



## CHEG 3063-P02: Kinetics and Reactor Design Spring 2020 Syllabus

Dr. Sheena Reeves, Assistant Professor

Office: 201D C.L. Wilson Phone: 936-261-9413

[smreeves@pvamu.edu](mailto:smreeves@pvamu.edu); [drsmreeves@gmail.com](mailto:drsmreeves@gmail.com)

Office Hours: M: 2:00-4:30 pm; T: 12:30 – 1:30 pm; R: 8:00-10:30 am

### COURSE

Meeting Time: TR 11:00 - 12:20 p.m.

Location: Wilson 103

Prerequisites: CHEG 2053, MATH 4013, and CHEG 3053

Recommend Text: Fogler, H. S., Elements of Chemical Reaction Engineering, Prentice-Hall, (5<sup>th</sup> Edition).

Evaluation: This course will utilize the following instruments to determine student grades and proficiency of the learning outcomes for the course. The course has been designed to ensure that students acquire a solid grounding in ABET Outcomes **1** and **2**.

Description: Application of fundamental concepts of reaction stoichiometry, kinetics, and equilibria to the interpretation of reaction rate data. Application of reaction rate, heat, and mass transfer correlations to the design of batch, continuous tank, and tubular reactors.

Goals: The goal of this course is to teach students the science and design of reaction engineering processes.

Outcomes: The student will have demonstrated the ability to:

1. Apply conservation laws.
2. Solve complex reaction engineering problems.
3. Design complex chemical reactors using modern calculation tools and techniques.

### GRADING POLICY

| Item        | Points |
|-------------|--------|
| Tests (2)   | 300    |
| Assignments | 200    |
| Quiz        | 100    |
| Final       | 200    |
| Project     | 200    |

| Grade Scale: | Points     |
|--------------|------------|
| A =          | 1000 - 900 |
| B =          | 899 - 800  |
| C =          | 799 - 700  |
| D =          | 699 - 600  |
| F =          | < 600      |

Tests: Two closed book exams will be given during the semester. The final exam is also closed book. Make-up exams will be given only to students who have a university excuse and who have discussed the situation with the instructor. Make-ups are always given **BEFORE** the regularly scheduled exam.

Homework: Five homework/computer assignments are scheduled. No late assignments will be accepted. Each assignment must be submitted on engineering paper that can be purchased at the bookstore or other retailers. Copying of assignments will not be allowed. Individuals associated with the sharing of solutions will be given a zero and referred to the department head. Homework assignments will cover Excel and Polymath.

Quiz: Three closed book quizzes will be given throughout the semester to assess performance. Quizzes will be based on material covered in class and homework assignments. Additional quizzes may occur in eCourses due to travel schedules.

Participation: Class time is an opportunity for the students to learn the material being covered NOT time for socializing. All students are expected to participate in class discussions and activities. Moreover, it is university policy that all students attend class regularly.

Project: Group projects are mandatory in this course and will be discussed at a later time.

Software: Students are **required** to download Polymath which is also available in computer lab.

## TENTATIVE LECTURE SCHEDULE

| Week | Lecture Topic                                                                                                                                                                                      | Grades                           |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 1    | Review of syllabus; Review of Notation/Units<br>Chapter 1: Mole Balances<br>(Types of Reactors)                                                                                                    |                                  |
| 2    | <b>MLK Day Monday, January 20, 2020</b><br>Chapter 2: Conversion and Reactor Sizing                                                                                                                | Q1                               |
| 3    | Chapter 3 and 4: Rate Laws and Stoichiometry<br><b>Begin Reports/Pick Groups</b>                                                                                                                   | H1                               |
| 4    | Chapter 3 and 4: Rate Laws and Stoichiometry                                                                                                                                                       | CA1                              |
| 5    | Chapter 5: Isothermal Reactor Design                                                                                                                                                               | H2, Q2                           |
| 6    | Chapter 6: Isothermal Reactor Design<br><b>BEGIN CHEMCAD PROJECT</b>                                                                                                                               | H3                               |
| 7    | Chapter 6: Isothermal Reactor Design<br><b>Exam I on Ch. 1 - 6</b><br><b>Thursday, February 27, 2020</b>                                                                                           | E1                               |
| 8    | Chapter 8: Multiple Reactions                                                                                                                                                                      |                                  |
| 9    | SPRING BREAK                                                                                                                                                                                       |                                  |
| 10   | <b>US COVID-19 OUTBREAK</b>                                                                                                                                                                        |                                  |
| 11   | Module 1: Live – Updates, Stoichiometry Review, and Q&A Session<br>Module 2: Stoichiometry for Multiple Reactions<br>Module 3: Semi-batch Reactors<br>Reference Material: Introduction to Polymath | Module Quiz                      |
| 12   | Module 4: Live – Membrane Reactors and Selectivity<br>Module 5: Pressure Effects and Reactor Design<br>Module 6: Scaling Up<br>Reference Material: Introduction to CHEMCAD                         | Polymath Homework<br>Module Quiz |
| 13   | Module 7: Thermodynamics and Kinetics<br>Module 8: Heat Transfer<br>Module 9: Catalysis                                                                                                            | CHEMCAD Homework<br>Module Quiz  |
| 14   | Module 10: Catalyst and Diffusion<br><b>Exam II, Thursday, April 16, 2020</b>                                                                                                                      | Module Quiz<br>Exam II           |
| 15   | <b>Scheduled Design Presentations (Week Long)</b>                                                                                                                                                  | Project Paper                    |
| 16   | Review Day<br>Final Exam: <b>Thursday, April 30, 2020</b><br><b>10:30 a.m. – 12:30 p.m.</b>                                                                                                        | FE                               |

*\*This schedule represents a tentative schedule only and is subject to change at the instructor's discretion.*

## CONDUCT

- Students will conduct themselves in a manner that is respectful to their fellow classmates and the instructor at all times.
- **Cell phones MUST be turned off and stored during class time.**
- Students will arrive to class prepared to discuss and participate in the lesson. Students should dress appropriately for class.
- Students who disrupt class will be asked to leave. No sleeping allowed!
- No headphones are allowed during class including quizzes and exams.

## UNIVERSITY RULES AND PROCEDURES

***Disability statement (See Student Handbook)***

Students with disabilities, including learning disabilities, who wish to request accommodations in class should register with the Services for Students with Disabilities (SSD) early in the semester so that appropriate arrangements may be made. In accordance with federal laws, a student requesting special accommodations must provide documentation of their disability to the SSD coordinator.

### ***Academic misconduct (See Student Handbook)***

You are expected to practice academic honesty in every aspect of this course and all other courses. Make sure you are familiar with your Student Handbook, especially the section on academic misconduct. Students who engage in academic misconduct are subject to university disciplinary procedures.

### ***Forms of academic dishonesty***

1. Cheating: deception in which a student misrepresents that he/she has mastered information on an academic exercise that he/she has not mastered; giving or receiving aid unauthorized by the instructor on assignments or examinations.
2. Academic misconduct: tampering with grades or taking part in obtaining or distributing any part of a scheduled test.
3. Fabrication: use of invented information or falsified research.
4. Plagiarism: unacknowledged quotation and/or paraphrase of someone else's words, ideas, or data as one's own in work submitted for credit. Failure to identify information or essays from the Internet and submitting them as one's own work also constitutes plagiarism.

### ***Nonacademic misconduct (See Student Handbook)***

The university respects the rights of instructors to teach and students to learn. Maintenance of these rights requires campus conditions that do not impede their exercise. Campus behavior that interferes with either (1) the instructor's ability to conduct the class, (2) the inability of other students to profit from the instructional program, or (3) campus behavior that interferes with the rights of others will not be tolerated. An individual engaging in such disruptive behavior may be subject to disciplinary action. Such incidents will be adjudicated by the Dean of Students under nonacademic procedures.

### ***Sexual misconduct (See Student Handbook)***

Sexual harassment of students and employers at Prairie View A&M University is unacceptable and will not be tolerated. Any member of the university community violating this policy will be subject to disciplinary action.

### ***Attendance Policy***

Prairie View A&M University requires regular class attendance. Excessive absences will result in lowered grades. Excessive absenteeism, whether excused or unexcused, may result in a student's course grade being reduced or in assignment of a grade of "F". Absences are accumulated beginning with the first day of class.

### ***Student Academic Appeals Process***

Authority and responsibility for assigning grades to students rests with the faculty. However, in those instances where students believe that miscommunication, errors, or unfairness of any kind may have adversely affected the instructor's assessment of their academic performance, the student has a right to appeal by the procedure listed in the Undergraduate Catalog and by doing so within thirty days of receiving the grade or experiencing any other problematic academic event that prompted the complaint.

## **COURSE OUTCOMES**

**Course Outcome 1: This outcome is the same as program outcome 1.**

**Students will have an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.**

The two performance criteria used to assess this outcome consist of

**1. Ability to identify and formulate reaction/reactor problems using the principles of mathematics, engineering, and science.**

Students are able to:

- (i) Identify the limiting reactant, basis of calculation, and excess reactants.
- (ii) Apply stoichiometric ratios or relative rates and develop a stoichiometric table based on phase and components.
- (iii) Perform mole balances and energy balances based on chemical reaction and/or reactor type.
- (iv) Understand reaction mechanisms and reaction pathways.
- (v) Derive mole balance equation for various reactors.
- (vi) Combine rate laws, mole balances, and stoichiometry to solve for volume, rate constant, concentration, or flow rate.
- (vii) Calculate pressure drops across tubular reactors using appropriate equations.
- (viii) Calculate conversion and concentration using appropriate equations.
- (ix) Identify and discuss the characteristics, design equations, design parameters, advantages, and disadvantages of batch, CSTR, PFR, PBD, semi-batch, membrane, fluidized bed, and bio-reactors.

**2. Ability to solve complex reaction engineering problems using graphing and computing tools.**

Given a problem, the student is able to:

- (i) Determine the final exit concentration using Excel.
- (ii) Calculate reactor volume using algebra, Levenspiel plots or approximations.
- (iii) Determine the optimum conversion based on graphs generated in Polymath.

**Course Outcome 2: This outcome is the same as program outcome 2.**

**Students will have 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.**

**1. Ability to select appropriate reactor and operating conditions for safe and economic reactor operation.**

Given a problem, the student is able to:

- (i) Evaluate the selectivity of products in reactions and choose feed location of raw materials.
- (ii) Increase desired product for single and multiple reactants by selecting appropriate reactor and feed conditions.
- (iii) Research common safety procedures utilized with different catalytic reactions.
- (iv) Design for the control of runaway reactions and select other safety apparatus.
- (v) Recognize the importance for safety and determine the risk associated with gas releases from reactors.
- (vi) Determine the heat required/produced during a reaction.
- (vii) Choose an appropriate reactor, reaction mechanism, or catalyst to maintain safety.

**2. Ability to conduct a Review of Literature and determine preliminary design considerations.**

Students are able to:

- (i) Summarize information retrieved from journal articles and books.
- (ii) Provide useful information in a short memo.
- (iii) Write a full technical report of literature review without plagiarism.
- (iv) Produces a report that is grammatically correct containing no direct quotes or the words "I, we, you, he, she, us, or they."
- (v) Determine the best method of producing a compound based on literature review.
- (vi) Develop a report with the following sections: Introduction, Problem Statement, Reactor/Catalyst Detail, Design Specifications, Conclusions, References, and Appendix

**3. Ability to perform detailed design of complex chemical reactors.**

Students are able to:

- (i) Determine the type of reactor and the phase of the reactants.
- (ii) Determine pressure drop and catalyst required for reaction at temperature and pressure specified.
- (iii) Determine reactor volume/length and catalyst weight required to meet specified need.
- (iv) Calculate composition or concentration of components entering and leaving reactor.
- (v) Meet design constraints given in the problem statement.
- (vi) Utilize ASPEN PLUS OR HYSYS to fully simulate a chemical reaction and determine the optimal operating conditions such as temperature, pressure, composition, flow rate, heat duty, and conversion.