
January 20	Last day for no-record drop of classes @ 100% refund
January 20	Last day to withdraw to 0 credits @ 100% refund
January 25	Financial Aid applied to Student Accounts
January 31	Last day to submit request to audit, pass/fail
February 21	Presidents' Day Holiday (no classes, offices closed)
March 4	Grades of Incomplete convert to F
March 14-18	Spring Break (no classes)
March 15	Undergraduate Spring graduation application due
March 15	Graduate student Intent to Graduate due
March 2 nd week	Summer/Fall registration appointment times available
April 8	Last day to drop classes with record (W)
April 8	Last day to withdraw to 0 credits
April 8	Spring commencement participation deadline
April 15	Holiday (no classes, offices closed)
April 18	Holiday (no classes, offices open)
May 2-6	Dead Week
May 9-13	Final Examinations
May 14	Commencement

SYLLABI ON WEB PAGES

The course syllabus is also available at Blackboard.