

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

**ECE 421**  
**Professor Beale**

**Classical Systems & Control Theory**  
**Science & Technology II – 257**

**SPRING 2006**  
**703-993-1596**

[http://ece.gmu.edu/~gbeale/ece\\_421/syl.421.html](http://ece.gmu.edu/~gbeale/ece_421/syl.421.html)

gbeale@gmu.edu

**OFFICE HOURS:**           Tuesday: 9:00 – 10:15 a.m. and 3:00 – 4:15 p.m.  
                                  Thursday: 9:00 – 10:15 a.m. and 3:00 – 4:15 p.m.  
                                  Other hours by appointment only.

**PREREQUISITES:**       Grade of C or better in ECE 220 or POL.

**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 .....	40%
Homework .....	10%
Analysis Project .....	10%
Design Project .....	15%
Final Exam .....	25%

The lower test grade will count 16%, and the higher test grade will count 24%. 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	Tuesday, February 21	Chapters 1, 3, 5 (half)
Test 2	Tuesday, March 28	Chapters 5 (half), 6
Final Exam	Tuesday, May 9 4:30 – 7:15 p.m.	Comprehensive, with Chapters 7, 8, 9 emphasized

Last Day to Drop without Dean's Permission: Friday, February 24  
No classes March 12 – March 19 due to **SPRING BREAK!!!**

## 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
Tuesday	Jan. 24	Introduction	1
Thursday	Jan. 26	Introduction and Block diagrams	1, 3
Tuesday	Jan. 31	Block diagrams	3
Thursday	Feb. 2	First-order systems	5
Tuesday	Feb. 7	Second-order systems	5
Thursday	Feb. 9	Second-order systems	5
Tuesday	Feb. 14	Second-order systems	5
Thursday	Feb. 16	Types of control actions (material not on Test 1)	5
Tuesday	Feb. 21	Test 1, Chapters 1, 3, and 5 (half)	1, 3, 5
Thursday	Feb. 23	Stability analysis with the Routh array	5
Tuesday	Feb. 28	Steady-state error	5
Thursday	March 2	Steady-state error	5
Tuesday	March 7	Introduction to pole movement, the root locus	6
Thursday	March 9	Root locus	6
Tuesday	March 14	SPRING BREAK	—
Thursday	March 16	SPRING BREAK	—
Tuesday	March 21	Root locus	6
Thursday	March 23	Introduction to compensator design (material not on Test 2)	7
Tuesday	March 28	Test 2, Chapters 5 (half) and 6	5, 6
Thursday	March 30	Compensator design using root locus	7
Tuesday	April 4	Compensator design using root locus	7
Thursday	April 6	Compensator design using root locus	7
Tuesday	April 11	Polar plots and the Nyquist stability criterion	8
Thursday	April 13	Review of Bode plots	8
Tuesday	April 18	Relative stability, gain and phase margins	8
Thursday	April 20	Gain and phase margins	8
Tuesday	April 25	Compensator design using Bode plots, phase lag	9
Thursday	April 27	Compensator design using Bode plots, phase lag, phase lead	9
Tuesday	May 2	Compensator design using Bode plots, phase lead	9
Thursday	May 4	Compensator design using Bode plots, lag-lead	9
Tuesday	May 9	Final Exam, comprehensive, Chaps. 7, 8, 9 emphasized	All