Biosystems Unit Operations
Bioengineering 437, Spring 2008
Course Syllabus

Instructor: Gönül Schara
Office: Agricultural Science 415I Telephone: 956-6596
Office Hours: Wednesday 3:00-4:00 PM & by appointment Email: gonul@hawaii.edu
(subject to change or rescheduling)

Meeting Times and Locations
Monday & Wednesday & Friday 1:30–2:20 pm @ AG SCIENCE 220

Grading:	Assignments, Reports, & Projects:	30%
	Midterms (2):	20% each
	Final:	30%

Textbook: *****Geankoplis, C. J., *Transport Processes and Separation Process Principles (Includes Unit Operation)*, 4th ed., Prentice Hall, 2006.
Ladisch, M. R., *Bioseparations Engineering: Principles, Practice, and Economics*, Wiley, 2001.
Belter, P.A., Cussler, E. L., and Hu, W.-S., Bioseparations: Downstream Processing for Biotechnology, Wiley, 1988.
McCabe, W.L., Smith, J.C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw-Hill, 1993.
* Recommended reading will be selected chapters from textbook
Additional readings & homeworks will be posted on Laulima:
https://laulima.hawaii.edu/portal
(Log on with your UH username and password, then click BE-437-001 [MAN.88774.SP09]).

Prerequisites: BE 373, CEE 320 or ME 322

Description: 3 credits. Introduction of unit operations common in biological processes for chemical, biochemical, and environmental engineering, food processing, and biotechnological processing

Course Content

Week	Topics
1	Introduction: bioproducts, bioseparation vs chemical separation, design of bioseparation processes, examples from industry. Evaporation of biological materials, types of evaporators, methods of operation of evaporators, calculations for single effect evaporators, Duhling & Enthalpy-Concentration Charts
2	Multiple effect evaporators
3	Filtration, types of filtration equipment, filter aids, basic theory of filtration and equations
4	Settling and Sedimentation, theory of particle movement through a fluid, equipment for settling and sedimentation
5	Centrifugation, centrifuges, equations used for centrifuges
6	Industrially important membrane separation processes: dialysis, reverse-osmosis, ultra-filtration, micro-filtration; common membranes
7	Liquid-liquid extraction, applications in pharmaceutical industry and Exam 1.
8	Single-stage equilibrium extraction; types of equipment and design for extraction, continuous multistage countercurrent extraction
9	Design of towers for extraction; Adsorption, adsorbents, batch adsorption, design of fixed-bed adsorption columns, scale-up laboratory adsorption column
10	Liquid Chromatography, purification of biologics and drugs: ion exchange, affinity, hydrophobic interaction, reversed phase chromatography and gel filtration
11	Precipitation and its mechanism, concentrating and purifying antibiotics and proteins
12	Crystallization and types of crystals, yields and heat and material balances in crystallization, equipment for crystallizations, production of sucrose from sugar beet
13	Crystallization theory.
14	Exam 2. Introduction and methods of drying, equipment for drying
15	Vapor pressure of water and humidity, humidity charts, adiabatic saturation temperature, wet-bulb temperatures
16	Freeze-drying of biological materials, unsteady state thermal processing and sterilization of biological materials, pasteurization
17	Open for contingencies, quizzes, review, and student evaluations.

* Note that some topics above will require more or less than 1 week to cover, and the syllabus should not be considered an absolute guide to the amount of time spent on each topic.

Important Dates:

January 12- First day of class
January 19- Holiday: Martin Luther King Jr. Day
January 20- Last day to drop courses
January 21- Last day to add classes, or change grading option
February 16- Holiday: President's Day
February 25- Midterm #1 (tentative)
March 13- Last day for restricted withdraws
April 1- Last day for submission of "I" removal grades
April 10- Holiday: Good Friday
April 13- Midterm # 2 (tentative)
May 6- Last day of class

May 15- (Friday) Final exam; 2:15 – 4:15 PM

Course Policies:

1. Late work will not be accepted except by advance arrangement with the instructor. In general, work will be collected in class, and should be given directly to the instructor. Students with unexcused absences from quizzes, exams, and labs will not receive credit for these. Absences will only be excused for extreme circumstances such as serious injury or illness, death in the family, participation in varsity athletics or other university sponsored activities, or observation of religious holidays. In general, advance notice for absence will be required.
2. All work submitted must be your own, with the exception of certain class projects which may be completed in small teams. Each member of a team is expected to contribute meaningfully to the project, and is responsible for understanding all of the material submitted.
3. All pertinent work must be shown on exams and papers to receive credit. Unintelligible work will not be graded.
4. Most assignments will be graded by the teaching assistant. Students wishing to contest the grade given on an assignment may not approach the TA with the problem. Instead, they must submit the relevant assignment with a written note to the instructor clearly explaining why a different grade should be awarded. The instructor will then meet with the TA and decide on the fairness of the grade.
5. Questions are encouraged. The instructor and TA should always make themselves available to you during scheduled office hours, and to the extent that their schedules permit they will answer questions by e-mail or phone, or arrange for meetings outside of class.
6. Grading: if the overall class average is greater than 75%, those above 90% will receive an A, those above 80% will receive a B, those above 70% will receive a C, and those above 60 will receive a D. If the class average is less than 75%, the grades will be adjusted to make the average 75%, and the grades will be distributed as described above.
7. Students are expected to be attentive in class, and to learn from the execution of the coursework. To encourage this, a discretionary amount of extra credit will be awarded to students who identify errors in lectures or solutions to problems sets and labs distributed by the instructor, or who offer simpler or more elegant proofs and derivations of equations used in class. Up to 3% may be added to the student's final grade per incidence, depending on the severity of the error and/or the astuteness of the student's observation. All extra credit will be added after adjustment of the final averages so that other students' grades are not affected.

Course Learning Objectives

Upon completing this course, the student will be able to:	*Level*[1]	**BE Outcome**[2]
i) Apply principles of mass/ energy conservation and force balance to derive differential equations describing a system	D	a
ii) Formulate and apply appropriate boundary/ initial conditions.	D	a
iii) Identify how molecular structure relates to material properties	D	b
iv) Recognize the structure and basic functions of DNA, RNA, and protein	D	b

v) Understand the relationship between free energy, entropy, internal energy, and enthalpy	D	c
vi) Recognize and define the problem to be solved	M	d
viii) Has fundamental understanding of the material and chemical properties of biological materials and their separation and purification	M	d
ix) Use models of process to identify the most salient characteristics governing system behavior	D	e
x) Demonstrates an understanding of simple fabrication/manufacturing processes.	I	f
xi) Prepare appropriate engineering plans including drawings	I	f
xii) Objectively discuss the problem and merits of possible solutions	D	g
xiii) Submit written work without errors in spelling, grammar, punctuation, and usage	D	i
xiv) Understand the environmental impacts of engineering activities	D	j
xv) Has the appreciation for the vastness of knowledge that can be applied to	I	k

[1] I = Introductory; D = Developmental; M = Mastery.

[2] UH Biological Engineering Course Outcomes:

a) The graduate has the ability to solve problems involving differential equations.

b) The graduate has the ability to solve physics problems involving mechanics, electromagnetics, and optics; chemistry problems involving inorganic and organic chemistry; problems involving general and micro-biology.

c) The graduate has the ability to solve engineering problems related to statics, dynamics, fluid mechanics, and thermodynamics.

d) The graduate has the ability to design a system, component, or process in which biology plays a significant role.

e) The graduate has the ability to design and conduct experiments to gather information for engineering designs.

f) The graduate has the ability to use modern engineering techniques, skills, and tools to define, formulate, and solve engineering problems.

g) The graduate has the ability to function effectively on multi-disciplinary teams.

h) The graduate has the ability to identify professional and ethical responsibilities when practicing engineering.

i) The graduate has the ability to communicate effectively in large and small groups.

j) The graduate has the background to understand the impact of engineering solutions on the surrounding context.

k) The graduate recognizes the need to engage in life-long learning through participation in professional conferences, workshops, and courses, and by reading and writing in the relevant literature.

l) The graduate has the ability to intelligently discuss contemporary issues.