

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. O₂/N₂ 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