George Mason University
School of Information Technology and Engineering
Department of Electrical and Computer Engineering

ECE 421 | **Classical Systems & Control Theory** | **FALL 2005**
Professor Beale | **Science & Technology II – 257** | **703-993-1596**
http://ece.gmu.edu/~gbeale/ece_421/syl_421.html | gbeale@gmu.edu

OFFICE HOURS: Monday: 3:00 – 4:15 p.m.
Wednesday: 3:00 – 4:15 p.m. and 6:00 – 7:00 p.m.
Other hours by appointment only.

PREREQUISITES: Grade of C or better in ECE 220 or POI.

COURSE TEXT: *Modern Control Engineering*, 4th Edition, K. Ogata, Prentice Hall, 2002, Chapters 1, 3, 5 – 9.

HONOR AND EXAM POLICY:

All students are expected to abide by the George Mason University Honor Code. Sharing of ideas and comparison of answers on homework is acceptable, but copied work will not be accepted. All tests and the final exam will be closed book and closed notes unless specifically stated otherwise by the Instructor. All work must be your own. Any reasonable suspicion of an honor violation will be reported.

Students must arrive in class within 15 minutes of the scheduled starting time for all tests and exams. Students arriving later than 15 minutes after the scheduled starting time will not be allowed to take the test/exam and will receive a grade of 0 for the test/exam.

OBJECTIVES:

1. Learn the purposes, advantages and disadvantages, terminology, and configurations of feedback control systems.
2. Learn ways of classifying, measuring, and analyzing the stability and performance properties of feedback control systems.
3. Learn various classical frequency domain and time domain techniques for designing compensators in order to improve performance in feedback systems.

GRADING:

2 Tests	50%
Homework	10%
Design Project	15%
Final Exam	25%

The lower test grade will count 20%, and the higher test grade will count 30%. Late homework will not be accepted. The lowest non-zero homework grade will be dropped in determining a student's homework average.

A student requesting a grade change for a homework or test problem must provide me with the following information in writing within two class periods after the work is returned: (1) the number(s) of the problem(s) to be considered; (2) a description of your mistakes made in the problem(s); and (3) the reason that you feel that you should receive additional points for the work.

COURSE OUTLINE

Chapter 1	Introduction, what control systems are, types of control systems, examples of control systems, what feedback is and why it is used – 1-1/2 class periods.
Chapter 3	Block diagrams and their manipulation – 1-1/2 class periods.
Chapter 5	Transient analysis for systems, model and characteristics of first-order systems, model and characteristics of second-order systems, effects of control actions on system performance, stability analysis with the Routh array, steady-state errors in systems – 8 class periods.
Chapter 6	Closed-loop poles and their movement, concept of the root locus magnitude and phase criteria, constructing the root locus plot, properties of the root locus – 3 class periods.
Chapter 7	Specifications for control systems, designing compensators using the root locus, phase lag and phase lead compensators, lag-lead compensation – 4 class periods.
Chapter 8	Frequency response analysis, polar plots and the Nyquist stability criterion, review of Bode plots, gain and phase margins – 4 class periods.
Chapter 9	Specifications for control systems, designing compensators in the frequency domain, phase lag and phase lead compensators, lag-lead compensation – 4 class periods.

TEST SCHEDULE:

Test 1	Wednesday, September 28	Chapters 1, 3, 5 (half)
Test 2	Wednesday, October 26	Chapters 5 (half), 6
Final Exam	Wednesday, December 14 4:30 – 7:15 p.m.	Comprehensive, with Chapters 7, 8, 9 emphasized

Last Day to Drop without Dean's Permission: Friday, September 30
No class on Monday, September 5, due to **Labor Day**.
No class on Monday, October 10, due to **COLUMBUS DAY BREAK!!!** Monday's class will be held on Tuesday, October 11, instead.

References

[1] J.J. D'Azzo and C.H. Houpis, *Linear Control System Analysis and Design*, McGraw-Hill, New York, 4th edition, 1995.

[2] Richard C. Dorf and Robert H. Bishop, *Modern Control Systems*, Addison-Wesley, Reading, MA, 7th edition, 1995.

[3] C.L. Phillips and R.D. Harbor, *Feedback Control Systems*, Prentice Hall, Upper Saddle River, NJ, 4th edition, 2000.

[4] G.J. Thaler, *Automatic Control Systems*, West, St. Paul, MN, 1989.

[5] William A. Wolovich, *Automatic Control Systems*, Holt, Rinehart, and Winston, Fort Worth, TX, 3rd edition, 1994.

[6] Graham C. Goodwin, Stefan F. Graebe, and Mario E. Salgado, *Control System Design*, Prentice Hall, Upper Saddle River, NJ, 2001.

COURSE CALENDAR

Day	Date	Topic	Chapter
Monday	Aug. 29	Introduction	1
Wednesday	Aug. 31	Introduction and Block diagrams	1, 3
Monday	Sep. 5	Labor Day – No Class Today	—
Wednesday	Sep. 7	Block diagrams	3
Monday	Sep. 12	First-order systems	5
Wednesday	Sep. 14	Second-order systems	5
Monday	Sep. 19	Second-order systems	5
Wednesday	Sep. 21	Second-order systems	5
Monday	Sep. 26	Types of control actions (material not on Test 1)	5
Wednesday	Sep. 28	Test 1, Chapters 1, 3, and 5 (half)	1, 3, 5
Monday	Oct. 3	Stability analysis with the Routh array	5
Wednesday	Oct. 5	Steady-state error	5
Tuesday	Oct. 11	Steady-state error	5
Wednesday	Oct. 12	Introduction to pole movement, the root locus	6
Monday	Oct. 17	Root locus	6
Wednesday	Oct. 19	Root locus	6
Monday	Oct. 24	Introduction to compensator design (material not on Test 2)	7
Wednesday	Oct. 26	Test 2, Chapters 5 (half) and 6	5, 6
Monday	Oct. 31	Compensator design using root locus	7
Wednesday	Nov. 2	Compensator design using root locus	7
Monday	Nov. 7	Compensator design using root locus	7
Wednesday	Nov. 9	Polar plots and the Nyquist stability criterion	8
Monday	Nov. 14	Review of Bode plots	8
Wednesday	Nov. 16	Relative stability, gain and phase margins	8
Monday	Nov. 21	Gain and phase margins	8
Wednesday	Nov. 23	Thanksgiving Break – No Class Today	—
Monday	Nov. 28	Compensator design using Bode plots, phase lag	9
Wednesday	Nov. 30	Compensator design using Bode plots, phase lag, phase lead	9
Monday	Dec. 5	Compensator design using Bode plots, phase lead	9
Wednesday	Dec. 7	Compensator design using Bode plots, lag-lead	9
Wednesday	Dec. 14	Final Exam, comprehensive, Chaps. 7, 8, 9 emphasized	All