1. **Course number and name - CHBE 4320 – Reactor Design *(required)***

2. **Credits and contact hours** - 2 credit hours, 2 lecture hours (2-0-0-2)

3. **Instructor's or course coordinator's name -** Dr. Michael Filler

4. **Textbook, title, author, and year**
   Elements of Chemical Reaction Engineering, H. S. Fogler, 6th ed., Prentice Hall, 2021; Chemical Engineering Kinetics and Reactor Design, C. H. Hill and T. W. Root, 2nd ed., John Wiley & Sons, 2014.

5. **Specific course information**
   a. **Catalog Description -** The basic principles of reactor design are introduced, including material and energy balances for homogeneous and heterogeneous systems
   b. **Prerequisites or co-requisites** – ChBE 2140 Chemical Engineering Thermodynamics (grade "C" or better), CHBE 3215 Heat and Mass Transfer (grade "C" or better); CHBE 3300 Chemical Kinetics (grade "C" or better).
   c. **Required, elective, or selected elective course** (as per Table 5-1) – Required

6. **Specific goals for the course**
   a. **Specific outcomes of instruction**:
   By the end of this course, a student should be able to:
   1) Develop and solve material and energy balances for various reactor types
   2) Determine reaction kinetics by analyzing data from a variety of reactor types
   3) Model and design ideal isothermal reactors and combinations thereof for homogeneous, heterogeneous, and biochemical reactions
   4) Model and design non-isothermal reactors by accounting for the heat effects
   5) Analyze residence time distribution (RTD) data to identify non-idealities in reactor configurations and utilize this information to predict reactor performance
   6) Analyze reaction/diffusion behavior in heterogeneous catalysts and the impact on reactor design

b. **Connection with Student Outcomes**

CHBE 3205							
	Student Outcomes						
Course Outcomes	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Course Outcome 1	**X**	**X**					
Course Outcome 2	**X**					**X**	**X**
Course Outcome 3	**X**	**X**					
Course Outcome 4	**X**	**X**					
Course Outcome 5	**X**	**X**				**X**	**X**
Course Outcome 6	**X**	**X**					

Student Outcomes

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(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
(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
(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

7. **Brief list of topics to be covered**
   a. Ideal isothermal reactor design
      1) Transient and steady-state mass balances for isothermal homogeneous batch reactors, continuous stirred tank reactors, and plug flow reactors
      2) Fractional conversion and space time
      3) Graphical interpretation of reactor design equations
      4) Effect of fluid density
      5) Reactors in series/parallel and recycle reactors
      6) Competitive reactions and reactor selection
      7) Instantaneous and overall yield and selectivity
      8) Biochemical reactors and parameters
      9) Photochemical and electrochemical reactors
   b. Ideal non-isothermal reactor design
      1) Review of thermodynamics of chemical reactions

   2) Coupled mass and energy balances for adiabatic and non-adiabatic homogeneous reactors
   3) Numerical and graphical solutions
   4) Multiple steady states
   5) Competitive reactions

c. Non-idealities in flow reactors
   1) Residence time distributions (RTDs)
   2) Step change and pulse tracer experiments
   3) Mean residence time
   4) Segregated flow, axial dispersion, and CSTRs in series models
   5) Mixing models

d. Heterogeneous reactions and catalytic reactors
   1) Catalyst pellet structure and transport
   2) Diffusion models with and without external mass transfer resistance
   3) Thiele modulus and effectiveness factor
   4) Packed and fluidized bed reactors
   5) Differential reactors