

# A First Course on Kinetics and Reaction Engineering

## Unit 6. Lesson Plan

### Before Class

- Provide the redacted slides to the students and tell them to bring them to class

### During Class

- Introduce today's topic and where it fits in the course (Slides 1 and 2)
- Review of Unit 6 (5 to 10 minutes)
  - Slide 3: Define a mechanism, review the rules it must obey, define reactive intermediates and note that since steps are elementary, the rate expression for the apparent reaction can be generated from the rates of the elementary mechanistic steps
  - Slide 4: Review open and closed sequence mechanisms and the different kinds of steps that can appear in a chain reaction mechanism
- Ask whether the students have any questions from their pre-class preparation and answer them
  - Slide 5
- Learning Activity (~20 minutes)
  - Slide 6 (as groups or individually): Put the slide up, answer any questions, and let them work
  - Slides 7: Note that with simple mechanisms, you can often see whether or not there is a combination of the steps that gives the overall reaction; illustrate this using the bullet items at the bottom of the slide; point out that visual inspection is good and often faster than a mathematical solution; if you see the linear combination visually, you are good to go, but if you don't, you might want to check mathematically
    - Slide 8: Go through the bullet item; remind them that to determine the number of independent reactions in a set they need to construct a reaction matrix with columns for species and rows for reactions (note, the reactions/rows are color coded on the slide); once they have the matrix they can either use software to find the rank or use Gaussian elimination
      - If they do so, they will find that the number of independent reactions changes (as would be predicted given the visual observation that the overall reaction is not a linear combination of the steps)
    - Slide 9 (optional): Walk through the MATLAB code that determines the number of independent reactions or replace it if your students use software other than MATLAB
- Learning Activity (20 minutes)
  - Slide 10 (as groups or individually): Put the slide up, answer any questions, and let them work
    - After some time has passed let them compare results with others (groups or individuals) and resolve as many differences as possible
  - Slide 11: Go through the solutions for intermediates, type of sequence and rate expression

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- ▶ There are three different possibilities for rate expressions for each mechanism; only one is shown, can have someone who got a different result put it on the blackboard
  - ▶ Someone may note that the rate expressions for a given mechanism have different mathematical functionality; you can discuss this in class or assign problem 6.2 for homework. (In essence, the parts that are functionally different must be insignificant; if they were not, then a different apparent reaction would be observed macroscopically) Alternatively, you can simply tell them that once the concentrations of reactive intermediates have been eliminated from the rate expressions, they will all be the same and that will be demonstrated in Unit 7
- Slide 12: show them what's next and how it relates to what's already been covered

### **After Class**

- Provide the complete slides (and optionally the MATLAB code) to the students.