CE 580 – Hydrodynamic Mixing Processes

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Office Hours: W 2:30p-4:00p, TH 10:30a-12:00p

Text: *Mixing in Inland and Coastal Waters*, Fischer et al.

Grading:  
Homework - 50%  
Projects - 30%  
Midterm - 20%

1. **Introduction** CE 580 focuses on environmental fluid mechanics. Of particular interest are the processes that lead to the dispersal of tracers in natural water bodies such as lakes, rivers, and oceans. These tracers can include pollutants, sediments, heat, and biological nutrients and an understanding of their motion is crucial from a water quality standpoint. As most of these tracers are passive, this essentially amounts to understanding the details of the fluid motions that carry them. Given that most environmental flows are (i) turbulent and (ii) density-stratified, this poses a challenge indeed! While the bulk of our attention will be paid to flows in water, some consideration will also be given to flows in air.

2. **Textbook** In addition to the text by Fischer, I have placed the following books on reserve in the Engineering Library:

   (a) *River Mixing*, Rutherford  
   (b) *Hydrodynamics of Estuaries*, Kjerfve  
   (c) *Dispersion in Estuaries and Coastal Waters*, Lewis  
   (d) *Hydraulic Behavior of Estuaries*, McDowell

3. **Additional Resources** You may wish to consult the following excellent websites:

   (a) http://ocw.mit.edu/OcwWeb/index.htm (enter ‘transport processes’ in the search box and follow the first link).  
   (b) http://ceprofs.tamu.edu/ssocolofsky/CVEN489/Book/Book.htm

4. **Class Management** All communications and distributions of class materials will take place via ANGEL, the PSU course management system. If you have not already done so, you are encouraged to visit www.angel.psu.edu and enroll. There, you will find homework assignments and solutions, announcements, and other materials relating to CE 580.

5. **Tentative List of Topics**

   (a) Fully mixed analysis, basics of mass conservation
(b) Fickian and turbulent diffusion  
(c) Diffusion in multiple dimensions  
(d) Influences of boundaries  
(e) Shear dispersion  
(f) Mixing (vertical, transverse) in rivers  
(g) Numerical models, development and use  
(h) Planning dye studies  
(i) Mixing in lakes, use of numerical models (DYRESM)  
(j) Mixing in estuaries, effects of tidal pumping, inflows, and salinity intrusions  
(k) Turbulent jets and plumes

6. Homework

Homework assignments will be given on a regular basis, approximately every 2-3 weeks. They are intended to be challenging, so please do not be alarmed when you first look them over! My goal as an instructor of a graduate class is to provide my students with ample information and numerous tools for solving problems. Our time in class is limited, however. Therefore, I view the homework in this class as an extremely important extension of the in-class learning process.

You are strongly encouraged to come see me if you are having difficulties with the homework assignments. I am more than happy to steer your towards the right track. You are also strongly encouraged to discuss any difficulties with your class mates, as they may be able to explain to you a particularly tricky point in a different and more helpful way than me. Please do note, however, that it is my hope and wish that this be an equitable ‘give-and-take’. If you make a habit of turning in homework that you do not understand, you are not doing yourself any favors.

Finally, note that many of the homework assignments will benefit from the use of mathematical computer programs such as Matlab, Mathcad, Mathematica, and Maple. I realize that you will all have different levels of experience and comfort with these programs. Thus, when appropriate, I will try to offer ‘tutorials’ of sorts, or example code to help you get started. Note as well that you are free to use other programs, such as Excel, or other programming languages such as Basic, C, etc.

7. Midterm

There will be one take-home midterm during the course of the semester. Unlike the homework assignments, it is expected that you will work alone on this exam.

8. Project

You will be responsible for two projects during the course of the semester. Given the size of the class, I will most likely break you up into two groups. The two projects will be:

(a) Planning and execution of a dye study on a local creek.  
(b) Numerical modeling (and validation with field data) of the evolution of thermal structure in a lake.
For each project, each group will turn in a single report detailing methods, results, and discussion.

9. Academic Integrity We are required by the university to include this, so here it is...As excerpted from University Faculty Senate Policy 49-20:

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University’s Code of Conduct states that all students should act with personal integrity, respect other students’ dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts.

Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.

More specific information about academic integrity, which you may wish to review, may be found at http://www.psu.edu/advising/integrit.htm.