CE 40420
Reactive Transport

Spring Semester, 2017
Instructor: Diogo Bolster
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Office Hours: Monday after class or by appointment or any time my door is open. I will also generally make myself available the day before homework is due.

Welcome to CE 40420! I hope that this course is rewarding to you and that you develop an appreciation and understanding of how contaminants and all sorts of other substances move and interact. The course aims to have a balance between theory and practice, with theory guiding our ability to perform back of the envelope or detailed calculations. I am always learning how to be a better teacher, so continuing feeback is **desired** and **encouraged**. This is the very first time I am teaching this class so any ideas and feedback will be welcomed. Let's make this a great course together. My goals for this course are broadly speaking

1. Introduce you to the basic concepts and techniques used in mass transfer and reactive processes.
2. Use current events, to help you learn these concepts and where they might be helpful.
3. Help you to develop skills in approaching complex problems where there may not be a single 'correct' answer or approach. Guesstimation and educated judgement are strongly encouraged and will be rewarded.
4. Encourage you to THINK, OBSERVE, and ANALYZE
5. Provide you with experience in approaching the decision making processes involved in a real engineering applications.

The primary means by which we will work together towards these goals are:

1. Lectures: I am looking for ACTIVE participation by each of you in the learning process,
2. Readings: Active analysis of case studies,
3. Assignments: Significant effort on your part in completing assignments, and
4. A creative project.

Please note that I DO expect you to be able to program at leaset minimally (in MATLAB, EXCEL or any other programming language of your choice.). Additionally, while I do not expect you to master it, you will find learning how to solve differential equations in Mathematica incredibly useful in this course.

As with all courses at Notre Dame, this course is covered by the Honor Code.

Topics we will cover in this class

The list below is approximate. If you have suggestions or interests, LET ME KNOW.

(1) Basic methods to solve ordinary differential equations analytically and numerically

(2) Surface waters (Streams, Rivers and Lakes)
   a. The basic ideas of mass balance and conservation of mass
   b. The advection dispersion equation
   c. Spatial Moment, Breakthrough Curves and Temporal Moments
   d. When can we treat systems as 1-d?
   e. Advection and Dispersion in streams
   f. First Order Reactions (e.g. Benthic Reaction approximation)
   g. Photochemical reactions
   h. Mixing in Lakes
   i. Compartmental Modeling
   j. Air-Water Exchange
   k. Sediments

(3) Groundwater
   a. Retardation
   b. Advection-Dispersion in 2 dimensions
   c. Adsorption-Desorption
   d. Non Aqueous Phase Liquids
   e. Random Walks and Finite-Difference Methods
   f. Microbial Communities
   g. Microbial Reactions
   h. Biofilms
   i. Particle/Colloid Transport in Porous Media

(4) Air Quality
   a. The Atmosphere
   b. Indoor Air Polution
   c. Local Outdoor Air Polution
   d. Urban-Scale Air polution
   e. Global Scale Models
   f. Atmospheric Chemical Reactions
   g. Greenhouse Gases

Your responsibilities - This is a 3 credit class

Homework – homework will be assigned as we complete topics.

Exams – 3 exams, two midterms and one final
Provisional dates for the Midterms are March 8 and April 19, although I reserve the right to change these should I feel the need to do so.

Creative Project – We will discuss this in class, but part of this class will be for you to come up with a creative project that embodies any aspect of this class that you find interesting. This is supposed to be fun and take you away from thinking about all of these things simply from a standard academic engineering perspective. It is supposed to help you learn to communicate important aspects of engineering to people who do not neccesarily have an engineering or science background. It can involve art, music, poetry, short story writing, essays, a collage, film, creating an app, writing an interactive GUI or applet – anything at all that you can think of. It need not be difficult, but should really be something that you enjoy or that you would like to learn more about. If you are simply not an artisitic type, we will brainstorm and find something for you.

Grading

There is no absolute grade scale for this course. The class will be graded both individually and collectively. On a class basis, all students in the course this semester will be judged by the general level of effort of the class as a whole. If the class portrays a relatively lazy attitude with memorization being the primary motivation, the average grade within this course will be lower. If, on the other hand, the class shows a spirit for the pursuit of knowledge, the average grade will be relatively high.

How does one demonstrate this spirit? First, the leaders among the students must truly have this spirit. This spirit is quite obvious from the questions asked during lectures, the level of interaction in class, the level of effort in the projects, and the level of effort in forming active study groups outside of class. Second, the students must demonstrate more interest in learning how to think like engineers than in receiving credit for a particular answer or minimizing the amount of effort placed in a homework assignment. This is not to say that you should not provide feedback as to whether problems are beyond your understanding. I STRONGLY ENCOURAGE ACTIVE FEEDBACK ON ALL PHASES OF THIS COURSE. Further, it is your responsibility (as well as mine) to make sure that your fellow students are getting the most from this course. If that requires challenging me to teach better, DO SO. If that requires challenging each other to work harder, DO SO. If that requires challenging yourself to become more involved, DO SO.

On an individual basis, students will receive points as listed below. How the points received will translate into grades will depend on the level of effort of the class as a whole.

Total Points= 100

- Exams = 55 points (15 for each midterm and 25 for final)
- Creative Project = 20 points
- Homework = 15 points
- In class participation = 10 points

To do today: Before Monday install Matlab and Mathematica on your computer. You can download them from https://oit.nd.edu/software-downloads/