BSE 3504: Transport Processes in Biological Systems
Spring 2016

CRN:	11482
Location:	409 Saunders
Time:	MWF 10:10-11:00 am
Instructor:	Dr. Warren Ruder
Office:	301K HABB1
Phone:	231-0035
E-mail:	wruder@vt.edu
Office Hours:	MW 2:30 – 4:00
HW Session:	M 5:15 – 6:15; Seitz 108
TA:	Breanne Ensor
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Catalog Description:

Introduction to material and energy balances in biological systems. Fundamentals of heat and mass transfer in biological systems. One and two dimensional conduction, convection, and diffusion of thermal energy and mass. Heat and mass transfer rates, steady and unsteady state conduction, convection, diffusion; design of simple heat exchangers. Application of these topics and fluid mechanics to fluid handling, bacterial growth, plant nutrient uptake, enzymatic reactions.

Prerequisites:

BSE 3154 Thermodynamics of Biological Systems and ESM 3024 Fluid Mechanics

Textbook:

Transport Processes and Separation Process Principles, Fourth Edition, by Christie John Geankoplis, 2003, Prentice-Hall Publishers, NJ. BSE 3504 covers Part I of this textbook (Chapters 1-7).

Course Website:

Check the course website (Canvas or http://canvas.vt.edu) regularly for course materials, assignments, and announcements.

Learning Objectives:

Upon successful completion of this course, the student will be able to:

1. Define a system and its boundaries and perform material, energy, and momentum balances.
2. Explain basic principles of momentum transport and solve problems involving pipe flow, fluid handling, packed beds, mixing, and non-Newtonian fluids.
3. Explain basic principles of heat transport. Solve problems involving steady state heat transport in conduction, convection, and radiation. Demonstrate understanding of heat exchanger design and use.

4. Apply general heat transport principles in solving non-steady state heat transfer problems.
5. Explain basic principles of mass transport. Solve problems involving diffusive and convective mass transport.

Course Outline:

This is a foundation course for all Biological Systems Engineering students. Fundamentals of heat and mass transfer including one and two dimensional conduction, convection, and mass diffusion will be covered. For heat transfer, both steady state and non-steady state heat transfer will be covered. Application of the above topics in biological systems will be addressed.

Tentative class schedule (subject to change at instructor's discretion):

Week 1: Introduction/Material and heat balances	Ch. 1
Week 2: Momentum transport	Ch. 2
Week 3: Momentum transport	Ch. 2
Week 4: Momentum transport applications	Ch. 2/3
Week 5: Momentum transport applications	Ch. 3
Week 6: Steady state heat transport	Ch. 4
Week 7: Steady state heat transport/Heat exchangers	
Exam 1 (Ch. 1-3) March 2	Ch. 4
Week 8: Spring Break (No class)	
Week 9: Steady state heat transport	Ch. 4
Week 10: Non-steady state heat transport	Ch. 5
Week 11: Non-steady state heat transport/Chilling and freezing/	
Exam 2 (Ch. 4,5) March 30	Ch. 5
Week 12: Mass transport/Diffusion	Ch. 6
Week 13: Diffusion in solids, liquids, and gases	Ch. 6
Week 14: Diffusion in solids, liquids, and gases	Ch. 6
Week 15: Non-steady state mass transport	Ch. 7
Week 16: Non-steady state/Convective mass transport	Ch. 7
Finals Week: Exam 3 (Ch. 6,7) Monday May 9 7:45 – 9:45 AM (10M)	

Course Grade:

Each student's grade in the course will be determined as follows:

Exam 1	33%
Exam 2	33%
Final Exam	34%
Total	**100%**

Grades will be assigned based on the following scale:

Letter Grade	From	To
A	93	100.00
A-	90	92.99
B+	87	89.99
B	83	86.99
B-	80	82.99
C+	77	79.99
C	73	76.99
C-	70	72.99
D+	67	69.99
D	63	66.99
D-	60	62.99
F	0	59.99

Assignments:

Assignments are optional weekly (ca. 14) homework assignments. The homework will be assigned on each Friday by 4 pm and will be due the following Wednesday by 4 pm. Homework can be submitted through Canvas only. The due date and time are **FIRM**. Electronic submissions must be 1 single PDF file (not scanned pages sent as multiple .jpeg files, for example) and must have the file name *student last name_HW#.pdf*. No typewritten solutions will be accepted unless the problem calls for the student to hand in computer code. Excuses that include, for instance, "computer or software problems related to Canvas" will not be accepted. Extra credit in the amount of 3 points added to the upcoming exam will be given if the student *completes* all assignments due prior to an exam. Thus, there will be three different opportunities to earn 3 points of extra credit based on homework assignment completion.

Electronic Devices:

Absolutely no electronic devices except a calculator may be used during an exam. Examples of electronic devices include laptops, cell phones, or tablets. If your class notes are on such a device, please transfer them to paper copies for the exam. You cannot use those devices as your calculator either.

Special Needs:

If you need adaptations or accommodations because of a disability, please provide the instructor with proper documentation from the Services for Students with Disabilities (SSD) office at the beginning of the semester so that proper arrangements can be made. Testing for students with disabilities will be conducted by SSD. Alternative times and locations will be decided upon prior to the exams in conjunction with SSD.

Procedure for Verified Absences:

If for some reason you miss an assignment or an exam and would like to make it up, the instructor will not decide whether or not your reason is acceptable. Instead, the

instructor with work with students having a verified absence and develop alternate arrangements for making up the assignment or exam. Students are not to share personal information with the instructor as a means to arbitrate an absence. Mechanisms exist within the university to verify absences without compromising student personal information. Students should have their absences verified by the Dean of Students Office or the Schiffert Health center. The verification of absence is sent by one of these offices to the student's academic dean's office. The academic dean's office then forwards the verification of absence to the student's professors. Thus, a student's personal information is retained at the university/college level.

Honor Code:

"The Virginia Tech Honor code will be strictly enforced in this course. All assignments submitted shall be considered graded work, unless otherwise noted. All aspects of your course work are covered by the honor system. Any suspected violations of the honor code will be promptly reported to the honor system. Honesty in your academic work will develop into professional integrity. The faculty and students of Virginia Tech will not tolerate any form of academic dishonesty."