

Title: CEE 6310 Process Principles in Environmental Engineering

Credits: 3-0-3

Time: Fall Semester 2019, TTH: 12:00-1:15

Instructor: Dr. Sotira Yiacoumi 106 Daniel Laboratory  
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Office Hours: By appointment

Teaching Assistant: Ziheng Shen 104 Daniel Laboratory  
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Office Hours: By appointment

Recommended Textbooks (either of the two):

1. Clark, M.M., Transport Modeling for Environmental Engineers and Scientists, 2nd Edition, Wiley, 2009.
2. Crittenden, J.C., Trussell, R.R., Hand, D.W., Howe, K.J., and Tchobanoglous, G., MWH's Water Treatment: Principles and Design, 3rd Edition, Wiley, 2012.  
<http://site.ebrary.com/prx.library.gatech.edu/lib/gatech/detail.action?docID=10558088>  
(digital copy)

References:

1. Himmelblau, D.M., Basic Principles and Calculations in Chemical Engineering, 8th Edition, Prentice Hall, 2012.  
<https://learning.oreilly.com/library/view/basic-principles-and/9780132885478/?ar>  
(digital copy)
2. Welty, J.R., Wicks, C.E., Rorrer, G.L., and Wilson, R.E., Fundamentals of Momentum, Heat, and Mass Transfer, 5th Edition, Wiley, 2008.
3. Geankoplis, C.J., Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, 1993.
4. Crank, J., The Mathematics of Diffusion, 2nd Edition, Oxford University Press (Clarendon Publishers), 1975.

5. Levenspiel, O., Chemical Reaction Engineering, 3rd Edition, Wiley, 1999.  
[https://app.knovel.com/web/myknovel.v?view=myprofile&full-profile-required=0&redirect\\_url=https%3A%2F%2Fapp.knovel.com%2Fweb%2Ftoc.v%2Fcid%3AkpCREE0005%2FviewerType%3Aatoc%2F%2Froot\\_slug%3AviewerType%253Aatoc%2Furl\\_slug%3Aroot\\_slug%253Achemical-reaction-engineering%3Fkpromoter%3Dfederation](https://app.knovel.com/web/myknovel.v?view=myprofile&full-profile-required=0&redirect_url=https%3A%2F%2Fapp.knovel.com%2Fweb%2Ftoc.v%2Fcid%3AkpCREE0005%2FviewerType%3Aatoc%2F%2Froot_slug%3AviewerType%253Aatoc%2Furl_slug%3Aroot_slug%253Achemical-reaction-engineering%3Fkpromoter%3Dfederation) (digital copy)
6. Howe, K.J., Hand, D.W., Crittenden, J.C., Trussell, R.R., and Tchobanoglous, G., Principles of Water Treatment, Wiley, 2012.  
<https://ebookcentral.proquest.com/lib/gatech/detail.action?docID=947864>  
 (digital copy)
7. Weber, W.J., Jr., Environmental Systems and Processes: Principles, Modeling, and Design, Wiley, 2001.
8. Weber, W.J., Jr., and DiGiano, F.A., Process Dynamics in Environmental Systems, Wiley, 1996.
9. Thibodeaux, L.J., Environmental Chemodynamics: Movement of Chemicals in Air, Water, and Soil, 2nd Edition, Wiley, 1996.
10. Grady, C.P.L., Jr., and Lim, H.C., Biological Wastewater Treatment: Theory and Applications, Marcel Dekker, 1980.

Note: All the books have been placed on Reserve at the Georgia Tech Library, and you may find paper copies there. Some have digital copies that may be accessed via <http://library.gatech.edu/>.

**Catalog Data:** Principles that can be used in the analysis and modeling of environmental engineering processes, including material and energy balances, mass transfer, and reaction engineering.

**Who should take it:** First-year graduate students in Environmental Engineering (EnvE).

**Educational Objectives:** This course is designed to introduce first-year EnvE graduate students to the principles of material balances, mass transfer, and reaction kinetics and reaction engineering. The principles covered are applied to the analysis and modeling of simple environmental engineering systems.

**Expected Outcomes:** Students will be able to write and solve material balance equations for simple environmental engineering systems. Comprehend the principles of mass transfer and apply them to the development of governing equations for systems of steady-state molecular mass transfer, unsteady-state molecular mass transfer, convective mass transfer, and interphase mass transfer. Given possible reaction mechanisms, construct rate expressions and determine rate constants from experimental data. Write and solve design equations for engineered and natural systems that can be modeled as ideal single isothermal reactors (batch, plug flow, perfectly mixed flow) and multiple reactors. Use tracer experimental data to quantify nonideality conditions in reactive systems and then analyze nonideal systems based on direct application of tracer experimental data and models (dispersion, tanks-in-series).

**Prerequisites:** Undergraduate calculus, differential equations, and fluid mechanics.

**Computer Usage:** Spreadsheets (MS Excel); Mathematica.

**Course Requirements and Approximate Basis for Grading:**

Midterm Exam	Thursday, October 10, 12:00-1:15	30 %
Final Exam	Thursday, December 12, 11:20-2:10	45 %
Homework (7 Problem Sets)		25 %

## Tentative Course Outline

<u>Topic</u>	<u>Approximate number of one-hour lectures</u>
• Material Balances	6.0
• Mass Transfer	16.5
Molecular Diffusion and the Diffusion Coefficient	
Differential Equations of Mass Transfer	
Steady-state Molecular Mass Transfer	
Unsteady-state Molecular Diffusion	
Convective Mass Transfer	
Interphase Mass Transfer	
• Midterm Exam	1.5
• Reaction Kinetics and Reaction Engineering	19.5
Stoichiometry	
Thermodynamics of Reactions	
Reaction Rates	
Analysis of Experimental Rate Data	
Ideal Isothermal Single Reactors	
Batch	
Plug Flow	
Perfectly Mixed Flow	
Multiple Reactors	
Multiple Reactions	
Nonideal Flow Reactors	
• Final Exam	3

## Suggested Readings

Textbook: Clark, M.M., Transport Modeling for Environmental Engineers and Scientists, 2<sup>nd</sup> Edition, Wiley, 2009

<u>Topic</u>	<u>Readings</u>
Material Balances	Chapter 1
Mass Transfer	Chapters 6, 7
Reaction Rates	Chapter 9
Ideal Isothermal Reactors	Chapter 10
Nonideal Flow Reactors	Chapter 10

Textbook: Crittenden, J.C., Trussell, R.R., Hand, D.W., Howe, K.J., and Tchobanoglous, G., MWH's Water Treatment: Principles and Design, 3<sup>rd</sup> Edition, Wiley, 2012.  
<http://site.ebrary.com.prx.library.gatech.edu/lib/gatech/detail.action?docID=10558088> (digital copy)

<u>Topic</u>	<u>Readings</u>
Material Balances	Chapter 6 (Section 6-2)
Mass Transfer	Chapter 7
Reaction Rates	Chapter 5
Ideal Isothermal Reactors	Chapter 6
Nonideal Flow Reactors	Chapter 6

### **Course Web:**

The course web pages are located at <http://canvas.gatech.edu>. Course handouts, homework assignments, and other resources will be posted on the web.

### **Course Conduct:**

Students in this class are expected to abide by the Georgia Tech Honor Code and to avoid any instances of academic misconduct, including but not limited to:

1. Use of cell phones during class. Place cell phones in your bag and turn them off/manner mode.
2. Possessing, using, or exchanging improperly acquired written or oral information in the preparation of homework and exams.
3. Use of material that is wholly or substantially identical to that created or written by another individual or group (including *Plagiarizing*).
4. False claims of performance or work that have been submitted by a student.

See the [Georgia Tech Honor Code](http://www.catalog.gatech.edu/policies/honor-code/) for further information at <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>.

### **Office of Disability Services:**

The Georgia Institute of Technology has policies regarding disability accommodation, and these policies are administered through The Office of Disability Services (<https://disabilityservices.gatech.edu>). Students with disabilities should contact this office if they need to request classroom accommodations.

### **Policies on Homework, Exams, Re-grades, and Class Participation:**

1. Homework: Homework assignments must be handed in at the start of class on the due date. Only medical reasons will be considered for late assignments. You may work alone or in groups to complete the homework assignments, but you should solve each problem and turn in your own solutions. If you do work in groups, write the names of the students you worked with at the top of the homework set.
2. Exams: One 75-min exam will be given during the term and a final, comprehensive exam will be given during finals week within the time period assigned to the class (see course requirements on page 2 for exam dates). If you must miss a scheduled exam, notify the instructor prior to that day. Make-ups will only be allowed if prior permission has been given or a documented excused absence has occurred. Exams will be closed book/notes.
3. Re-grades: All requests for re-grades must be made in writing and must be submitted within one week after the instructor returns the homework or exam. There are no exceptions to this policy. Re-grades will not be considered at the end of the semester.
4. Class Participation: Class participation and active discussion during class time is very important. Students are expected to attend each class, to actively participate in discussions, and to ask and answer questions regarding the material being covered.

## **Support Services and Resources**

In your time at Georgia Tech, you may find yourself in need of support. Below you will find some resources to support you both as a student and as a person.

### ***Academic support***

- Center for Academic Success <http://success.gatech.edu>
  - 1-to-1 tutoring <http://success.gatech.edu/1-1-tutoring>
  - Peer-Led Undergraduate Study (PLUS) <http://success.gatech.edu/tutoring/plus>
  - Academic coaching <http://success.gatech.edu/coaching>
- Residence Life's Learning Assistance Program  
<https://housing.gatech.edu/learning-assistance-program>
  - Drop-in tutoring for many 1000 level courses
- OMED: Educational Services <http://omed.gatech.edu/programs/academic-support>
  - Group study sessions and tutoring programs
- Communication Center <http://www.communicationcenter.gatech.edu>
  - Individualized help with writing and multimedia projects

### ***Personal Support***

#### Georgia Tech Resources

- The Office of the Dean of Students: <http://studentlife.gatech.edu/content/services>; **404-894-6367**; Smithgall Student Services Building 2<sup>nd</sup> floor
  - You also may request assistance at [https://gatech-advocate.symplicity.com/care\\_report/index.php/pid383662?](https://gatech-advocate.symplicity.com/care_report/index.php/pid383662?)
- Counseling Center: <http://counseling.gatech.edu>; **404-894-2575**; Smithgall Student Services Building 2<sup>nd</sup> floor
  - Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. Their website also includes links to state and national resources.
  - *Students in crisis may walk in during business hours (8am-5pm, Monday through Friday) or contact the counselor on call after hours at 404-894-2204.*
- Students' Temporary Assistance and Resources (STAR):  
<http://studentlife.gatech.edu/content/need-help>
  - Can assist with interview, clothing, food, and housing needs.
- Stamps Health Services: <https://health.gatech.edu>; **404-894-1420**
  - Primary care, pharmacy, women's health, psychiatry, immunization and allergy, health promotion, and nutrition
- OMED: Educational Services: <http://www.omed.gatech.edu>
- Women's Resource Center: <http://www.womenscenter.gatech.edu>; **404-385-0230**
- LGBTQIA Resource Center: <http://lgbtqia.gatech.edu/>; **404-385-2679**
- Veteran's Resource Center: <http://veterans.gatech.edu/>; **404-385-2067**
- Georgia Tech Police: **404-894-2500**