BE 404: Modern Control in Biomedical Engineering
Course Syllabus

Summary

Analysis of feedback control systems including both frequency domain and state space approaches. Proportional, integral, derivative (PID) control design methods. Controllability, observability, and design of optimal controllers and observers. Complementary frequency-domain methods, including root locus and Nyquist analysis. Emphasis on models and applications for biological and biomedical systems.

Textbook

Norman S. Nise. *Control Systems Engineering*

Prerequisites

BE 403 Biomedical Signals and Controls

Expected Outcomes

At the end of the course students should know how to do the following:

- Identify open and closed loop systems
- Write scripts in Matlab to solve engineering design problems
- Understand and calculate key concepts such as stability, tracking, and performance measures
- Design feedback control laws for single input, single output systems
- Use design tools such as root locus and Nyquist plots
- Use mathematical models to describe dynamic processes
- Use frequency response plots to design control algorithms
- Understand tradeoffs and limitations in feedback control design

Course Topic List

Please note that the order and list of topics is tentative and subject to change.

- Models of dynamical biomedical systems, Laplace transform review, transfer functions
- Poles, zeros, stability, response vs. pole location, step, impulse, and arbitrary inputs
- Open loop vs. closed loop, block diagrams
- PID control, lead-lag compensation, and other controllers
- Routh-Hurwitz criterion
- Root locus method and design
- Frequency response, Bode plots
- Gain margin, phase margin, performance specifications
- Design given performance specifications; loop shaping
- Nyquist plots, time delays
- State space design
- Controllability
- Observability and observers