Class Meeting Location  STD CENTER B335  
Class Meeting Times  MN B4, WE B4  
Instructor  ALPER ERDOĞAN  
Office Hours  Wednesday 16:00-17:00  
Office Location  ENG 221  
Office Phone  
Email  alperdogan@ku.edu.tr  
Web Address  http://aspc.ku.edu.tr  
Number of Credits  3  
ECTS Credits  6  
Prerequisites  
Language  English  

Assistant  
<table>
<thead>
<tr>
<th>TA/RA/Lab Assistant Name</th>
<th>Email</th>
<th>Office Hours</th>
<th>Office Location</th>
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<tr>
<td>MURAT KIŞCU</td>
<td><a href="mailto:mkuscu@ku.edu.tr">mkuscu@ku.edu.tr</a></td>
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Course Description  

Course Objectives  
The course aims to provide linear system theory background to students for taking advanced classes or performing research in signal processing, communications, control and other engineering disciplines.

Learning Outcomes  
Major outcomes of this course can be listed as follows  
1) Comprehend basic linear algebra and vector space concepts.  
2) Understand basic matrix factorizations such as QR, LDU, EVD, Schur, SVD and their applications in linear systems  
3) Understand special matrices with emphasis on (semi)definite matrices and their use in quadratic forms.  
4) Understand inner product and norm space concepts and their use in various linear system related applications, with emphasis on projection theorem.  
5) Least Squares method and its applications in linear systems.  
6) Learn State-Space Description of both continuous time and discrete time systems.  
7) Understand the derivation of time response as a function of state space parameters.  
8) Comprehend the concepts of controllability, observability and minimal realization.  
9) Understand the stability concept in connection with the state space models.  

Teaching Methods  
The course duration is 14 weeks, and each week will contain two 75-minute lectures. The students will be regularly assigned homework exercises. There will be one midterm and one final exam.

Course Contents  
<table>
<thead>
<tr>
<th>Session Number</th>
<th>Starting Date</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1</td>
<td>16/09/2013</td>
<td>Introduction and Motivation</td>
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<tr>
<td>1</td>
<td>18/09/2013</td>
<td>Linear Algebra Review: Vector Space and Subspace</td>
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<tr>
<td>1</td>
<td>23/09/2013</td>
<td>Linear Algebra Review: Linear Combination, Span, Linear Independence, Basis, Euclidian Norm in $\mathbb{R}^n$</td>
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<td>Linear Algebra Review: Euclidian Inner Product in $\mathbb{R}^n$, Matrix-Vector Product, Range Space of a Matrix</td>
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Linear Algebra Review: Null Space, Direct Sum of Subspaces, Four Fundamental Spaces
Linear Algebra Review: Rank, Analysis of Ax=b based on Fundamental Spaces, On Solutions of Ax=b
Linear Algebra Review: Basis Change, Eigenvalue Decomposition and Diagonalization, Schur Decomposition and Triangularization
Complex Inner Product, Orthogonal and Orthonormal Sets, Orthogonal Projection, Projection Matrices, Unitary and Orthogonal Matrices.
QR Factroization: Gram-Schmidt Orthogonalization, Householder Triangularization
Normal Matrices, Hermitian Matrices, Positive (Negative) (semi)definite Matrices
Quadratic Forms
Properties of (semi) definite matrices, matrix square root, Cholesky Decomposition with Applications
Norm Spaces, Vector Norms, Matrix Norms: Frobenius Norm, Induced Norms, Schatten-p norms
Inner Product Spaces, Projection Theorem, Linear Least Squares
Least Norm Solution and Applications
Singular Value Decomposition, Polar Decomposition with Applications
State Space Description of Dynamical Systems
Time Domain Solution of State Space Equations
Frequency Domain Methods
Linear Dynamical System Examples
Canonical State Space Realizations
Controllability
Observability
Stability
Linear Quadratic Regulator
Lyapunov Theory
Lossless Systems

Assessment Methods

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<th>Type</th>
<th>Description</th>
<th>Final Grade, %</th>
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<tr>
<td>Homework</td>
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<tr>
<td>Midterm Test</td>
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<td>35</td>
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<tr>
<td>Final Exam</td>
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Workload Breakdown

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<tr>
<td>Assignment</td>
<td>Homework Solution Preperation</td>
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<td>Exam</td>
<td>Midterm Preparation and Midterm Exam</td>
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</tr>
<tr>
<td>Exam</td>
<td>Final Exam Preparation and Final Exam</td>
<td>20</td>
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<tr>
<td>Other</td>
<td>Pre-lecture Preparation</td>
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<td>Other</td>
<td>Lecture Review</td>
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<td><strong>Total</strong></td>
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Sources

Recommended Readings

- Matrix Analysis by Horn and Johnson
- Linear Systems by Thomas Kailath
- Linear System Theory and Design by Chi-Tsong Chen
- Linear Algebra and its Applications by Gilbert Strang

Other

N/A

Academic Dishonesty