**BMEG 315 - Transport Phenomena in Biological Systems**

**Pre-requisites**: MATH 261 and (BIOL 235 or BIOL 117)

**Instructor:** Dr. Jessica Allen

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**Class:** 2:00-3:50pm MW, 209 MRB

**Office Hours:** 4-5pm MW or by appointment

**Course Description**

Students will learn to develop fundamental relationships for momentum and mass transfer from microscopic and macroscopic balance equations and to apply these basic relationships to biological systems that include biochemical reactions, interphase transport, and transient phenomena.

**Student Learning Objectives**

Students will be able to:

1. Apply conservation laws and constitutive equations to problems related to the transport of mass and momentum in physiological systems. (ABET Outcome 1)
2. Formulate governing equations using macroscopic balances to obtain solutions for both simple flow geometries and biologically realistic flow geometries (ABET Outcome 1)
3. Formulate governing equations using microscopic balances to determine appropriate boundary conditions and to solve simple 1-D mass or momentum transport problems or problems in physiological systems. (ABET Outcome 1)
4. Distinguish between modes of mass transfer. (ABET Outcome 1)
5. Analyze complex fluid flows by approximate analytical methods or computational tools. (ABET Outcome 1)
6. Predict complex transport phenomena within biological systems, such as 2-D or transient behavior, using either approximate analytical methods or computational tools. (ABET Outcome 1)

**Required Text**

R.J. Roselli, K.R. Diller. *Biotransport: Principles and Applications*, Springer, 2011

**Related Texts and Recommended Reading**

G.A. Truskey, F. Yuan, D.F. Katz, *Transport Phenomena in Biological Systems*, Pearson Prentice Hall, 2004.

R.B. Bird, W.E. Stewart, E.N. Lightfoot, *Transport Phenomena*, John Wiley & Sons, 2006.

**Grading**  2 Exams (@ 30 % each) 60 %

Final Exam 30 %

Homework Problem Sets 10 %

100 %

**Grade Assignment:** A: 90 – 100

 B: 80 – 89

 C: 70 – 79

 D: 60 – 69

 F: 0 – 59

 At the instructor’s discretion, this scale may be lowered, but not raised.

**Exams:**

* There will be two mid-term exams during the semester and a comprehensive final exam.
* No make-up exams except by prior arrangement with instructor.
* For each mid-term exam, you will be permitted to use one 8.5 by 11-inch handwritten sheet of notes (front and back). For the final exam, you will be permitted two 8.5 by 11-inch handwritten sheets of notes (front and back). All notes must be turned in with the exam.
* Exam grading appeals must be received in writing on the day the exam is returned. If you miss that class, you lose the opportunity for regrading. In addition, the instructor reserves the right to regrade all the problems on the exam, not just the ones for which the appeal is made.

**Homework Assignments**:

* Each homework assignment will contribute an equal amount to your final homework grade.
* Homework must be neat and easy to follow. You must use 8.5” x 11” paper (either plain white printer paper or engineering paper). Each problem must start on a new page. Answers must be boxed and have units as appropriate. No credit will be given for answers without work. Credit will also be deducted for using incorrect paper, not starting each problem on a new page, missing or incorrect units, and sloppy work that is hard to follow.
* Many homework assignments will require you to use MATLAB. Your MATLAB code and associated answers must be printed out and turned in along with any written work.
* Students are encouraged to work together to understand the concepts in the homework; however, each student should work out his/her own solutions. Submitted homework should reflect your own work. Assignments that are obviously copied will receive no credit.
* Homework assignments are due at the beginning of class one week after assigned. Homework solutions will be posted 24 hours after the homework is due. Absolutely no credit will be given for homework turned in after solutions are posted. Late homework will be subject to a strict deduction policy as follows:

If homework is turned in by: - Beginning of class: Full credit

* End of class: 10% deduction
* 9am the next day: 30% deduction
* 2pm the next day: 50% deduction

(24 hours after due)

**Electronic Device Policy:**

If your use of electronic devices distracts others (including me) during class time, I reserve the right to deduct points from your grade for each such instance without warning. All cell phones should be on silent. Absolutely no electronic devices will be allowed during exams.

**Attendance Policy:**

Consistent with WVU guidelines, students absent from regularly scheduled examinations because of authorized University activities will have the opportunity to take them at an alternate time. Make-up exams for absences due to any other reason will be at the discretion of the instructor.

**Academic Integrity:**

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, instructors will enforce rigorous standards of academic integrity in all aspects and assignments of their courses. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the [West Virginia University Academic Standards Policy](http://catalog.wvu.edu/undergraduate/coursecreditstermsclassification) (http://catalog.wvu.edu/undergraduate/coursecreditstermsclassification). Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see your instructor before the assignment is due to discuss the matter. **Inclusivity Statement:**

The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion.

If you are a person with a disability and anticipate needing any type of accommodation in order to participate in your classes, please advise your instructors and make appropriate arrangements with the [Office of Accessibility Services](https://accessibilityservices.wvu.edu/). (https://accessibilityservices.wvu.edu/)

More information is available at the [Division of Diversity, Equity, and Inclusion](https://diversity.wvu.edu/%29) (https://diversity.wvu.edu/) as well.

**Approximate Schedule – Subject to Change**

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| --- | --- | --- | --- |
| **Week** | **Date** | **Topic** | **Reading** |
| 1 | 1/07/19 (M) | Introduction to BioTransport | MathHandouts |
|  | 1/09/19 (W) | **No Class (1/9, Dr. Allen travel)** |
| 2 | 1/14/19 (M) | Momentum Transport Concepts | Ch. 4 |
|  | 1/16/19 (W) | Macroscopic Biofluid Analysis | Ch. 5 |
| 3 | 1/21/19 (M) | **No Class (1/21, MLK)** |  |
|  | 1/23/19 (W) | Macroscopic continued |  |
| 4 | 1/28/19 (M) | 1D Momentum Transport (Shell Balance) | Ch. 6 |
|  | 1/30/19 (W) |  |  |
| 5 | 2/04/19 (M) | Differential Equations of Change (EOC) | Ch. 7 |
|  | 2/06/19 (W) |  |  |
| 6 | 2/11/19 (M) | Momentum Transport Review |  |
|  | 2/13/19 (W) | **MIDTERM EXAM #1**  |  |
| 7 | 2/18/19 (M) | Mass Transport Concepts | Ch. 12 |
|  | 2/20/19 (W) | Macroscopic Biomass Transport | Ch. 13 |
| 8 | 2/25/19 (M) |  |  |
|  | 2/27/19 (W) | Shell Balance for Mass Transport | Ch. 14 |
| 9 | 3/04/19 (M) |  |  |
|  | 3/06/19 (W) | EOC for multicomponent systems | Ch. 15 |
| **10** | **3/11/19** | **No Class, Spring Recess** |  |
| 11 | 3/18/19 (M) |  |  |
|  | 3/20/19 (W) | Mass Transport Review |  |
| 12 | 3/25/19 (M) | **MIDTERM EXAM #2**  |  |
|  | 3/27/19 (W) |  |  |
| 13 | 4/02/19 (M) | Non-isothermal EOC / Energy Transport | Ch. 8 & 11 |
|  | 4/03/19 (W) |  |  |
| 14 | 4/08/19 (M) | Advanced/Applied Topics |  |
|  | 4/10/19 (W) |  |  |
| 15 | 4/15/19 (M) | Advanced/Applied Topics |  |
|  | 4/17/19 (W) |  |  |
| 16 | 4/22/19 (M) | Advance/Applied Topics |  |
|  | 4/24/19 (W) | Review for Final |  |
|  | **4/29/19 (M)** | **FINAL EXAM (4/29, 11AM-1PM)** |  |
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