BME 2240 Biotransport
Spring 2013 Learning Guide
collab.itc.virginia.edu/portal/

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When and where do we meet?

Class discussions:	Tue/Thu 9:30-10:45 am, THN xxxx
Coaching sessions:	Fri 9:00-9:50 am, MR5 1040
Dr. Helmke office hours:	xxx
TA office hours:	xxx

Why should you care about Biotransport?

How can you deliver a drug to kill tumors without killing the patient? How can you harness nanotechnology to design inexpensive kits to diagnose diseases in low-resource countries? How do new blood vessels grow? These are examples of "grand challenges" faced by practicing biomedical engineers that require us to design mathematical and experimental approaches for predicting, measuring, and interpreting flow phenomena quantitatively. In this course, you will combine your knowledge of applied mathematics and human physiology from the molecule to cell to whole body length scales to begin exploring how to answer grand challenge questions such as these.

How will this course help you succeed?

Grand challenges are fundamental questions in biotransport with broad applications to science, engineering, and human health. This course will help you acquire a conceptual and practical framework that you can apply to solve complex grand challenges in your future research, engineering practice, or clinical practice. By the end of the course, you will be able to answer the following questions:

1) How do I use math to figure out how, why, and where stuff flows in the body?
2) Some equations in physics and engineering are easy, like $F = ma$. When and how can I use simple common sense equations for flows in my complicated biology models or medical device designs?
3) I've taken classes like calculus and cell biology, but I don't know what those classes have to do with each other. How do I put stuff from other classes together to solve real-world biology problems or to design medical devices?
4) Can I use equations and answers that I found using Google and Wikipedia to solve homework problems and to do engineering design?
5) How do I use equations and answers from this class to solve problems in research and medicine next year in my Senior Capstone Project or after I graduate?

Want to see these objectives in the geeky language of academics and ABET? Click here.

Where can you look for important information?

Anywhere you want! "Real" biomedical engineers use handbooks, textbooks, online resources, peer-reviewed articles, personal communications with colleagues, etc. to learn what they need to know to answer complex questions like the ones listed above. As your colleague, I will recommend some resources and post my notes on the class Collab site, but you should not feel limited to only the materials I suggest. In fact, you will probably need additional resources to complete the full story surrounding some of these challenging questions.

How will you succeed in this course?

Participate. You are expected to participate actively in the course based on your own learning goals. Since you all come from different backgrounds and science experiences, your peers are valuable resources for learning. Don't shortchange them and yourself by coming to class without preparing or by sitting quietly during class discussion.

Communicate. This course may be unlike any of your previous courses, with increasingly complex content and new kinds of engineering challenges. Because I am committed to helping you address these new challenges, I have an open door policy in addition to class and office hours; I will meet with you or respond to your email within 24 hours whenever possible. You should let me know what ideas and tools are challenging to you and how you are doing in the class. If you start this habit early in the semester, then I will be able to better tailor our activities to help you learn. If you're not comfortable with email or office hours, then post a comment in Anonymous Feedback on the class Collab site.

Take risks. Engineering design often requires personal judgments about which references to include or ignore, which mathematical approaches to follow, and/or how to interpret complex data. Sometimes the "right" answer is unknown, incomplete, or even wrong! Nobel Prize breakthroughs have often resulted from attempting to support a "best guess" with incomplete data or from finding evidence to explain an "experiment gone wrong." You will be rewarded for going out on a limb to defend your ideas as long as your assumptions and decision-making process are transparent in your answers. If you're not sure how to start a problem, don't be scared to defend your assumptions and go for it!

Have fun. Sometimes we all need a mental break. During each class, we will take a break while one or more of you tells a joke. The only rule is that it must not be a joke that will get me fired! Jokes are not graded; it's just for fun! A suggested schedule of daily jokers is listed on the iSyllabus.

How will you and I evaluate your progress?

Solving a grand challenge (25%). In this group project, you will identify and set up a framework to solve a grand challenge in biotransport. We will work together early in the semester to identify a list of topics based on your suggestions, research and design challenges in the BME department and UVa, and current events in medicine and engineering. Your team's goal is to identify, to evaluate, and to integrate resources from class, in textbooks, in peer-reviewed literature, and online that you will use to develop a framework for addressing the grand challenge. In some cases, you may be able to propose a complete mathematical solution. Your grade will be based on a rubric (that I will share with you) that assesses criteria such as problem definition, evaluation of resources, peer review of each other's work, responses to peer review, quality and completeness of the solution framework, and discussion of the innovativeness and importance of your project.

Out-of-class problems (25%). Practicing by doing is often effective to help you learn common equation derivations and mathematical methods. The homework problems are designed to give you practice setting up and solving analytical equations that you will be able to apply to answer questions in specific biomedical engineering applications. The TA and I are available during Friday morning coaching sessions to help you when you get stuck. The Homework Guide will help you with formatting guidelines, electronic submission, and grading rubric. In some cases, you will grade each other's answers.

In-class problems (25%). In the role of professional consultant, biomedical engineers sometimes need to come up with common equations and solution methods quickly. During a few classes, you will act as consultants, either individually or in teams, to solve new twists on problems that you have seen before. You can solve the problems using any resources available to you in the classroom (including web-enabled devices).

Final exam (15%). The cumulative final exam will challenge you with a series of short questions and problems to assess your ability to integrate concepts and methods from class discussions and your grand challenge project.

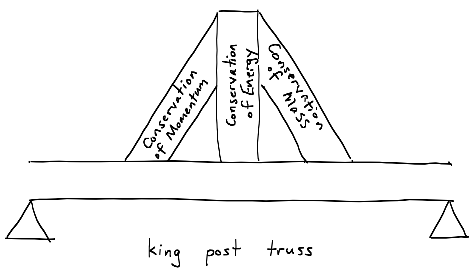
Helping yourself learn (10%). In order to evaluate your own progress in learning each day's concepts, you will be asked to answer a short question or write a "one-minute paper" either during or after each class. Specific instructions will be provided with each assignment. These answers will not be graded individually, but completing them thoughtfully will count towards your grade. Some will be submitted anonymously. In order to help us figure out where we are, the following class will sometimes start with feedback and discussion of these answers.

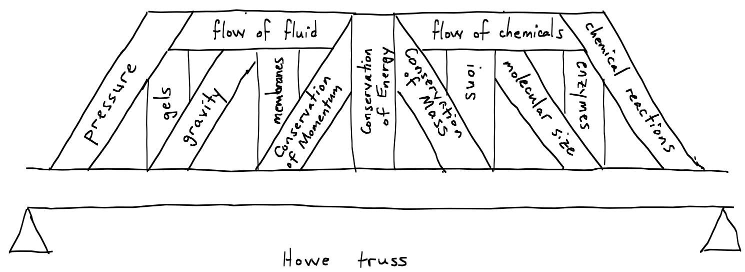
Professional and Academic Integrity

As practicing professionals, engineers are trusted to maintain the highest standards of ethics, integrity, and personal responsibility. Since you have joined this community of trust to prepare for your future career, I expect you to fully comply with all of the provisions of the UVa Honor System. In addition to pledging that you have neither received nor given aid on an assignment, your signature also affirms that you have not knowingly represented as your own any opinions or ideas that are attributable to another author in published or unpublished notes, study outlines, abstracts, articles, textbooks, or web pages. In other words, I expect that all assignments and reports are your original work and that references are cited appropriately. Breaking this trust agreement not only will result in zero credit for the assignment in question and referral to the Honor Committee but also will jeopardize your future as a professional engineer. Don't let yourself down.

What will we do in this course?

The bridge truss diagrams below illustrate how we will develop your framework for solving a grand challenge question in biotransport. The three conservation laws are like the basic shape of a king post truss bridge: they are required and sufficient to provide a stable foundation for any bridge truss design or to solve any biotransport problem. However, for more complicated or specialized problems, like longer bridge spans, heavier truck loads, or multi-lane highways, more complicated truss designs are required that use additional truss elements. Likewise, we will solve complex biotransport problems by adding elements to the basic conservation laws.





The calendar of class activities is published here. In order to help you plan, the due dates for assignments are fixed. The rest of the list is *dynamic* so I can adjust the activities and timing based on our progress and interests. I will update the calendar after each class to keep you informed.

More questions?

Check out the class FAQ.

Learning Goals

1) To approach problem-solving as a practicing engineer. (Foundation Knowledge; Application; Integration; Learning to Learn)
2) To become curious and creative in using math to solve medical problems. (FK; Application; Caring; Learning How to Learn)
3) To integrate skills and knowledge from earlier courses. (Integration)
4) To appreciate classical engineering fluids and mass transport solutions and their relevance to more modern or sophisticated numerical approaches. (Foundation Knowledge; Application; Caring)

Formal Objectives (ABET)

1) to identify the principles, assumptions, and mathematics governing biological transport processes [Foundation Knowledge];
2) to apply classical engineering solutions, boundary conditions, and governing equations to complex biomedical transport processes and device designs [Practical Thinking];
3) to integrate knowledge of cell and organ physiology with mathematical expression of transport principles [Application; Integration];
4) to find and to evaluate critically classical engineering problem solutions available in well-known textbooks or online resources [Critical Thinking; Practical Thinking; Learning How to Learn];
5) to synthesize new applications of analytical engineering solutions to problems in research and medicine [Creative Thinking; Caring; Learning How to Learn].