BENG 122A: BIOSYSTEMS AND CONTROL

Fall 2020

Class lectures Tue and Thu 9:30-10:50am, Zoom: https://ucsd.zoom.us/j/95305285764
Discussions Wed 11-11:50am, noon-12:50pm, and 2-2:50pm, Zoom

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

Instructor:
Dr. Gert Cauwenberghs
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TAs:
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Consultations: 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 discussions. The Zoom online lectures and discussions will be recorded and 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 on-line, held asynchronously, 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.

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. Consultation hours are posted on the web.

Course Outline—Fall 2020

Week	**Topics**
Oct 1, 6-8	Introduction to biosystems and control. Linearized models and linear transforms. *Reading*: Tranquillo Ch. 1-4 **HW#1, Due Thu 10/15**
Oct 13-15	System response, transfer function, and block diagrams. Matlab and Simulink. *Reading*: Tranquillo Ch. 8 & 5 **HW #2, Due Thu 10/22**
Oct 20-22	Stability and feedback. *Reading*: Tranquillo Ch. 6-7 **HW #3, Due Thu 10/29**
Oct 27-29	Review. Control fundamentals. *Reading*: Tranquillo Ch. 1-8 (recap); Sec. 9.1-2
Nov 3	**Quiz #1, Due Wed 11/4**
Nov 5	Proportional, integral, and derivative (PID) control systems. *Reading*: Tranquillo Ch. 9 **HW #4, Due Thu 11/12**
Nov 10-12	Frequency response. Bode design and phase margin. *Reading*: Tranquillo Ch. 11 **HW #5, Due Thu 11/19**
Nov 17-19	Review. Features of biological control systems. Neuromorphic systems engineering. *Reading*: Tranquillo Ch. 9 & 11 (recap).
Nov 24	**Quiz #2, Due Wed 11/25**
Dec 1-3	Guest lectures: *Rodolphe Sepulchre, Cambridge*: Neuromodulatory control systems. *John Doyle, Caltech*: Diversity enabled sweet spots.
Dec 8-10	**Final project presentations**
Dec 17	**Final project reports due**