# EE 557

Prof. Nicholas Nagel

## *Dynamics of Controlled Systems*

***Course Logistics:***
Date: Mondays 6:00pm – 9:50pm
Room: EEB 025
Instructor: Prof. Nagel (nnagel@uw.edu)

***Course Purpose:***
The objectives of this course are to present a systematic approach to control system design. It is the intent to do so in a physically insightful method using mathematics as a tool to analyze real world systems as opposed to homework exercises. We will explore systems in multiple domains (mechanical, electrical, thermal) and see the parallels between them. This course presents an intuitive, physics based approach to control systems.

***Course Description:***
There are three mini-projects, a midterm exam, and a final exam. These all take the form of written reports which will demonstrate an understanding of the analysis and results of the problem presented. Each assignment will have clearly written requirements associated with them. There is no assigned textbook for the class. All material needed will be presented in the lectures. A basic course in control systems theory is a prerequisite.

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## *Course Syllabus*

| ***Lec*** | ***Topic*** | ***Assignment*** |
|---|---|---|
| 1 | Course Overview, Background Material, State Space Representation of Systems, Goals of Control Systems, Modeling and Block Diagram Representation of Physical Systems | Software tools review |
| 2 | Disturbance Response, Calculation of Dynamic Stiffness Functions, Nonlinear System Block Diagrams, Operating Point Analysis of Nonlinear Systems, Operating Point Dynamic Stiffness, HW#1 Handout | Hand out HW #1 |
| 3 | State Feedback Augmentation for Disturbance Rejection, Modification of System State Feedback Gains – DC Motor Example, Null Regulators, Disturbance Input Decoupling | |
| 4 | Input Cross Coupling Decoupling, DC Motor Torque Regulator, Full State Command Vectors, Classical Industrial Motion Controller vs. State Feedback Controller | Hand in HW #1, Hand out HW #2 |
| 5 | Introduction of the Resonant Load Problem, Resonant Frequencies, Dynamic Stiffness of Resonant Load System, Relative Active Feedback, Gain Calculation for Required System Eigenvalues | Hand in HW #2, Hand out Midterm (take home) |
| 6 | Review of HW#2, Midterm Discussion | |
| 7 | System Energy States, Command Feedforward, Nonlinear Command Feedforward, Command Tracking | Hand in Midterm, Hand out HW#3 |
| 8 | State Filters, Observers, Estimation Error, Phase Lag Properties of Filters, Multi-zone Temperature Controller Example | |
| 9 | Review of Midterm, State Feedback Partitioning, Controller Design, Nonlinear Decoupling State Feedback | Hand in HW #3 Hand out Final Exam (take home) |
| 10 | Course Review, Discussion of Take Home Final | |