

# APPL 385

## Flow of Force, Matter and Energy Through the Biosphere









### Fall 2023

#### Course Information

Credit Hours	4 credit hours. Out of these hours, there will be 3 hours/week of class time and 1 hour/week of Lab time.
Pre or Co-requisites	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).
Target Audience	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 .
Meeting Pattern	TBD
Instructional Format	In-person
Classroom or Location	TBD

#### Instructor Information

**Note:** Instructors should hold a total of 3 office hours per week for a standard 3-credit hour course.

Instructor	Name: Dr. Ehssan Nazockdast  Office Location: Murray Hall 1112  Office Hours: TBD  Contact Email: <a href="mailto:ehssan@email.unc.edu">ehssan@email.unc.edu</a>  Zoom Room ID: NA
Teaching Assistant(s)	Name: TBD  Office Location: TBD  Office Hours: TBD  Contact Email: TBD  Zoom Room ID:

#### Course Content

##### Course Description

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 *Transport Phenomena* in science and engineering.

##### Course Texts & Software

There is no required text for this course. The following book is a great resource to learn more about the general concepts of fluid mechanics, mass, and heat transfer, and provides a more in-depth the mathematical treatment of the

problems, compared to what we will cover in the main class. The book will be made electronically available through Canvas:

Bird, R. B., Stewart, W. E., Lightfoot, E. N., & Klingenberg, D. J. (2015). *Introductory transport phenomena*. Wiley Global Education.

We will be using MATLAB programming language and different packages (for example, FEATool) for solving the partial differential equations for mass, momentum, and energy transport during the Lab times. MATLAB is available to all UNC undergraduate students and FEATool basic software can be downloaded for free from <https://www.featool.com/download>. Any other software that we may use in this course will also be freely available through UNC or open-sourced.

### Course Goals and Learning Outcomes

By the end of this course, students should be able to do the following:

- 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 and other computational tools to solve the equations numerically, and analyze the findings to draw conclusions on the parameters controlling the transport processes (Lab component)
- Work effectively in teams
- Communicate solutions to problems in written and oral form

### Expected Time Dedicated to the Class

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.

We expect the students to spend about 6 hours/week outside of classroom for this 4h/week course.

## Course Assignments & Assessments

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➤ YOUR ASSIGNMENTS & COURSE GRADE	
Homework, simulations, and interviews	35%
In class activities, such as worksheets, quizzes	35%
Project 1	10%
Project 2	20%
<b>Total</b>	<b>100%</b>

➤ 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>ACADEMIC HONESTY</b> 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: <a href="http://honor.unc.edu">http://honor.unc.edu</a> .

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

## ➤ 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
- Guess speakers (week 11)
- Final project. Multiphysics Simulations. (weeks 12-14)
  - Defining the project
  - Learning to use [MATLAB Partial Differential Equation \(PDE\) package FEATool Multiphysics](#)
  - Use FEATool to work on projects

## Academic and Course Policies

### Attendance Policy (Required)

#### University Policy:

No right or privilege exists that permits a student to be absent from any class meetings, except for these University Approved Absences:

1. Authorized University activities
2. Disability/religious observance/pregnancy, as required by law and approved by [Accessibility Resources and Service](#) and/or the [Equal Opportunity and Compliance Office](#) (EOC)
3. Significant health condition and/or personal/family emergency as approved by the [Office of the Dean of Students](#), [Gender Violence Service Coordinators](#), and/or the [Equal Opportunity and Compliance Office](#) (EOC).

#### Class Policy:

**Note:** Instructors may work with students to meet attendance needs that do not fall within University approved absences. For situations when an absence is not University approved (e.g., a job interview or club activity), instructors determine their own approach to missed classes and make-up assessments and assignments. Please provide your approach on the course syllabus.

	<b>Example:</b> Please communicate with me early about potential absences. Please be aware that you are bound by the Honor Code when making a request for a University approved absence.
Honor Code Statement (Required)	Students are bound by the Honor Code in taking exams and in written work. The <a href="#">Honor Code of the University</a> is in effect at all times, and the submission of work signifies understanding and acceptance of those requirements. Plagiarism will not be tolerated. Please consult with me if you have any questions about the Honor Code.
Acceptable Use Policy	By enrolling as a student in this course, you agree to abide by the University of North Carolina at Chapel Hill policies related to the acceptable use of IT systems and services. You may be asked to participate in online discussions or other online activities that may include personal information about you or other students in the course. The rights and protection of other participants are protected under the UNC-Chapel Hill <a href="#">Information Technology Acceptable Use Policy</a> , which covers topics related to using digital resources, such as privacy, confidentiality, and intellectual property. Consult the University website " <a href="#">Safe Computing at UNC</a> " for information about the data security policies, updates, and tips on keeping your identity, information, and devices safe.
Late Submissions	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).
Syllabus Changes (Required)	The instructor reserves the right to make changes to the syllabus, including project due dates and test dates. These changes will be announced as early as possible.
Optional Mask Use	<b>Community Standards in Our Course and Mask Use.</b> UNC-Chapel Hill is committed to the well-being of our community – not just physically, but emotionally. The indoor mask requirement was lifted for most of campus on March 7, 2022. If you feel more comfortable wearing a mask, you are free to do so. There are many reasons why a person may decide to continue to wear a mask, and we respect that choice.
Grade Appeal Process	If you feel you have been awarded an incorrect grade, please discuss with me. If we cannot resolve the issue, you may talk to our departmental director of undergraduate studies or appeal the grade through a formal university process based on arithmetic/clerical error, arbitrariness, discrimination, harassment, or personal malice. To learn more, go to the <a href="#">Academic Advising Program</a> website.

## Services and Student Support

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Accessibility Resources and Services (Required)	The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in barriers to fully accessing University courses, programs and activities. Accommodations are determined through the Office of Accessibility Resources and Service (ARS) for individuals with documented qualifying disabilities in accordance with applicable state and federal laws. See the ARS Website for contact information: <a href="https://ars.unc.edu">https://ars.unc.edu</a> or email <a href="mailto:ars@unc.edu">ars@unc.edu</a> .
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<p><b>Counseling and Psychological Services (Required)</b></p>	<p>CAPS is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: <a href="https://caps.unc.edu/">https://caps.unc.edu/</a> or visit their facilities on the third floor of the Campus Health Services building for a walk-in evaluation to learn more.</p>
<p><b>Title IX Resources (Required)</b></p>	<p>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. Reports can be made online to the EOC at <a href="https://eoc.unc.edu/report-an-incident/">https://eoc.unc.edu/report-an-incident/</a>. Please contact the University's Title IX Coordinator (Elizabeth Hall, interim – <a href="mailto:titleixcoordinator@unc.edu">titleixcoordinator@unc.edu</a>), Report and Response Coordinators in the Equal Opportunity and Compliance Office (<a href="mailto:reportandresponse@unc.edu">reportandresponse@unc.edu</a>), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (<a href="mailto:gvsc@unc.edu">gvsc@unc.edu</a>; confidential) to discuss your specific needs. Additional resources are available at <a href="http://safe.unc.edu">safe.unc.edu</a>.</p>
<p><b>Policy on Non-Discrimination</b></p>	<p>The University is committed to providing an inclusive and welcoming environment for all members of our community and to ensuring that educational and employment decisions are based on individuals' abilities and qualifications. Consistent with this principle and applicable laws, the University's <a href="#">Policy Statement on Non-Discrimination</a> offers access to its educational programs and activities as well as employment terms and conditions without respect to race, color, gender, national origin, age, religion, creed, genetic information, disability, veteran's status, sexual orientation, gender identity or gender expression. Such a policy ensures that only relevant factors are considered and that equitable and consistent standards of conduct and performance are applied.</p> <p>If you are experiencing harassment or discrimination, you can seek assistance and file a report through the Report and Response Coordinators (see contact info at <a href="http://safe.unc.edu">safe.unc.edu</a>) or the <a href="#">Equal Opportunity and Compliance Office</a>, or online to the EOC at <a href="https://eoc.unc.edu/report-an-incident/">https://eoc.unc.edu/report-an-incident/</a>.</p>
<p><b>Diversity Statement</b></p>	<p><i>A diversity statement is recommended on all syllabi. You may use the following example or create your own.</i></p> <p>I value the perspectives of individuals from all backgrounds reflecting the diversity of our students. I broadly define diversity to include race, gender identity, national origin, ethnicity, religion, social class, age, sexual orientation, political background, and physical and learning ability. I strive to make this classroom an inclusive space for all students. Please let me know if there is anything I can do to improve, I appreciate suggestions.</p>
<p><b>Undergraduate Testing Center</b></p>	<p>The College of Arts and Sciences provides a secure, proctored environment in which exams can be taken. The center works with instructors to proctor exams for their undergraduate students who are not registered with ARS and who do not need testing accommodations as provided by ARS. In other words, the Center provides a proctored testing environment for students who are unable to take an exam at the normally scheduled time (with pre-arrangement by your instructor). For more information, visit <a href="http://testingcenter.web.unc.edu/">http://testingcenter.web.unc.edu/</a>. (source: <a href="http://testingcenter.web.unc.edu/">http://testingcenter.web.unc.edu/</a>)</p>
<p><b>Learning Center</b></p>	<p>The UNC Learning Center is a great resource both for students who are struggling in their courses and for those who want to be proactive and develop sound study practices to prevent falling behind. They offer individual consultations, peer tutoring, academic coaching, test prep programming, study skills workshops, and peer study groups. If you think you might benefit from their services, please visit them in SASB North or visit their website to set up an appointment: <a href="http://learningcenter.unc.edu">http://learningcenter.unc.edu</a>.</p>

## Writing Center

The Writing Center is located in the Student and Academic Services Building and offers personalized writing consultations as well as a variety of other resources. This could be a wonderful resource to help with your writing assignments in this course (and any assignments in your other courses). You do not need a complete draft of your assignment to visit; they can help you at any stage! You can chat with someone in the writing center or set up an appointment on their website: <http://writingcenter.unc.edu>.