A First Course on Kinetics and Reaction Engineering
Unit 30. Lesson Plan

Before Class

- Provide the redacted slides to the students
- Tell the students to print the worksheet for Activity 30.1 and bring it to class
- Tell the students to print the equations from Unit 17 or, preferably, the AFCoKaRE Exam Handout and bring it to class

During Class

- Introduce today's topic and where it fits in the course
  - Slides 1 and 2
- Review of Unit 30 (5 minutes)
  - Slides 3 and 4: go over points on the slides
    ‣ Point out that they aren't free to choose which mean temperature difference to use, but it will be specified along with the corresponding heat transfer coefficient
  - Slide 5: ask whether the students have any questions from their pre-class preparation and answer them
- Learning Activity 30.1 (~40 minutes)
  - Slide 6: Read through the problem statement. Point out that the fluid is an aqueous solution and that they may assume constant fluid density
  - Slide 7: Read through the items. If you want them to work in pairs or teams, form the teams. Tell them to work on analysis of the integrated system now, not the stand-alone PFR.
  - Slides 8 and 9: Tell them to make the sketch, give them a few minutes to do so, then show the diagram and answer any questions.
  - Slides 10 and 11: Read the first slide and tell them to start, give them some time to answer, circulate an answer individual questions as they work, when most are done or nearly so, show the results on the second slide and answer any questions.
  - Slides 12 and 13: Read the first slide, tell them to get out their equation sheet and find the general design equations for a PFR (make sure everyone can find the correct equations); discuss the need to convert from axial position to cumulative volume as the independent variable and discuss the need to assume negligible pressure drop; give them a few minutes to set up the equations, circulate answering questions as they do,, when most are done or nearly so, show the results on the second slide and answer any questions.
  - Slides 14 through 16: Show the first slide and tell the class to pretend it is an exam where they need to identify the exact equations to be solved numerically, to identify the kind of equations they are (non-linear or ODEs), to identify the different kinds of variables (independent and dependent for ODEs, unknowns for non-linear equations). Give them

a few minutes to do so, then go over the results (second slide) and answer any questions. Then tell them to continue to pretend it is an exam and that they need to explain what they must provide in order to solve the equations numerically (it is on the AFCoKaRE Exam Handout, if they are using that). Give them a few minutes to work, then show the third slide. Go through the equations variable by variable, noting whether it will be given, is a known constant or must be calculated in order to evaluate the equations

- Slide 17: Go over how to calculate the unknown quantities needed for a numerical solution
  ‣ Point out to them that they know everything they need in order to solve the PFR design equations except for the inlet temperature. Since they can't solve the PFR design equations, they'll have to move on to the heat exchanger design equations
- Slides 18 and 19: Read the first slide, point out that in this problem they will use the cold approach instead of the heat transfer equation, tell them to start, give them some time to answer, circulate an answer individual questions as they work, when most are done or nearly so, show the results on the second slide and answer any questions.
- Slides 20 through 22: Show the first slide and tell the class to pretend it is an exam where they need to identify the exact equations to be solved numerically, to identify the kind of equations they are (non-linear or ODEs), to identify the different kinds of variables (independent and dependent for ODEs, unknowns for non-linear equations). Give them a few minutes to do so, then go over the results (second slide) and answer any questions. Then tell them to continue to pretend it is an exam and that they need to explain what they must provide in order to solve the equations numerically (it is on the AFCoKaRE Exam Handout, if they are using that). Give them a few minutes to work, then show the third slide. Go through the equations variable by variable, noting whether it will be given, is a known constant or must be calculated in order to evaluate the equations
  ‣ Point out that their code will be given Tb, so it can solve the PFR design equations ... as per the bullets
- Slides 23 and 24: show the first slide and tell them now that they can solve all the equations, they need to explain how to answer the questions asked, give them a few minutes to do so and then show the second slide and go over the results, answering any questions.
  ‣ Optionally assign the numerical solution of the problem as homework.
- Summary
  - Slide 25: Put the material covered in this class into the overall context of the course.

After Class

- Optionally assign as homework, a memo that explains why the outlet temperatures are nearly equal while the conversions are substantially different.
- Make the complete slides and the MATLAB code for Activity 30.1 available to the students