
ADVANCED CHEMICAL REACTION ENGINEERING (CBE 60546)

University of Notre Dame, Fall 2021

Prof. Mark McCready (mjm@nd.edu)
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Classroom: 118 DBRT
Lecture MWF 10:30-11:20

1 Reactions and Reactors

Chemical reaction engineering is “par excellence the domain of the chemical engineer” (R. Aris)—the analysis and design of chemical reactors (big and small) to economically produce useful products. The utility of the concepts, though, go well beyond the Haber-Bosch reactors that launched the field or the fluidized catalytic crackers responsible for the wide availability of inexpensive and high quality gasoline. Reaction engineering ties together virtually all elements of Chemical Engineering, from thermodynamics and chemical kinetics to mass and energy balances to mass and heat transfer.

We will approach this from a bottom up perspective, starting from the most basic concepts of chemical reactions, reaction thermodynamics, and chemical kinetics, to the development and application of mass and energy balances for simple to more complicated reactors.

We strongly encourage you to keep up with the material and homework, to use the resources available and to find your own resources, and to bring up questions in class. Don’t be bashful: if you don’t understand something, chances are that many of your classmates (and quite possibly your instructor!) don’t either.

2 Text

2.1 Primary

- Hill and Root, *Introduction to Chemical Engineering Kinetics & Reactor Design*, 2nd edition, Wiley 2014

2.2 Supplementary

- Davis and Davis, *Fundamentals of Chemical Reaction Engineering*, McGraw-Hill. Available online [here](#).

3 Web

This syllabus, reading assignment, the homework assignments and solutions, a course outline, and supplementary materials are available on the web at <https://github.com/wmfischneider/CBE60546>.

4 Format

The topics will be presented in a series of self-contained lectures as outlined on the website. Lecture notes for each lecture will be posted on-line. Attendance is expected, and you should be prepared to ask and answer questions.

5 Topics

1. Stoichiometry
2. Chemical Thermodynamics and Equilibria
3. Empirical Kinetics
4. Molecular Basis of Chemical Kinetics

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5. Mechanisms of Chemical Reactions
 6. Heterogeneous Reactions and Catalysis
 7. Liquid Phase Reactions
 8. Ideal Reactor Design
 9. Reactor Optimization
 10. Non-isothermal Reactors
 11. Non-ideal Flow
 12. Catalytic Reactor Design
 13. Bioreactors

6 Homework

Ten problem sets will be distributed during the semester and will be due at the beginning of class on dates to be announced. The problem sets will be designed to reinforce your knowledge and ability to apply the course material. **Assignments turned in late will automatically lose 20%, and those turned in after the solutions are posted will not be accepted.** Your lowest two score on homework will be dropped. You may discuss the homework with your classmates, but **what you turn in must be your own work.**

Homework will in general require some computations. You may write out solutions by hand or you may use Python or Mathematica notebooks. In any case, the solution of each problem must begin with a complete description of the problem, and the solution must be structured for ease of interpretation by the instructor and TAs.

7 Grading

Grades will be based on the homework (30%), two in-class exams (20%), and two out-of-class exams (50%).

8 Academic honesty

Should go without saying. Any cheating or misrepresenting of work as your own will be dealt with according to the Honor Code policies of the University. WE reserve the right to relocate any students during an examination at my discretion.

9 Professional courtesy

As a courtesy to the instructor and your classmates, please refrain from texting, web browsing, tweeting, updating, or using your phone or laptop for any purpose during class time. If you must use an electronic device, excuse yourself from class.

10 Teaching Assistants and Office Hours

Bo Wei Cynthia Chen	bchen8@nd.edu	
James Carpenter	jcarpen3@nd.edu	
Mark McCready	mjm@nd.edu	
Bill Schneider	wschneider@nd.edu	Th 4-5 Zoom

11 Health and Well-Being

Resources for students experiencing stress or difficulty coping are available at <http://care.nd.edu>. COVID has certainly added to everyone's stress level in one way or another. Information regarding University policies is available at <http://covid.nd.edu>. Please feel free to raise any questions or concerns with the instructors.

12 Course calendar

Table 1: Tentative Course Calendar

8/23	8/25	8/27
Welcome!	Python notebooks	
8/30	9/1	9/3
	HW 1	
9/6	9/8	9/10
	HW 2	
9/13	9/15	9/17
	HW 3	Exam 1
9/20	9/22	9/24
		Grad Symp
9/27	9/29	10/1
	HW 4	
10/4	10/6	10/8
	HW 5	
10/11	10/13	10/15
Exam 2		
10/18	10/20	10/22
BREAK	BREAK	BREAK
10/25	10/27	10/29
	HW 6	
11/1	11/3	11/5
	HW 7	
11/8	11/10	11/12
	HW 8	Exam 3
11/15	11/17	11/19
11/22	11/24	11/26
HW 9	Thanksgiving	Thanksgiving
11/29	12/1	12/3
12/6	12/8	12/10
HW 10	Last class	Study day
12/13	12/15	
	Final Exam	