332: 418 Capstone Design — Control Systems, Spring 2006

MEETING PLACES: ELE 107 Lab, starting by Feb. 2, 2006. ARC 105 and EIT Lab in Jan. 2006.
Instructor: Zoran Gajic, ELE 222, gajic@ece.rutgers.edu, tel: 5–3415
Office Hours: M 11:40–1:00, Th 8:40–10:00am
Class Home Page: http://www.ece.rutgers.edu/~gajic/418.html
Teaching Assistant: Jian Zhang
Textbook: Z. Gajic and M. Lelic, *Modern Control Systems Engineering*, Prentice Hall, 1996 (GL96)
or any other undergraduate controls textbook + Class Notes (CN06)

Part 1: BACKGROUND MATERIAL (posted on the class website)
A. DESIGN SPECIFICATIONS
Review of system stability margins from Nyquest plot and Bode diagrams
Review of transient response parameters and specifications
Review of steady state response characteristics and specifications
Essence of feedback — review
Review of operational amplifiers (CN06)
B. DESIGN TECHNIQUES
Review of the types of feedback controllers
Essence of the root locus technique — review
Review of the design of controllers based on the root locus technique
Review of the design of controllers based on Bode diagrams
Review of state space block diagrams (canonical forms)
Reviw of linear observers
Review of linear-quadratic optimal controllers
Review of linearization of nonlinear systems and control of nonlinear systems via linearization (CN05)
Exam I on the Background Material (30% of the course grade), **Monday, January 30, 2006.**
Students MUST score at least 70% on this exam to qualify for the design stages (Parts 2 and 3)

C. DESIGN SIMULATION (30% of the course grade)
Part 2: DESIGN OF CONTROLLERS VIA SIMULATION using MATLAB and Simulink
STUDENTS MUST HAVE WORKING KNOWLEDGE OF MATLAB/Simulink.
Project # 1: Controller designs via the root locus technique for a ship.
Project # 2 Design of a controller for a vehicle lateral dynamics error.
Project # 3 A pitch controller for a BOEING aircraft.
Project # 4 Control of a nonlinear robot arm via the linearization technique.

D. DESIGN IMPLEMENTATION (ELECTRONIC BOARD DESIGN AND TESTING), 40% of the grade.
Part 3: DESIGN OF CONTROLLERS USING ELECTRONIC BOARDS (Teams of 3 students)
Project # 1: Controller electronic board designs for a ship and a voltage regulator from Part 2.
Project # 2: Controller electronic board design for a vehicle lateral dynamics error.
Project # 3: Electronic board design for a pitch controller for a BOEING aircraft.
Project #4: Observer design for a BOEING aircraft.
Project #5: Controller design for a robot submarine (if time permits).

Grading Scale: $A \geq 90,\ B^+ \geq 82,\ B \geq 75,\ C^+ \geq 67,\ C \geq 60,\ D \geq 50$
(Part 1 =30%, Part 2 = 40%, Part 3 = 30%)