ECE 521 - Modern System Theory
George Mason University
Electrical and Computer Engineering Department
Spring Semester 2016

Instructor
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Instructor’s Office Hours
Time: Wednesday 16:30 - 18:30 (or by appointment)

Lectures
Time: Monday, 19:20 - 22:00
Location: Nguyen Engineering Building 1107

Prerequisites
ECE 220 (Signals and Systems), MATH 203 (Linear Algebra) and MATH 214 (Elementary Differential Equations) or their equivalents. This includes:
1. linear algebra and matrix operations
2. Laplace transforms
3. signal and system representations and transformations
4. ordinary differential equations

Textbook

Other References
Course Objectives

The main objective of the course is to provide a comprehensive introduction to modern system theory from an input-output and state space point of view. This material is essential in continuing studies in controls, signal processing, and communications. The main mathematical tool employed is linear algebra, which will be reviewed succinctly at the beginning of the course.

Grading Policy

Homeworks - 20% (weekly)
Midterm Exam 1 - 25% (February 29, 2016)
Midterm Exam 2 - 25% (April 4, 2016)
Final Exam - 30% (May 9, 2016)

Remark: Midterm exams (70 minutes) will be followed by a 70 minutes lecture.

Course Policies

1. On average homework will be assigned once a week with solutions posted the following week. Home-
   works must be turned in person before the start of the lecture.
2. The lowest homework grade will be dropped in computing the overall average.
3. As a graduate student, you are responsible for reviewing the topics listed in the course outline below
   after each lecture is given. It will not be possible to cover every topic in detail during lecture. Therefore,
   you should use the course textbook and the other references provided for reinforcing those topics.
4. The course webpage is the clearinghouse for all information concerning the course. Note that it is not
   located on Blackboard. It will be updated frequently, so check it first when you have any question or
   concern about the course.

Honor System

The Honor System at George Mason University is based on individual integrity, and is a required
commitment for all students registered in ECE 521.

To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members
of the George Mason University community and with the desire for greater academic and personal
achievement, we, the student members of the University Community have set forth this:

“Student members of the George Mason University community pledge not to cheat, plagiarize,
steal, and/or lie in matters related to academic work.”

More details about the honor code can be found in http://oai.gmu.edu/the-mason-honor-code-2/
1. Introduction and Background Material
   - Motivation for the Study of Linear Systems
   - Linear Algebra Review
   - Some Additional Facts About Matrices

2. Some Numerical Linear Algebra
   - Sensitivity of Linear Equations: Condition Numbers
   - Matrix Norms
   - The Singular Value Decomposition

3. State Space Descriptions
   - Some Canonical State Space Realizations
   - State Equations in the Time Domain
   - State Space (Similarity) Transformations
   - State Equations in the Frequency Domain
   - Nominal System Functions
   - State Observability and Controllability
   - Discrete-Time Systems, Controllability and Observability
   - Minimality of State Space Realizations
   - Decompositions of Nonminimal Realizations
   - The Popov-Belevitch-Hautus (PBH) Tests
   - Solving the State Equation
   - Modal Decomposition
   - Stability of Linear Systems

4. Linear State-Variable Feedback
   - Compensation via Output Feedback
   - Compensation via State-Variable Feedback

5. Asymptotic State-Variable Observers
   - Open-Loop Observers
   - Closed-Loop Asymptotic Observers
   - Combined Controller-Observer Compensators: The Separation Principle

Important dates

1. January 25: First lecture
2. March 7: Spring break.
3. May 2: Last lecture