

APPL 385

Flow of Force, Matter and Energy Through the Biosphere

Spring 2021

Introduction	Flow and movement of matter, force and energy are ubiquitous in every aspect of life on our biosphere, from our motile cells that transfer chemical energy to motion to the flow and mixing of air and water in the atmosphere and the oceans. Underpinning all these transport processes are three fundamental laws of nature: conservation of mass, momentum and energy. Although these processes can occur over vastly different length scales, the equations and physical principles that describe them are in fact very similar. By studying different examples, we will see throughout the course that the flow of mass, momentum and energy can be analyzed in a single framework known as <i>Transport Phenomena</i> in science and engineering.
Methods	Given the uncertainties surrounding COVID-19, class may be partially online. Each class session will include a small group activity using Zoom breakout rooms. For examples, students may be working together on simulations and modeling, or discussing the role of transport processes in different natural phenomena. There will be a variety of assignments, including interviews, programming simulations using MATLAB, and group projects. Some class sessions will be project work time and the faculty and TAs will float between breakout rooms in zoom to provide extra help. Students will also be expected to work on their projects outside of class time.
Results	By the end of this course, students should be able to do the following: <ul style="list-style-type: none"> • Identify the processes involving flow of energy, mass and momentum in natural settings or applications. • Analyze these processes and divide them into subprocesses such as diffusion of different materials, heat convection and fluid flows. • Formulate these processes in mathematical form and do a “back of the envelop” calculation to assess the relative importance of different processes. • Use MATLAB computational tools to solve the equations numerically, and analyze the findings to draw conclusions on the parameters controlling the transport processes • Work effectively in teams • Communicate solutions to problems in written and oral form
Prerequisites	Student must have taken and enrolled in MATH 233 (Calculus of Functions of Several Variables) course. We encourage you to take the complementary class Math 383 (First Course in Differential Equations). This class is appropriate for you: if you are thinking about a minor in Applied Sciences and Engineering; if you anticipate that you could be working with engineering or perusing engineering related studies in graduate school; if you are interested in bioengineering, environmental science and scientific computing as a whole.

Class Essentials

Dr. Ehssan Nazockdast

Teaching assistants

 Office Location: Murray Hall 1112  Email: ehssan@email.unc.edu  Office phone: 919-962-5097  Office Hours: TBD	TBD
--	-----

Course content

➤ COURSE TOPICS AND SCHEDULE

- Exploring examples of different transport processes in nature (week 1)
- Interviewing professionals in industry or academia working in areas related to transport processes (week 2)
- Transport of mass, heat and momentum through **Advection** (week 3)
- Transport of mass, heat and momentum through **Diffusion** (week 4)
- Project 1 (week 5)
- Formulating differential equations for conservation of mass, momentum and energy. (weeks 6 and 7)
- Modeling simple examples (weeks 8-10)
 - Mass transfer in synthetic and biological membranes
 - Heat transfer in fins in natural and industrial settings
 - Flow in channels and vessels in natural and industrial settings
 - Buckingham Pi theorem and its applications
- Guest speakers (week 11)
- Final project. Multiphysics Simulations. (weeks 12-14)
 - Defining the project
 - Learning to use MATLAB Partial Differential Equation package FEATool
 - Use FEATool to work on projects

To help you succeed

➤ COURSE EXPECTATIONS AND POLICIES

- Watch all online lectures and do all reading assignments before coming to class (in-class quizzes will help to encourage you to do this).
- Participate in class discussions and activities.
- During class time, do not use your phone or computer for something unrelated to class
- Come to every scheduled class and let us know ahead of time if you cannot attend.
- Turn in assignments on time; if an assignment is up to 24 hours late, there is a 25% deduction, and if an assignment is beyond 24 hours late, you will get a zero. If you need an extension, you must ask at least 24 hours before the time that the assignment is due (you can avoid a grade deduction this way).

Zoom etiquette:

- Turn on your video if your Internet bandwidth is good enough to handle it

- Use a virtual background if you don't want anyone to see your sloppy room, your half-dressed roommate, or your mom in the background
- If you have to use the bathroom during class, don't take **anything** (AirPods, phone, etc.) with you!
- During class, put your phone and computer in "Do Not Disturb" mode, and close everything on your computer that is unrelated to the class
- Keep your mics muted when we are together as a large group, except breakout rooms, when you should unmute your mic
- We will frequently use the chat window, Google Docs, and breakout rooms for interaction this semester
- Use a computer instead of a phone or tablet for class. We will be using Matlab and doing other activities during class that are much easier to do with a computer

➤ STUDENT RESOURCES

SEE, SAY, DO SOMETHING

We're happy you are here and eager to learn. Despite our best intentions to follow a plan, life may throw us a curve ball. If you or someone you know is experiencing some distress or you are concerned about the well-being of a student, please report it here: <https://deanofstudents.unc.edu/carereport>. It is important to support one another. If you see something, say, and do something.

ACCESSIBILITY RESOURCES

UNC-CH provides accommodations for any students with documented disabilities. If you have a disability and believe you require accommodations, please contact the Department of Accessibility Resources at <http://accessibility.unc.edu>. Please contact us early in the semester so we can make any necessary arrangements and discuss the learning checks.

Title IX Resources

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Please contact the Director of Title IX Compliance (Adrienne Allison –Adrienne.allison@unc.edu), Report and Response Coordinators in the Equal Opportunity and Compliance Office (reportandresponse@unc.edu), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (gvsc@unc.edu; confidential) to discuss your specific needs. Additional resources are available at safe.unc.edu.

Community Standards in Our Course and Mask Use.

This fall semester, while we are in the midst of a global pandemic, all enrolled students are required to wear a mask covering your mouth and nose at all times in our classroom. This requirement is to protect our educational community — your classmates and me — as we learn together. If you choose not to wear a mask, or wear it improperly, I will ask you to leave immediately, and I will submit a report to the Office of Student Conduct. At that point you will be disenrolled from this course for the protection of our educational community. An exemption to the mask wearing community standard will not typically be considered to be a reasonable accommodation. Individuals with a disability or health condition that prevents them from safely wearing a face mask must seek alternative accommodations through the Accessibility Resources and Service. For additional information, see Carolina Together.

Assignments & Evaluation

➤ YOUR COURSE GRADE

Homework, simulations, and interviews	35%
In class activities, such as worksheets, quizzes	35%

Project 1	10%
Project 2	20%
Total	100%

➤ GRADE INTERPRETATION & HONOR CODE

Your final course grade will be determined from a standard scale:

A	93+
A-	90.0 - 92.9
B+	87.0 - 89.9
B	83.0 - 86.9
B-	80.0 - 82.9
C+	77 - 79.9
C	73 - 76.9
C-	70 - 72.9
D+	67 - 69.9
D	60 - 66.9
F	<60

ACADEMIC HONESTY

There will be clear communication if assignments are individual or group. For individual assignments, while I encourage collaboration, it is a violation of the honor code if a student duplicates work or obtains solutions from another student and submits it on their own. Please reference the honor code: <http://honor.unc.edu>.

➤ CLASS RECORDING POLICIES

The University may record meetings of this class for educational purposes. These recordings will be shared only with students enrolled in the course for purposes of academic instruction only. Your instructor will communicate to you how you may access any available recordings.

Unauthorized student recording of classes on personal devices or on any other format is prohibited.

Students requesting the use of assistive technology as an accommodation should contact [Accessibility Resources & Service](#). Other students must obtain express permission from the department to record the class, and the University will only grant such permission in extraordinary circumstances in which the student otherwise lacks access to a recording made by the University or instructor. Students shall not copy, reproduce, or distribute any recordings of their classes, and students shall delete any recordings at the conclusion of the course.

Any violation of these prohibitions or restriction on the making, use, copying, or distribution of recording of classes shall constitute an honor code violation.

I reserve to right to make changes to the syllabus, including project due dates and test dates (excluding the officially scheduled final examination), when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules.