CEE 6314
Environmental Engineering and Modeling
Spring 2023 Syllabus

Class Time: T Th 9:30-10:45
Class Location: Mason 5134

The instructor for the first half of the course will be Dr. Jen Kaiser.
Office: 3224 Ford ES&T
Email: jkaiser34@ gatech.edu
Office Hours: Immediately after class, or by appointment.

The instructor for the second half of the course will be Dr. A. G. (Ted) Russell
Office: 3210 Ford ES&T
Email: ar70@ gatech.edu
Ph: 404-894-3079
Office Hours: Feel free to call or **email** to set up a time.

Objective. In order to understand the fate, transport and impacts of pollutants, one needs to be able to use field and laboratory observations to better understand fundamental processes to apply basic principles to understanding larger, complex environmental systems and/or extrapolate those observations to systems of interest. Typically, this involves the development and application of environmental models. Such models range in complexity, but are typically based upon solving various mathematical systems analytically and/or computationally. This course is intended to give the student the fundamentals needed to develop and apply environmental models. The major objective is to understand the basic approaches used in environmental modeling. The thrust here is not to learn a bunch of techniques, but to look at a number of environmental systems, and how one might attack them. Another reason for taking this course is that we get people of a variety of backgrounds in environmental engineering, and this course helps integrate across various areas and provides a basic level of understanding for use in other courses. Topics covered include a review of some mathematical methods, environmental models of chemical equilibrium and kinetics, intermedia pollutant transfer, compartment models, first principles transport models, observation-based models (including time-series analysis), numerical methods and analytical methods. Another objective is to get you to use some more powerful systems to do environmental modeling, in particular using Matlab © and/or R. While much of the homework can be done using excel (indeed, excel can be a great environmental modeling tool), there are some homeworks where using Python, Matlab or R will make the problems almost trivial as opposed to impossible in Excel or using another language without built in functions.

Textbook: Ramaswami, Milford and Small "Integrated Environmental Modeling: Pollutant Transport, Fate and Risk in the Environment" Wiley Interscience.
Assigned Reading: Models in Environmental Regulatory Decision Making, National Academy Press, 2007
Other useful references include: Schnoor: Environmental Modeling, Wiley Interscience, O'Neil: "Advanced Engineering Mathematics"; Weber, "Environmental Systems and Processes: Principles, Modeling and Design"; Hildebrand, F "Advanced Calculus for Applications", Burden and Faires "Numerical Analysis", Chapra and Canale, "Numerical Methods", any books or websites that provide simple instructions on using Python, Matlab or R.

Grading:	Midterm:	20%
	Final:	30%
	Homework:	20%
	Project	30%

Web site: The canvas course website will be used extensively. There, you will be able to find the syllabus, "hand outs" (virtual and otherwise), homework, presentation material and other interesting information. You should also receive e-mail and other information from us via the associated class list.

Homework: A few notes on the homework. First**: IT MUST BE NEAT AND RELATIVELY EASILY UNDERSTOOD**. (You should take the use of all caps, bold and underlined as meaning that this is an important point and your grade in this class might be influenced adversely if you dismiss it.) Imagine that you are working in a consulting firm (as many of you will), and your homework is the final report to your client. If the client does not like what s/he gets for paying your company a few hundred dollars for each hour of your time, s/he will not use your firm again. You will be fired. This is bad news. Your homework will be graded as if it is a final report to the client.

Late work is not accepted without prior approval. Note, again clients do not want to be given some excuse as to why his/her project is not done as promised, and saying that another client needed their report will not hack it. You see, clients tend to think that their money is just as green as others.

You may work together on homework assignments, unless instructed not to do so, though if you do work together, please note on your homework with whom you worked.

Homework will be assigned roughly every other week. It is to be turned in in-person, hard-copy, at the start of class on the due date.

Tests: One midterm and one final are planned.

Project: A fair fraction of your grade is based on a term project. You should group together in small teams (~4-5 individuals), and pick a topic that will require both mathematical and numerical analysis of some environmental system, though the specific topic can not be too closely aligned with your thesis topic, though it can be related: it can not simply use a model being used in a team member's thesis. (A few ideas will be provided, and hopefully at least one group will pick up on each of them.) Each team member should spend ~20 hours on the project over the term. A final report is due on the last day of class, and class presentations will be given as well. The final report should include no more than 5 pages of text, not including figures and tables, though should also include an appendix(ces) fully laying out your calculations and potentially including the code. A major fraction of the grade will depend on how well the report is written, so you should make sure that the final report is proofread and edited carefully. There will be a couple of mid-year project submissions and presentations as well.

Academic integrity, honor code: Each individual is to have read and follow the Institute Honor Code: www.honor.gatech.edu. In this class, you may work together on homework. We expect any member of the class to be able to replicate, by themselves, the homework they turn in as their own. You are not allowed to plagiarize, and it will not be tolerated. Note the following definition:
Plagiarizing is defined by Webster's as "to steal and pass off (the ideas or words of another) as one's own: use (another's production) without crediting the source."
You are not allowed to work together, or copy someone else's work, on any test. Doing so will result in an F. On the other hand, you may work together on homework assignments, though if you do work together, please note on your homework with whom you worked.

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit http://www.catalog.gatech.edu/policies/honor-code/ or http://www.catalog.gatech.edu/rules/18/.
Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for students with disabilities: If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or http://disabilityservices.gatech.edu/, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

How to succeed in this class: Your instructors in this class are interested in your learning the concepts, not the details (though the details help). As such, you should focus on being able to demonstrate the various modeling techniques, and explain the concepts behind them. Knowing the basics is key. Doing the homework is important, as the test questions are derived from the homework. You will be expected to read the stated chapters in the book as we can not go over all the concepts in class. The outside (non-textbook) reading can very much help you understand what less technical audiences are concerned about, and some of it is required reading (in particular, parts of the National Academy report as well as the article by Oreskes et al.). Ask questions. Discuss homework questions with your friends, but do not always work together. Do as much as you can on your own. Work with your friends on the tougher ones. Consult an instructor before you spend too much time (say 12 hours) on any one assignment.

Student-Faculty Expectations Agreement: At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

CEE 6314 – Environmental Engineering Modeling (and Math):

Spring 2023 (*approximate*) Schedule

Date	Topic	Ramasawmi Reading
1/10/2023	Course Intro, concept of a model	Ch1
1/12/2023	The environmental modeling process	
1/17/2023	Key Math Concepts 1. Differentiation, Taylor series, Integration	Ch 6
1/19/2023	Key Math Concepts 2. DiffEQ approaches	
1/24/2023	Mass/Material balance	
1/26/2023	Project Introduction; Nature of Pollutants, formation/fate/impacts	Ch 2
1/31/2023	Intermedia Transfer: Equilibrium Analysis	Ch 3
2/2/2023	Intermedia Transfer: Equilibrium Analysis	
2/7/2023	Intermedia Transfer: Equilibrium Analysis	
2/9/2023	Intermedia Transfer: Kinetics	Ch 4
2/14/2023	Intermedia Transfer: Kinetics	
2/16/2023	Intermedia Transfer: Kinetics	
2/21/2023	Project Presentations	
2/23/2023	Midterm Exam	
2/28/2023	Transport fundamentals and the conservation equations	Ch 5
3/2/2023	Conservation of momentum and closure methods	
3/7/2023	Methods to solve simple ODEs and PDEs	
3/9/2023	Numerical approaches to solving ODEs and PDEs	
3/14/2023	Numerical approaches to solving ODEs and PDEs	
3/16/2023	Observation-based models	
3/21/2023	Spring Break	
3/23/2023		
3/28/2023	Fitting data with functions: Least squares method	
3/30/2023	Systems of equations	
4/4/2023	The problem with R2 and other measures of functional fitting	
4/6/2023	GAM models	
4/11/2023	Machine learning methods	
4/13/2023	Machine learning methods	
4/18/2023	Factor analytic methods	
4/20/2023	Factor analytic methods	
4/25/2023	Last Day of Class: Project Presentations	