Syllabus
Mechanical Engineering 530.485
Physics and Feedback in Living Systems
Fall, 2015
(3 credits, EQ)

Description
The complex mechanisms of living systems cannot be reduced to a set of base pairs: genes are only one part of mystery of life. Rather, organisms must develop, move, interact, and function in their natural environment, and thus are constrained by the laws of physics. For example, during locomotion an animal must accelerate according to Newton’s laws by applying forces between itself and the environment. Beyond physical principles alone, biological systems extensively use feedback to enhance stability and facilitate adaptation in the presence of a changing world. This course examines the critical roles that physical principles and feedback mechanisms play in life, with special emphasis on animal locomotion and its control. Juniors and Seniors only.

Prerequisites
Juniors and Seniors only. It is expected that students are comfortable with linear differential equations and linear systems of equations.

Instructor
Professor Noah Cowan, ncowan@jhu.edu.
http://limbs.1csr.jhu.edu/people/cowan/
Office: Hackerman 126.
Office hours: After class and by appointment.

Teaching Assistant
Mert Ankarali, mertankarali@jhu.edu
Office: Hackerman 136
Office hours: Tuesday, 2:00 to 3:00 PM, in TBD

Meetings
Monday, Wednesday, 3:00–4:15 pm, Shaffer 304

Textbook
• Main course text:
  Note that the book is freely available online:
  http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page
• Reading list: To be posted on the course web page.

Online Resources
Course webpage:
http://limbs.1csr.jhu.edu/cowan/courses/pfls/
Course Objectives

(1) Learn to think wholistically about biological systems. This is not a physiology class, per se, although we will learn some concepts from biology / physiology.
(2) Learn to understand the critical role that feedback control plays in biological systems, especially neural control systems.

Course Topics

- Review of the differential equations, state space representations, complex analysis, the Laplace transform and frequency-domain analysis, Bode diagrams, and Nyquist stability.
- Simplified mechanical system modeling of biological systems, especially locomotion systems.
- Experimental approaches to analyzing neuromechanical systems.

Course Expectations & Grading

(1) Homework (20% of final grade): We will give you homework assignments each week (except weeks with exams or written assignments). The homework exercises have problems to solve and questions to answer, so that you can make sure that you understand the material as we go along and can get help right away if you don't. The homework for each week will be posted on Wednesday after lecture and a printed copy due the following Wednesday before class (3:00 PM). No late homework will be accepted. Homework discussion topics will be held as needed during TA office hours and recitation (see above for times). Your lowest homework score can be dropped.
(2) Midterm (20% of final grade): In class on Wednesday October 21.
(3) Writing Assignments (20% . . . ): During the semester you will complete four writing assignments geared towards the completion of your final project report. The assignments will be due on alternating weeks and additional homework will be limited. The assignments will be short reports:
   (a) introductory material for your project, including bibliographic citations
   (b) methods proposal for data collection
   (c) analyzed results of obtained data
   (d) conclusions and discussion of data. Each assignment is worth 5% of the grade.
(4) Final project report and presentation (20%): As part of your final project you will turn in a research report that consists of an introduction, method, results and discussion section. The full report should include appropriate citations to literature, figures and statistics as needed. This will be due after you've received grades/feedback on your 4 writing assignments.
(5) Final exam (20%): Wednesday, December 16, 2-5PM.

Key Dates

- Midterm, In class on Wednesday October 21.
- Final exam, Wednesday, December 16, 2-5PM
- Final presentations, last week of class (in-class).

Assignments & Readings

Will be announced on the course webpage.

Ethics

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

In addition, the specific ethics guidelines for this course are:
(1) Working together on homework problems is encouraged, but it must be at the conceptual level and your collaborator(s) must be acknowledged on your problem set. DO NOT COPY. Your problem set writeup should come from your brain not your friend’s paper.

(2) Computational assignments (matlab, etc): All coding for homeworks MUST be done by each individual (except when sharing is explicitly allowed, such as for team projects). **Do not email code, share via thumb-drive, etc, at any time!** You can explain coding concepts, give pointers, etc, is OK—but this must be acknowledged in the comment portion of your code, much as described above for problem sets in general).

Your final writeups for computational pre-lab exercises and lab assignments must be done independently without reference to any notes from group sessions, the work of others, or other sources such as the internet.

(3) While working on your final writeups for assignments, you may refer to your own class notes, your own laboratory notes, the text, internet, etc.

(4) Disclosure of Outside Sources: If you use outside sources other than your class notes and your text to solve problems in the pre-lab and lab assignments (i.e. if you have used sources such as your roommate, study partner, the Internet, another textbook, a file from your office-mate’s files) then you must disclose the outside source and what you took from the source in your writeup. **THIS IS GENERALLY OK** – just disclose your sources. While most problem sets are unique, some problems will inevitably be re-used from previous years. If you discover solutions online, please let me know.

Report any violations you witness to the instructor.

You can find more information about university misconduct policies on the web at these sites:

- Undergraduates: [e-catalog.jhu.edu/undergrad-students/student-life-policies/](https://e-catalog.jhu.edu/undergrad-students/student-life-policies/)
- Graduate students: [e-catalog.jhu.edu/grad-students/graduate-specific-policies/](https://e-catalog.jhu.edu/grad-students/graduate-specific-policies/)

**Students with Disabilities**

Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Student Disability Services, 385 Garland, (410) 516–4720, studentdisabilityservices@jhu.edu.

**ABET Outcomes**

- Ability to apply mathematics, science and engineering principles (a).
- Ability to design and conduct experiments, analyze and interpret data (b).
- Ability to function on multidisciplinary teams (d).
- Ability to identify, formulate and solve engineering problems (e).
- Understanding of professional and ethical responsibility (f).
- Ability to communicate effectively (g).