BENG 122A: BIOSYSTEMS AND CONTROL

Fall 2023

Class lectures Tue and Thu 3:30-4:50pm, Warren Lecture Hall 2205 and Zoom:
https://ucsd.zoom.us/j/95305285764
Discussions Wed 11am-12:50pm, Central Hall 220 and Zoom:
https://ucsd.zoom.us/j/95305285764

Web site: http://isn.ucsd.edu/courses/beng122a

Instructor: TAs:
   Prof. Gert Cauwenberghs   Benjamin Balster, bbalster@ucsd.edu
   Department of Bioengineering   Tatiana Kassem, tkassem@ucsd.edu
   Email: gcauwenberghs@ucsd.edu   Consultations: see web site
   Office hours: see web site

Overview: This course will provide an overview of systems and control theory applied to bioengineering, from modeling and stability of linear time-invariant dynamical systems to design of closed-loop feedback control systems, with examples in sensorimotor control and neuromorphic engineering. A control systems design project and an oral presentation are required. There are guest lectures from experts in bioinspired control systems.

    The Tuesday and Thursday lectures will be formal presentations of course material, with further review and examples presented during the Wednesday and Friday discussions. Zoom recorded class lectures will be posted on Canvas for asynchronous access.

Textbook: Tranquillo VT. *Biomedical Signals and Systems*, Morgan & Claypool Publishers, Dec. 2013. https://doi.org/10.2200/S00551ED1V01Y201311BME052

Homework: There will be 5 homework assignments as indicated in the course outline. They are posted on the class web page and are due over Canvas. Homework assignments are the best way to learn engineering. You are expected to complete every homework problem on your own, but may consult with classmates before completing a problem. Please turn in your homework on time; late assignments will not be accepted. Each homework will have some form of a design problem. Solutions will be made available on Canvas.

Tests: There will be two quizzes weeks 5 and 8, covering all material up to the previous week. Quizzes are take-home, and are open-book and open-notes. No web browsing is allowed, nor is any form of communication, other than questions to the instructor and TAs, until submissions are due.

Project: The class culminates in a final project, in groups of five students each. Students define a biomedical control problem of their choice and apply systems and control concepts towards an effective solution, validated through simulation in Matlab/Simulink.

Grades: Final letter grades will be based on a combination of:
Homework: 30% (6% each assignment);
Quizzes: 40% (20% each quiz);
Final project: 30% (10% in-class presentation; 20% final report).

Reviews: The TAs conduct reviews during the discussion sessions and take questions about grading during consultations.

Course Outline—Fall 2023

Week	Topics

Week   **Topics**

Sep 28, 3-5 — Introduction to biosystems and control. Linearized models and linear transforms.
Reading: Tranquillo Ch. 1-4
HW#1, Due Fri 10/13

Oct 10-12 — System response, transfer function, and block diagrams. Matlab and Simulink.
Reading: Tranquillo Ch. 8 & 5
HW #2, Due Fri 10/20

Oct 17-19 — Stability and feedback.
Reading: Tranquillo Ch. 6-7
HW #3, Due Fri 10/27

Oct 24-26 — Review. Control fundamentals.
Reading: Tranquillo Ch. 1-8 (recap); Sec. 9.1-2

Oct 31 — **Quiz #1, Due Wed 11/1**

Nov 2 — Proportional, integral, and derivative (PID) control systems.
Reading: Tranquillo Ch. 9
HW #4, Due Mon 11/13

Nov 7-9 — Frequency response. Bode design and phase margin.
Reading: Tranquillo Ch. 11
HW #5, Due Fri 11/17

Nov 14-16 — Review. Features of biological control systems. Neuromorphic systems engineering.
Reading: Tranquillo Ch. 9 & 11 (recap).

Nov 21 — **Quiz #2, Due Wed 11/22**

Nov. 28-30 — Guest lectures and projects

Dec 5-7 — **Final project presentations**

Dec 14 — **Final project reports due**