Electrical and Computer Engineering Course Syllabus

Instructor:	Prof. Henry Pfister	**E-mail:**	`hpfister@tamu.edu`
Office / Hour:	WERC 235A / T 4-5 pm	**Phone:**	(979) 862-3198
Class Room:	ZEC 223A	**Class Time:**	T-TH 2:20-3:35 PM

Course Name: **ECEN 601**

Course Title: **Linear Network Analysis**

Prerequisite(s): None

Required Text(s): Mathematical Methods and Algorithms for Signal Processing by Todd K. Moon and Wynn C. Stirling, Prentice Hall

Other Text(s): Proofs and Fundamentals: A First Course in Abstract Mathematics by Bloch, Linear Algebra by Hoffman and Kunze, Optimization by Vector Space Methods by Luenberger

Course Objectives:

1. Explore fundamental concepts of logic including sets, axioms, quantifiers, implications, necessary and sufficient conditions. Illustrate valid proof methods such as proofs by contradiction, proofs by contrapositive, the principle of mathematical induction and counter examples.
2. Establish basic notions of topology in the context of metric spaces. Study formal definitions for open sets, closed sets, convergence, limit points, completeness and continuous functions.
3. Review linear algebra, combinations of vectors, independence, bases and dimensions. Distinguish between vector spaces, normed spaces and inner-product spaces. Go over the projection theorem and illustrate some of its applications.
4. Introduce the notions of linear operators, fundamental subspaces, matrix representations, inverses and pseudoinverses. Examine the properties of characteristic polynomials, eigenvalues, eigenvectors and eigenfunctions. Develop the theory of the singular value decomposition. Survey special matrices and important matrix factorizations.
5. Apply vector space methods to signal processing, optimization, least-squares filtering, and minimum mean-square error estimation. Acquire the ability to recognize, formulate and solve pertinent engineering problems using vector space methods and Hilbert spaces.
6. Gain proficiency at using high-level programming languages such as Matlab and Mathematica.
7. Engage the student in an active learning experience. Expose the student to search engines, scholastic resources, research tools, indexes and databases. Prepare the student to become an active contributor to the common body of knowledge.

Course Topics and Hours:

Unit	Topics	Hours
1	Mathematical Review	4.5
2	Topology	4.5
3	Linear Algebra	6
4	Representations	4.5
5	Linear Operators	6
6	Matrix Factorizations	4.5
7	Canonical Forms	4.5
8	Singular Value Decomposition	3
9	Convex Optimization	4.5
10	Additional Topics	3
	Total Hours	45

Lecture Schedule: 2 meetings / week, 125 minutes total

Student Evaluation:

Homework / Quizzes	20%	Roughly 12 assignments throughout the semester
Midterm Exams	40%	Two equally weighted midterm exams
Final Exam	30%	Comprehensive final exam on Wednesday, December 16 from 1-3 pm
Project	10%	Use the tools acquired in this class to solve an engineering problem

Rules and Guidelines:

The class shall follow all established policies of TAMU. This includes the Aggie Honor Code and the Americans with Disabilities Act (ADA). The honor code is "An Aggie does not lie, cheat, or steal or tolerate those who do." and more information is available from `http://www.tamu.edu/aggiehonor`. The ADA is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities and more information is available from `http://disability.tamu.edu`. Links to these and other policies can be found at `http://www.ece.tamu.edu/~hpfister/courses.html`.

Course Outline

1. Mathematical Review
   (a) Logic
   (b) Set Theory
   (c) Functions
2. Metric Spaces and Topology
   (a) Metric Spaces
   (b) Introduction to Topology
   (c) Continuity and Completeness
   (d) Contraction Mapping Theorem
3. Linear Algebra
   (a) Fields, Matrices and Vector Spaces
   (b) Norms and Inner Products
   (c) Orthogonal Projections
   (d) Banach and Hilbert Spaces
4. Representations and Approximations
   (a) Approximations in Hilbert Spaces
   (b) Matrix Representations
   (c) Applications and Examples
5. Linear Transformations and Operators
   (a) Linear Transformations, Functionals and Operator Norms
   (b) Linear Functionals and Adjoints
   (c) Fundamental Subspaces and Pseudoinverses
6. Matrix Topics
   (a) Matrix Factorizations
   (b) Perturbation Bounds
7. Canonical Forms
   (a) Characteristic Values
   (b) The Jordan Form
8. Singular Value Decomposition
   (a) Hermitian Matrices
   (b) Singular Value Decomposition
9. Constrained Optimization
   (a) Karush-Kuhn-Tucker Conditions
   (b) Convex Functions and Convex Sets
   (c) Lagrangian Duality
10. Additional Topics (time permitting)
    (a) Circulant and Toeplitz Matrices
    (b) Asymptotic Equivalence