MECH 3610 CONTROL PRINCIPLES
Fall 2023

Course Description:

Introduce to basic control concepts, system equation, block diagrams, signal flow graphs, transient response using convolution integral, root locus and frequency response methods. Design controller using root locus, PID, frequency response, and phase compensation techniques, Nyquist stability test.

Instructor: Lilong Cai (Room 2545, Tel: 7209, e-mail: melcai@ust.hk)

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Grading Policy: Homework 15% and Lab. 5%
Midterm Exam: 35%
Final Exam: 45%

Textbook:. *MODERN CONTROL SYSTEMS, 13th* by Richard C. Dorf.

Supplementary Texts: *Modern Control Engineering, 3nd edition*, by Katsuhiko Ogata

Feedback Control of Dynamic Systems, 2nd edition, by G. F. Franklin, J. D. Powell and A. Emami-Naeini.

Laboratory Work: 1) Feedback control of DC motors.
2) Feedback control of Inverse pendulum on a cart

Contents in the lecture

1. Introduction to Control Systems (1 weeks)
   * Introduction
   * Examples
   * Control system design
2. Mathematical Models of Systems (2 weeks)
   * Differential equations of physical systems
   * Laplace Transform
   * Transfer function and block diagram

3. State Variable Models (1 week)
   * The State Differential Equation
   * Transfer Function of a State Space Model
   * The State Transition Matrix

* Characteristic Equation and Eigenvalues
* Controllability & Observability

4. Feedback Control System Characteristics (1.5 week)
* Open- and closed-loop control systems
* Sensitivity of control systems to parameter variations
* Transient response and steady-state error of control systems

5. Performance of Feedback Control Systems (1.5 week)
* Test input signal
* Performance of a second-order system
* Estimation of damping ratio
* Performance Indices Stability of Linear Feedback Systems (1.5 weeks)
* The concept of stability
* The Routh-Hurwitz stability criterion
* The relative stability of feedback systems

7. The Root Locus Method (1.5 weeks)
* The Root Locus concept
* The Root Locus procedure
* Design example

8. Frequency Response Method (1.5 weeks)
* Frequency response plots
* Performance specification in the frequency domain
* Log magnitude and phase diagrams

9 Stability in the Frequency Domain (1.5 week)
* The Nyquist Criterion and its applications
* Relative stability and the Nyquist criterion