Syllabus for EEE 598 Linear Algebra and Convex Optimization

Course Description
Linear algebra and convex optimization. Vector spaces, matrix algebra, linear programming, Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions, and duality theory, and algorithms for convex optimization. Newton's method, gradient and steepest descent methods. Algorithms for unconstrained, equality constrained, and inequality constrained problems, which include interior point methods. Applications to approximation and data fitting and some geometric problems. Applications to signal processing, communications, and control systems. Background in linear algebra necessary to be successful in this course.

Enrollment requirements
Graduate standing.

Course Overview:
In addition to the course description above, an overview of the course topics are itemized below:

1. History, context, and applications
2. Vector spaces, matrix algebra and decompositions
3. Least squares
4. Linear programming
5. Convex sets, functions and optimization
6. Duality, Lagrange multipliers, KKT conditions
7. Approximation and fitting problems
8. Newton's method
9. Interior point methods
10. Applications to signal processing, communications, and control problems.

In addition to the homework assignments throughout the semester, there will be at least one project that requires students to implement the iterative convex optimization algorithms covered in class. The students will also need to use cvx to check their results, which is an existing convex optimization engine that works with MATLAB, which in tern is available on the ASU system for students to use.

Student Learning Outcomes
Students completing EEE 598 will be able to formulate engineering problems as optimization problems, and be able to formulate these as convex problems whenever possible. Students will be able to recognize linear programming, quadratic programming, and geometric programming problems and be able to solve these using existing solvers such as cvx. Students will have an understanding of Newton's method and its variations, and understand its convergence behavior.

Assignments:
There will be about 10 homework assignments throughout the semester, and one computer project which will be due at the end of the semester. The homeworks are problems assigned from the textbook that reinforce basic concepts, and also introduce some advanced concepts not covered in class. Each homework should take about 4-5 hours to complete. The project should take about a week to complete with 2-3 hours a work every day. The homeworks, exams and the project will be designed to reinforce learning. All of the homework will be 15% of the grade. The midterm exam is 25% and the final exam is 30%. The computer project will be 30%. Late assignments will not be accepted.

Required primary and secondary materials:
The required materials include the textbook:
Convex Optimization by S. Boyd and L. Vandenberghe.
Please see http://www.stanford.edu/~boyd/cvxbook/bv_cvxbook.pdf for more info, or a free soft copy of the book.

The students are also required to have access to MATLAB technical computing software, which is available through the ASU myapps system.

Course Itinerary:
The course will have regular meetings at the scheduled times (usually 1 hour and 15 minute classes, 2 times a week). Below is the weekly schedule:

Week	**Topic**
1	Introduction to the course and Introduction to linear algebra
2	Matrices, linear equations
3	Vector spaces, QR factorization
4	Overdetermined systems, least squares
5	Symmetric matrices, quadratic forms, matrix norm, and SVD
6	Introduction to optimization
7	Convex sets and functions
8	Convex optimization
9	Linear, quadratic, and geometric programming
10	Duality theory
11	Approximation and geometric problems
12	Unconstrained minimization, Newton's method
13	Equality constrained minimization
14	Interior point methods
15	Applications to filtering
16	Applications to controls

Grading
Homework 15 %
Semester (Midterm) Exam 25 %
Computer Project 30 %
Final Exam 30 %

Academic Integrity
All students in this class are subject to ASU's Academic Integrity Policy (available at http://provost.asu.edu/academicintegrity) and should acquaint themselves with its content and requirements, including a strict prohibition against plagiarism. All violations will be reported to the Dean's office, which maintains records of all offenses.

Disability Resources
Suitable accommodations will be made for students having disabilities and students should notify the instructor as early as possible if they will require same. Such students must be registered with the Disability Resource Center and provide documentation to that effect.