CHBE 4200/4210 Unit Operations/Bioprocesses Laboratory (required course)

Credit: 2-3-3

Instructors: Dr. Yonathan Thio and Ms. Jacqueline Mohalley Snedeker

Textbook: None (All materials are available in class or on our online course management system, T-square. Students also use other reference texts that they have used in previous classes or those on reserve in the library.

Catalog Description: This course illustrates engineering/scientific principles and physical models important to the data collection/interpretation of process important to the practice of chemical engineering.

Prerequisites: Separation Processes (ChBE 3225), minimum grade of "C"
Transport II (ChBE 3210), minimum grade of "C"
Kinetics & Reactor Design (ChBE 4300), minimum grade of "C"

Learning Outcomes: By the end of this course, a student should be able to:

1. Work effectively in 3- or 4-person teams to cooperatively carry out a project involving problem identification, data gathering and analysis, and written and oral communication. (Student Outcomes: d, f, g, l)
2. Determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely. (Student Outcomes: a, b, d, e, f, g, i, k, l, m, n)
3. Analyze experimental data using standard statistical methods to establish quantitative results. (Student Outcomes: a, b, f, k, l, n)
4. Write effective technical reports for the experiments. (Student Outcomes: f, g)
5. Serve as team leader for two experiments and make two oral presentations. (Student Outcomes: b, d, e, f, g, i, l)

Topical Outline:

1. Continuous Stirred Tank Reactor
   a. Unsteady and steady-state operation
   b. Reversible/irreversible reaction kinetics
   c. Fundamental model
2. Fluidized Bed
   a. Ergun equation
   b. Minimum fluidization velocity and pressure drop
   c. Gas and liquid fluidization

3. Agitated Aerobic Fermentation
    a. Gas-liquid mass transfer coefficient
    b. Yeast catalyzed fermentation
    c. Gassed power consumption
    d. Stirred reactor scale-up
4. Heat Exchanger
    a. Shell and tube and plate types
    b. Co-current and counter-current flow
    c. Overall heat transfer coefficient
    d. Fouling coefficient
5. Fractional Distillation
    a. McCabe-Thiele method
    b. Overall column efficiency and Murphree plate efficiency
    d. Optimum feed plate location
    e. Reflux ratio
6. Isomerization in a Packed Bed Reactor
    a. Glucose-fructose isomerization
    b. Michaelis-Menten kinetics
    c. External mass transfer and pore diffusion
    e. Rate limiting step
    f. Thiele Modulus and Effectiveness Factor
    g. Packed bed mass and volumetric productivity
7. Membrane Separation
    a. O_2/N_2 separation
    b. Retentate and permeate purity
    c. Permeance and selectivity
    d. Flow configuration
8. Protein Separation from Fermentation Broth
    a. Biomass and protein quantification
    b. Centrifugation, sonication, tangential flow filtration, and homogenization
    c. Bradford assay
    d. Lambert-Beer's law for absorbance
9. Enzyme Membrane Reactor
    a. Biocatalytic reaction
    b. Membrane filtration
    c. Continuous stirred tank reactor
    d. Biot's law for optical activity
    e. Enzyme leakage rate
10. Transdermal Drug Delivery
    a. Model compounds through mouse skin
    b. Biological tissue sample preparation
    c. Diffusion and permeability
    d. Lag time
    e. Statistical significance of differences