

Chemical Kinetics and Reactor Design

ECH 4504

Class Number: 25588 Section: CKRD

Class Periods: T,R | Period 8 – 9 (3:00 PM - 4:55 PM)

Location: ROL 0205

Academic Term: Spring 2023

Instructor:

Dr. Sergey Vasenkov

Professor

University of Florida, Chemical Engineering Department

Office: 320 Black Hall

Email: svasenkov@che.ufl.edu

Phone: 352-392-0315

Office Hours: each Wednesday between 5:00 and 6:00 pm and each Thursday between 1:00 and 2:00 pm

Supervised Teacher (ST):

Mr. Param Dhavale

University of Florida, Chemical Engineering Department

Email: param.dhavale@ufl.edu

Office Hours: TBA

Course Description

This course will provide an introduction to the fundamental concepts and the techniques used to perform quantitative analysis and design of different types of chemical reactors for the production of chemical and biological products

Course Pre-Requisites

ECH 3264 and ECH 4123

Course Objectives

1. Learn the principles and approaches (including rate laws and material balance) used to solve problems related to performance and design of chemical reactors
2. Apply these principles and approaches in combination with appropriate calculation techniques to analyze and design chemical reactors

Professional Component (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Medium
3. An ability to communicate effectively with a range of audiences	
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the	

impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Low
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Low
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbook

H Scott Fogler, Elements of Chemical Reaction Engineering, 6th edition, Pearson, ISBN # 13: 9780135486221

Required software

Python, Excel

Strongly Recommended materials

<https://cache.org/teaching-resources-center/kinetics-and-reaction-engineering>

Tentative Course Schedule

Week 1: Introduction, general mole balance / Chapter 1
 Week 2: Conversion and reactor design equations / Chapters 2
 Week 3: Rate laws and stoichiometry / Chapters 3, 4
 Week 4: Isothermal reactor design for batch reactors (BRs) and continuous-stirred tank reactors (CSTRs) / Chapter 5
 Week 5: Tubular reactors, pressure drop in reactors / Chapter 5
 Week 6: Isothermal reactor design: the mole balance and molar flow rate balance / Chapter 6
 Week 7: Multiple reactions / Chapter 8
 Week 8: Active intermediates and nonelementary rate laws, chain reactions / Chapter 9
 Week 9: Catalysis and catalytic reactors, steps in a catalytic reaction / Chapter 10
 Week 10: Nonisothermal reactor design, the energy balance, and adiabatic operation / Chapter 11
 Week 11: Adiabatic equilibrium conversion and reactor staging / Chapter 11
 Week 12: Steady-state tubular reactor with heat exchange / Chapter 12
 Week 13: Steady-state nonisothermal reactor design, multiple steady states / Chapter 12
 Week 14: Nonisothermal multiple chemical reactions / Chapter 12

Attendance Policy, Class Expectations, and Make-Up Policy

Class attendance is strongly recommended. Excused absences are consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation. Requests for make-up tests will be granted only if appropriate documentation about illness, family emergency or UF-related travel are given to the Instructor.

Exams: There will be 2 exams during the semester and a final exam during the exam week. The exams are scheduled for TBA. The final exam is scheduled for TBA. No credit will be given for problems that have a solution but all the work leading to this solution is not shown. Partial credit will be assigned based on the rules that will be consistently applied to all students.

For all exams in this class the following rules will be applied: For each exam you can prepare 2 pages with the expressions of your choice. You can use both sides of the page. No other materials are allowed, except for the handouts given by the Instructor for the exam.

- Homework:
1. As a rule, homework will be assigned approximately once a week.
 2. Solutions will be posted on the course website.
 3. The homework must be submitted to Canvas at the beginning of class on the due date.
 4. Late homework will be accepted only with instructor approval. As a rule, there will be a 20% penalty for each day it is late. No late homework accepted after the solutions are posted.
 5. No credit will be given for problems that have a solution but all the work leading to this solution is not shown.
 6. The following format has to be used:
 - a. The student's name should be written on the front page.
 - b. Begin each problem on a new page.
 - c. Underline all intermediate answers. Box all final answers.
 - d. **For problems requiring the use of numerical techniques:** In addition to analytical solution, add results obtained by numerical techniques at the end of the analytical solution to create a single pdf. You need to upload to canvas a single zip file for each homework which will include this pdf and the Python/Excel files used to obtain answers (numerical values or plots) in the pdf.

One homework assigned at the beginning of the semester will entirely be devoted to a review of using Python solvers to solve systems of ODEs, nonlinear equations, and the combinations of both.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets* (10-13)	10 each	20%*
Exam 1	10	25%
Exam 2	10	25%
Final Exam	10	30%
		100%

* It is expected that each student will have the total score larger than 35% for all homework assignments during the semester. A failing grade will be assigned to students if the total score for all homework assignments is smaller than 35%. In each homework assignment only one randomly selected problem (or parts of a problem, if problem has a, b, c, ... parts) will be graded. Instructor will make the problem selection.

Grading Policy

The grades will not be curved.

Percent	Grade
100 - 90	A
89.9 - 85.0	A-
84.9 - 80.0	B+
79.9 - 75.0	B
74.9 - 70.0	B-
69.9 - 65.0	C+
64.9 - 58.0	C
57.9 - 50.0	C-
49.9 - 45.0	D+
44.9 - 40.0	D

39.9 - 35.0	D-
34.9 - 0	E

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>). It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at

<https://gatorevals.aa.ufl.edu/students/>.

Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via

<https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code." On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied:

On my honor, I have neither given nor received unauthorized aid in doing this assignment.

The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see:

<http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.