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

BASIC INFORMATION
Number of credits: 3
Meeting place and time: TTh 12:30-1:45 p.m. @ Ladd 209
Instructor's name: Zhulu Lin
Office location: Ladd 104C
Office hours: Monday and Thursday 11:00 a.m.-12:00 p.m. or by appointment
Contact information: Zhulu.Lin@ndsu.edu/231-7118

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 of energy and mass transport processes as they are applied in a biological or environmental context. [ABET–(1)]
2. Define problems, governing equations, and boundary conditions, and solve these problems in biological and environmental systems. [ABET– (1)]
3. Design a heat or mass transfer process to produce solutions that meet specified needs in biological and environmental systems. [ABET– (2)]
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 (NDSU Library Call #: R856.D375 2002)
Other Resources: A regularly checked e-mail account, data storage devices, and a calculator are required.

COURSE SCHEDULE*/OUTLINE/CALENDAR OF EVENTS

Wk	Day	Date	Topics	Readings	HW	Tests
1	T	1/14	Course introduction & pre-test			
	Th	1/16	Equilibrium, energy conservation, and temperature in the environment	Chapter 1		
2	T	1/21	Modes of heat transfer (Conduction, convection, & radiation)	Chapter 2	HW1	
	Th	1/23	Equation and boundary conditions of heat transfer (Derivation of heat transfer governing equation and three types of boundary conditions)	Chapter 3		
3	T	1/28	Conduction heat transfer: steady-state (Bioheat transfer equation for mammalian tissue Applications: insulation materials, R-values, fins, bio-heat transfer)	Chapter 4		
	Th	1/30				
4	T	2/4			HW2	
	Th	2/6	Conduction heat transfer: unsteady-state (Heat transfer processes in compost piles and human body Applications: incubation, food sterilization, burial depths of water mains in soils)	Chapter 5		
5	T	2/11				
	Th	2/13			HW3	
6	T	2/18	Convection heat transfer (Calculations of convective coefficient in different flow regimes and geometries, wind chill)	Chapter 6		
	Th	2/20	Exam 1			Exam
7	T	2/25				
	Th	2/27	Heat transfer with change of phase (Freezing of cellular tissues: Applications: Freezing time of water and biomaterials, evaporations)	Chapter 7		
8	T	3/4				
	Th	3/6			Design	
9	T	3/11	Spring Break			

	Th	3/13	Spring Break			
10	T	3/18	Radiative heat transfer (Photosynthesis and transmissivity of a leaf Applications: Electromagnetic spectrum and photosynthesis, thermal radiation)	Chapter 8	HW4	
	Th	3/20	Equilibrium, mass conservation, and kinetics (Psychrometric chart, food preservation, half-life of pesticides in environment)	Chapter 9		
11	T	3/25				
	Th	3/27	Modes of mass transfer (Molecular and capillary diffusion, dispersion, convection, and flow through porous media)	Chapter 10		
12	T	4/1				
	Th	4/3	Exam 2			Exam
13	T	4/8	Equations and boundary conditions of mass transfer (Derivation of mass transfer governing equation and three types of boundary conditions)	Chapter 11		
	Th	4/10	Diffusion mass transfer: steady-state (Growth rate of bacteria and biomass Applications: contaminant and oxygen transfer through biofilms)	Chapter 12		
14	T	4/15				
	Th	4/17			HW5	
15	T	4/22	Diffusion mass transfer: unsteady-state (Applications: wood drying, food preservation, oxygen diffusion in silage and composting piles)	Chapter 13		
	Th	4/24				
16	T	4/29				
	Th	5/1	Convection mass transfer (Applications: pollutant discharge/spills into surface waters and soils, mulching, calculations of convective mass transfer coefficients)	Chapter 14		
17	T	5/6			HW6	
	Th	5/8	Graduate student term paper presentation			
18	F	5/16	Exam 3 (8:00 - 10:00 a.m.)			Exam

[*]Except for examination dates (https://www.ndsu.edu/registrar), the above course schedule is subject to change.
[†]ABC – advanced biological contents.

ATTENDANCE POLICY

In accordance with NDSU Policy 333 (http://www.ndsu.edu/fileadmin/policy/333.pdf), class participation is expected at all regularly scheduled class meeting 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. Attendance will be taken regularly by the instructor and 25 bonus points will be awarded to students who regularly attend the class with one or fewer missed class sessions *under any circumstances* throughout the semester. For students who have more than one missed session, no bonus points will be awarded.

Although students are expected to participate in the course in person, when needed *occasionally* students may request the instructor to record the lecture and review it at a different time. If you are unable to attend class at the regularly scheduled time due to health issues, contact the instructor prior to the class meeting time for alternate arrangements, including recordings of class sessions and accommodations needed for assignments.

EVALUATION PROCEDURES AND GRADING CRITERIA

Assignment Policy: Due dates for homework, design projects and term papers 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 4 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.

You are encouraged to work together with others for your homework and lab assignments because that will help you learn. You are also encouraged to contact the instructor for assistance during office hours or by appointment. Although students are encouraged to work together and assist one another with assignments, all work submitted should be created by that individual. If it is apparent that work has simply been copied from other's work, all students involved will receive zero point for that assignment.

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 ≥ 90%, 80% ≤ B < 90%, 70% ≤ C < 80%, 60% ≤ D < 70%, F < 60%.

Work category	Points	
	Undergraduate students	Graduate students
Homework (6)	150	150
Quizzes (5)	50	50
Mid-term exams (2)	200	200
Process design project (1)	50	50
Final (Exam 3)	150	150
Term paper (1)	N/A	100
Total	600	700
Attendance (Bonus)	25	25

Graduate Student Term Paper:

Progress	Due Date	Points	Requirements
Topic selection	Jan 28 (T)	10	1. At least two references 2. Minimum half-page write-up, including title, outline, and references
Proposal	Feb 25 (T)	10	1. No less than 2 pages 2. Include an introduction, proposed methods, preliminary results, and references
Draft report	Apr 15 (T)	30	See requirements for the draft/final written report
Oral presentation	May 8 (Th)	10	See requirements for oral presentation
Final Report	May 16 (F)	40	See requirement for the draft/final written report

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 Center for Accessibility and Disability Services (www.ndsu.edu/disabilityservices) as soon as possible.

FAMILY EDUCATIONAL RIGHTS AND PRIVACY (FERPA) STATEMENT
Your personally identifiable information and educational records as they relate to this course are subject to FERPA.

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.

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

Jan 13	Mon	Classes begin at 4:00 p.m.
Jan 14	Tue	First full day of classes
Jan 20	Mon	HOLIDAY — Martin Luther King, Jr. Day (no classes, offices closed)
Jan 21	Tue	Last day to be added to Campus Connection Wait Lists
Jan 23	Thu	Last day to Add classes via Campus Connection.
Jan 23	Thu	Last day for no-record Drop of classes @ 100% refund
Jan 23	Thu	Last day to Withdraw to Zero Credits @ 100% refund
Jan 28	Tue	Financial aid applied to NDSU account balances
Jan 29	Wed	Payments due for NDSU account balances
Feb 3	Mon	Last day to submit requests to Audit, Pass/Fail
Feb 17	Mon	HOLIDAY — Presidents' Day (no classes, offices closed)
Feb 24	Mon	Last day to Withdraw to Zero Credits @ 75% refund
Mar 10-14	M-F	Spring Break Week (no classes, offices open)
Mar 15	Sat	Late fee applied to unpaid account balances (11:59 p.m.)
Mar 27	Thu	Last day to Withdraw to Zero Credits @ 50% refund
Apr 11	Fri	Last day to Drop classes with 'W' record*
Apr 11	Fri	Last day to Withdraw to Zero Credits for Spring
Apr 15	Tue	Late fees applied to unpaid account balances (11:59 p.m.)
Apr 18-21	F-M	HOLIDAY -- Spring Recess
May 5-9	M-F	Dead Week
May 9	Fri	Last day of Spring classes
May 12-16	M-F	Final Examinations

SYLLABI ON WEB PAGES

The course syllabus is available on Blackboard and ABEN Department webpages.