A First Course on Kinetics and Reaction Engineering
Unit 19. Lesson Plan

Before Class

- Provide the redacted slides and the handouts 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 19 (5 to 10 minutes)
  - Slides 3 and 4: go over the key concepts on the slides
- Ask whether the students have any questions from their pre-class preparation and answer them
  - Slide 5
- Learning Activity 19.1 (~30 minutes)
  - Slide 6: Tell students to get out copy of handout and go over the problem statement and ask if there are any questions. Ask the students what steps they will follow to solve the problem and take a few answers.
  - Slide 7: Show them this sequence of steps and tell them the class is going to work through it step by step. Tell them to work individually, but feel free to ask a classmate or you if they get stuck.
  - Slide 8: Tell them to write the mole balances that they would use. They should expand all summations and delete any terms that are zero-valued or negligible. Circulate, observe, correct and answer questions as they work.
  - Slide 9: Go over the mole balances and answer any questions
  - Slide 10: Tell them to write out the energy balance they would use. They should expand all summations and delete any terms that are zero-valued or negligible. Circulate, observe, correct and answer questions as they work.
  - Slide 11: Go over the energy balance and answer any questions. Make sure they understand why the three terms were eliminated and why only the heat capacity of the inert is used. On the last bullet, point out that there are 7 different derivatives with respect to t (and therefore 7 dependent variables), but only six equations. Therefore they either need to eliminate one of the derivatives or add an equation.
  - Slide 12: Tell them that here they will eliminate one of the derivatives, but in the next activity they will see how to add a seventh ODE. Tell them to eliminate dP/dt using the ideal gas law (they should have seen this in the example readings). Circulate, observe, correct and answer questions as they work
  - Slide 13: Go over the results and their substitution into the energy balance.
  - Slide 14: Point out that now there are 6 ODEs that contain derivatives of 6 different quantities with respect to t. Tell them that numerical solution usually requires that the equations be written in the form shown and tell them to do so. Also tell them to identify the

indicated quantities, noting that in order to solve the equations, they'll need to calculate the other variable quantities.

- Slide 15: Give them a minute or two then go over the results.
- Slide 16: Tell them that in order to solve the equations, they will need to provide some input; in most cases the items shown here. Tell them to write what they would provide or what equations their code would use. Circulate, observe, correct and answer questions as they work.
- Slide 17: Go over the results and point out that at this point they can solve the ODEs and find the values of the dependent variables at the final condition. Ask them how they would use that information to answer the question posed in the problem.

• Learning Activity 19.2 (~10 minutes)

- Slide 18: Tell them that with most software it isn't necessary to eliminate the dP/dt or to write the equations with one derivative on the left side of each equation. Go over the rest of the slide and tell them they can work in small groups to answer. Circulate, observe, correct and answer questions as they work. If they don't know where to begin, tell them to rearrange the equations so in each equation all terms containing derivatives are on the left side and terms without derivatives on the right.
- Slide 19: Show them that the functions they provide to the software are the right hand sides of the equations and they differ from those used in Activity 19.1
- Slide 20: Show the result. Point out that each row corresponds to one of the equations and each column corresponds to one of the derivatives, with the elements in the matrix being the coefficient of the corresponding derivative in the corresponding equation.

• Slide 21: Put the material covered in this class into the overall context of the course.

After Class

• Provide the complete slides and MATLAB code to the students.

Variations

• If your class uses mathematics software other than MATLAB, replace Activity 19.2 with an activity where you show them how to use that software to solve this problem