Dynamic Systems Modeling
Bioengineering 350, Fall 2008
Course Syllabus

Instructor: Gönül Schara
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Office Hours: Tuesday 3:00-4:00 PM & by appointment (subject to change or rescheduling) — Email: gonul@hawaii.edu

Teaching Assistants:
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Meeting Times and Locations
Tuesday & Thursday, 1:30 – 2:45 PM; AG SCIENCE 204
(Thursday, BE 350L, 7:30 – 10:15 AM, AG SCIENCE 315)

Grading:

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

Textbook: There is no required textbook. Course notes and additional readings will be posted on Laulima: https://laulima.hawaii.edu/portal
(Log on with your UH username and password, then click "**Dyn. Syst. Modeling** (BE-350-001 [MAN.76529.FA08])".

Farlow, J., Hall, J. E., McDill, J. M., West, B. H. *Differential Equations & Linear Algebra* , 2nd ed., Prentice Hall, 2007.

Prerequisites: BIOL 171, CHEM 162 or 181A, EE 160, MATH 243 or 252A, and PHYS 170; or consent. Co-requisite: BE 350L.

Description: 3 credits. Introduction to analytical and numerical solutions for systems of differential equations. Modeling and computer simulation of representative dynamic systems encountered in biological engineering.

Course Content

Week	Topics
1	Introduction of basic principles: conservation of mass, energy, momentum, mass, charge, etc. Review of systems of linear equations and linear algebra.
2	Determinate and indeterminate systems, singularity. Simple biomass balances using linear algebra. Solution of linear ordinary differential equations.
3	Solution of systems of linear ordinary differential equations. Representative biological systems modeled by systems of linear ordinary differential equations. Particular solutions for higher order ordinary differential equations.
4	Particular solutions for systems of linear differential equations. Example system of linear equations. Introduction to MATLAB programming environment.
5	Solutions of systems of differential equations with repeated and/or complex eigenvalues: system oscillation.
6	Introduction to Laplace transforms for solving differential equations. Introduction to LabVIEW data acquisition software and/or data loggers.
7	Laplace transforms and Exam 1.
8	Evaluating more inverse laplace transforms: partial fraction expansion. Laplace transforms for cascaded systems
9	Characteristics of transfer functions in laplace domain, implementation in MATLAB software. Introduction to numerical methods for solving differential equations.
10	Continuation of numerical methods for solving differential equations: Euler, modified Euler, and Runge-Kutte approximations. Implementation of numerical models in MATLAB software.
11	Simple modeling of dynamic systems in biological engineering: ‘lumped’ analysis for transient mass and energy transfer, thermal transport in well mixed systems
12	Multiple pool lumped parameter heat and mass transport
13	Models of representative biological systems: counter current heat exchange. Exam 2
14	Models for enzyme kinetics
15	Models for reversible and irreversible inhibition. Alternative graphical analyses for enzyme kinetics
16	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:

August 26- First day of class (for BE 350)
September 2- Last day to drop without ‘W’
September 3- Last day to add classes, or change grading option
October 7- Midterm #1 (tentative)
October 24- Last day to withdraw (with ‘W’)
November 3- Last day for submission of “I” removal grades
November 4- Election day holiday
November 11- Veteran’s day holiday
November 20- Midterm # 2 (tentative)
November 27- Thanksgiving holiday
December 11- Last day of class

December 16- (Tuesday) Final exam; 12:00 – 2:00 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	M	a
ii) Formulate systems of differential equations through coupled/ interdependent variables.	M	a
iii) Formulate and apply appropriate boundary/ initial conditions	M	a
iv) Apply analytical techniques for the solution of ordinary differential	M	a

equations		
v) Understand basic principles of how light and electromagnetic radiation interact with materials	D	b
vi) Identify how molecular structure relates to material properties	D	b
vii) Understand of the concept of pH, buffering, and protonation/ deprotonation.	D	b
viii) Understand the relationship between free energy, entropy, internal energy, and enthalpy	D	c
ix) Recognize and define the problem to be solved	D	d
x) Apply predictive models for cell growth, mortality, metabolism, and enzyme kinetics.	D	d
xi) Apply computational tools for the solution of multidimensional and partial differential equations	M	f
xii) Demonstrate ability to write structured code to simulate a system, or to interface a computer/ controller with a system or process.	M	f
xiii) Design simple circuits for signal processing and measurement	M	f
xiv) Submit written work without errors in spelling, grammar, punctuation, and usage	D	i
xv) Understand the environmental impacts of engineering activities	D	j

[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.