# 332:416 Control System Design — Spring 2004

**Prerequisites:** 332:415 Introduction to Automatic Control or 650:401 Mechanical Control Systems

**Instructor:** Zoran Gajic, ELE 222, tel. 5–3415; gajic@ece.rutgers.edu

**Office Hours:** Tu3, Th3.

**Class Home Page:** http://www.ece.rutgers.edu/˜gajic/416.html

**Teaching Assistant:**

**Text:** Z. Gajic and M. Lelic, *Modern Control Systems Engineering* , Prentice Hall, 1996. (GL96) and Class Notes (CN00)

Recommended Reading: B. Friedland, *Advanced Control System Design*, Prentice Hall, 1995. (F95)

**Topics:**

*Lectures 1:* Review of control system design specifications (GL96—Chapters 6, Section 4.6)

*Lectures 2–3:* Classical controller design based on the root locus technique (GL96—Chapters 7 and 8)

*Lectures 4–5:* Classical controller design based on Bode diagrams (GL96—Chapter 9)

*Lecture 6:* System controllability and observability (GL96—Chapter 5)

*Lecture 7:* System state feedback pole placement technique (GL96—Section 8.2)

*Lectures 8–9:* Full-order observer design. Reduced-order observer design (GL96 —Section 5.6)

*Lecture 10:* Linear-quadratic optimal deterministic regulator problem (GL96—Section 10.3, CN00)

*Lectures 11–12:* Kalman filter and optimal stochastic regulator (GL96—Sections 10.2, 10.3.2, 10.3.3, CN00)

*Lecture 13:* Discrete-time linear-quadratic optimal regulator (CN00, F95—Chapter 9)

*Lecture 14:* Discrete-time observer and Kalman filter (CN00, F95—Chapter 9)

*Lecture 15:* Exam I

*Lecture 16:* System identification (GL96—Section 10.5.1)

*Lectures 17–18:* SIMULINK fundamentals (handout)

*Lectures 19–20:* Quantitative behavior of nonlinear systems. Stability by the first and second methods of Lyapunov (CN00, F95—Chapter 2; GL96—Section 4.3)

*Lecture 21:* Linearization of nonlinear systems (GL96—Section 1.6)

*Lectures 22–23:* Controlling nonlinear systems: extended separation principle; linearization about a set point; extended linearization; feedback linearization (F95—Chapter 4)

*Lecture 24:* Describing function method (F95—Chapter 3, CN00)

*Lecture 25:* Observers for nonlinear systems (F95—Chapter 6)

*Lecture 26:* Reduced-order observers for nonlinear systems (F95—Chapter 6)

*Lecture 27:* Extended Kalman filter (F95—Chapter 6; CN00)

*Lecture 28:* Relay tuning of universal (industrial) PID controllers (CN00)

**Grading**

MATLAB Design Projects 40%

Exam I 30% (Presentation of design algorithms and main control design concepts)

Final Exam 30% (Presentation of design algorithms and main control design concepts)