Hellen and John C. Hartmann Department of Electrical and Computer Engineering

New Jersey Institute of Technology

ECE431—Introduction to Feedback Control Systems

Credits and contact hours: 3 credits, 3 contact hours

Instructor's name: Bernard Friedland

Text material:

1. B. Friedland, Lecture Notes for ECE431. Distributed via Highlander Pipeline.
2. N. S. Nise, "Control Systems Engineering" John Wiley., Recommended, but not required.
3. K.J. Astrom, and R.M. Murray, Feedback Systems: An Introduction for Scientists and Engineers. Princeton Univ. Press. (Free PDF copy is available at course website; case bound copy from Amazon at about \$30.) Recommended, but not required.
4. B. Friedland, Control System Design: An Introduction to State-Space Methods, Dover, (Under \$20 at Amazon) May be useful in ECE432 and graduate courses.

Course Catalog Description:
Concept of feedback control. Typical feedback control systems. System dynamics by Laplace transform and state space methods. Stability definition and assessment: Routh-Hurwitx criteria. Graphical stability methods: Root locus, Nyquist and Bode plots. Performance evaluation and simulation. Matlab/Simulink used extensively. A good background in Laplace transform and linear (matrix) algebra highly desirable.

Specific course information: Introduction to feedback control systems. Examples of feedback control, block diagrams, analytical techniques (Laplace transform, state space methods), stability evaluation (Routh-Hurwitz criteria, root-locus, Nyquist plot, Bode plot) Performance evaluation (criteria, evaluation methods). Design project. Matlab/Simulink used extensively.

Prerequisites: **ECE 333**

Required course in Control Systems Track

Course Learning Outcomes

Students will be able to:

1. determine stability of a single-loop feedback control system analytically and with the aid of the Matlab Control System Toolbox;
2. evaluate the performance of a single-loop feedback control system using the Matlab Control System Toolbox and Matlab's Simulink Toolbox;
3. design a PI control algorithm and evaluate performance;
4. perform a "paper" design of a simple control system and present a written and oral report of the result.

Relevant ABET Student Outcomes

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (CLO 1-4)
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (CLO1-4).
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (CLO 3-4).

Brief list of topics to be covered

1. Introduction [1/2 wk]

2. Review of Laplace transform [1/2 wk]
Basic properties Transfer functions, Block diagrams

3. State-space methods [3 weeks]
Vector-matrix representation of differential equations, Transition matrix and resolvent, Transfer functions, Matlab tools

4. Stability [2 weeks]
Definitions,Linear systems, Routh-Hurwitz algorithms

5. Graphical stability algorithms [3 weeks]
Root-locus method, Nyquist plot, Bode plot, Stability margins, Nichols chart

6. Performance [1 week]
Steady state; system type, Transient; dominant pole concept

7. Introduction to design [2 weeks]
PID, State-variable feedback, total transfer function synthesis

8. Projects [2 weeks].