Chemical and Biomolecular Engineering 142
Chemical Kinetics and Reaction Engineering
Fall Semester 2017
Course Website: CBE 142 - FALL 2017 on bcourses.berkeley.edu

**Instructor:** Prof. Alexander Katz (233 Hildebrand Hall, 643-3248, askatz@berkeley.edu)
Office Hours: Mon 1:00 pm – 2:00 pm, Fri 1:00 pm – 2:00 pm; appointment.

**GSIs:** Mr. Matthew Witman (1 Gilman Hall, mwitman1@berkeley.edu)
Office Hours: Mon 9:00 am – 10:00 am, 100D Hildebrand Library
Fri 9:00 am – 10:00 am, 100D Hildebrand Library

Ms. Danna Nozik (373 Tan Hall, danna_nozik@berkeley.edu)
Office Hours: Mon 11:00 am - 12:00 pm, 395 Tan Hall
Fri 10:30 am - 11:30 am, 395 Tan Hall

Mr. Christopher Barnes (277 Stanley Hall, cbarne20@berkeley.edu)
Office Hours: Mon 12:00 pm - 1:00 pm, Bixby North
Fri 12:00 pm - 1:00 pm, 100F Hildebrand Library

First Discussion (MW): Monday, 4:00 pm – 5:00 pm, 205 Dwinelle
Second Discussion (MW): Wednesday, 4:00 pm – 5:00 pm, 122 Latimer
Third Discussion (CB): Wednesday, 3:00 pm – 4:00 pm, 122 Latimer
Fourth Discussion (CB): Monday, 4:00 pm –5:00 pm, 121 Latimer
Fifth Discussion (DN): Friday, 12:00 pm – 1:00 pm, 237 Cory
Sixth Discussion (DN): Friday, 3:00 pm – 4:00 pm, 102 Latimer

**Lecture Hours:** TuTh, 3:30 pm – 5:00 pm, 50 Birge

**Text:** H. S. Fogler, Elements of Chemical Reaction Engineering, 5th Edition, Prentice Hall, 2016.

**Course Grade:** The course grade will be determined by the following:

| | |
|---|---|
| Homework: | 5% |
| Design Projects: | 5% |
| Midterm Exam 1: | 25% |
| Midterm Exam 2: | 20% |
| Final Examination: | 45% |

**Homework:** Homework will be assigned on Tuesdays and will be due at the beginning of lecture on the following Tuesday, unless indicated otherwise. Approximately three to five problems will be assigned each week (typically a subset of these will be graded). Solutions will be posted on the class website to this and prior homework.

**Computer Use:** The use of a numerical methods program for solving systems of ordinary differential equations and non-linear algebraic equations will be part of this course. GSIs will provide background for implementation of numerical methods in the beginning of the course. College of Chemistry facilities are equipped with MatLab, MathCad, and Polymath, which are sufficient for the types of problems being addressed in this course.

**Grading Policies:**

1. Homework must be turned in at the designated time – **before lecture at 3:30 pm**. Late problem sets will be corrected but assigned a score of zero.
2. Students should feel free to discuss the homework and design project assignment with others; however, **the final product must be entirely your own work**.
3. Although homework and design projects will not be regraded, requests for all homework/design project regrades can be made at the end of the course and will be taken into consideration when determining the final course grade.
4. Each student who submits a course evaluation by November 30, 2017 will have the **lowest four homework scores dropped** from their total score, when calculating the average homework course grade.
5. Exams will not be given early or late. If you miss an exam for a valid reason, your scores from other exams will be averaged to make up for the missed exam. Missing more than one exam will result in either an I or an F grade for the course. Missing an exam without a valid reason will result in a zero grade for that exam. Requests for exam regrades, if approved, will require the entire exam to be regraded (select portions will not be regraded).

**References:**

The following books have been placed on reserve in the Chemistry Library. These books are intended to complement lecture notes and the primary textbook.

**Chemical Kinetics**

K. J. Laidler, Chemical Kinetics, 3rd edition, Harper & Row, 1987. (2 copies)
J. W. Moore and R G. Pearson, Kinetics and Mechanism, 3rd edition, Wiley, 1981.
W. C. Gardiner, Jr., Rates and Mechanisms of Chemical Reactions, W. C. Benjamin, Inc., 1969.
M. Boudart, Kinetics of Chemical Processes, Prentice-Hall, 1968.

**Reaction Engineering**

H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2006.
H.S. Fogler, Essentials of Chemical Reaction Engineering, 2011,
Prentice Hall, Upper Saddle River, New Jersey.
O. Levenspiel, Chemical Reaction Engineering, 3rd edition, Wiley, 1999.
C. G. Hill, Jr., An Introduction to Chemical Engineering Kinetics and Reactor Design, Wiley, 1977. (3 copies)
J. M. Smith, Chemical Engineering Kinetics, 3rd edition, McGraw Hill, 1981. (2 copies)

**Heterogeneous Systems and Catalysis**

C. N. Satterfield, Mass Transfer in Heterogeneous Catalysis, MIT Press, 1970. (2 copies)
J. J. Carberry, Chemical and Catalytic Reaction Engineering, McGraw Hill, 1976. (2 copies)

**Chemical and Biomolecular Engineering 142**
*Fall Semester 2017 Class Schedule*

| | Date | Lecture N$^o$ | Topic | Chapter |
|---|---|---|---|---|
| Aug | 24 | 1 | Introduction; Definition of reaction rate | Preface; 1 |
| | 29 | 2 | General mole balances;<br>Basic types of chemical reactors | 1 |
| | 31 | 3 | Reactor design equations | 2 |
| Sept | 5 | 4* | Reactor design for single reactions;<br>Multiple-reactor systems | 2 |
| | 7 | 5 | Chemical reactions with volume and phase changes;<br>Isothermal reactor design | 4; 5 |
| | 12 | 6* | Concepts in chemical kinetics | 3 |
| | 14 | 7 | Reaction rate laws;<br>Mechanisms of homogeneous reactions | 3; 9 |
| | 19 | 8* | Mechanisms of homogeneous reactions | 9 |
| | 21 | 9 | Examples of reaction mechanisms | 9 |
| | 26 | 10* | Semibatch reactors | 6 |
| | 28 | 11 | Recycle and membrane reactors; | 6 |
| Oct | 3 | 12* | Reactor energy balances | 11 |
| | 5 | -- | **Midterm 1** | |
| | 10 | 13 | Reactor energy balances | 11 |
| | 12 | 14 | Design of non-isothermal reactors | 11; 12 |
| | 17 | 15* | Multiple steady-states;<br>Reactor stability and thermal runaway | 12 |
| | 19 | 16 | Unsteady-state nonisothermal reactors | 13 |
| | 24 | 17* | Design of reactors for multiple reactions;<br>Series and parallel reactions | 8; 13 |
| | 26 | 18 | Concepts in heterogeneous catalysis | 10 |

| Date | | Lecture N° | Topic | Chapter |
|---|---|---|---|---|
| Oct | 31 | 19* | Mechanisms of surface-catalyzed reactions; Catalytic reactions | 10 |
| Nov | 2 | 20 | External transport effects in catalyst particles | 14 |
| | 7 | 21* | Intraparticle diffusion and reaction; Catalyst effectiveness factor | 15 |
| | 9 | -- | **Midterm 2** | |
| | 14 | 22* | Catalyst effectiveness factor | 15 |
| | 16 | 23 | Nonisothermal catalyst particles | 15 |
| | 21 | 24* | Nonisothermal catalyst particles | 15 |
| | 23 | -- | Thanksgiving Holiday | |
| | 28 | 25 | Mass transfer and reaction in packed beds | 15 |
| | 30 | 26* | Criteria for transport limitations/Summary | 15 |
| | 15 | -- | **Final Examination (7 PM – 10 PM)** | |

* Denotes dates on which homework problem assignments are due unless other arrangements are announced