1. ECE/MATH 520: Optimization Methods-Control and Communication

2. 3 credits: 2-75 minute lecture sessions/week

3. Edwin Chong

4. An Introduction to Optimization. Chong , E. K. P. & Żak, S. H. 2013.

5. Course Information
    a. Linear and nonlinear optimization theory and methods; applications in systems, control, and communication
    b. Prerequisites: MATH 229 or MATH 369; MATH 317
    c. Selected Elective: Electrical Engineering; Computer Engineering

6. Goals for the Course
    a. Course Learning Objectives
        i. Analyze optimization problems to determine appropriate solution methods, including applying analytical and numerical methods
        ii. Apply necessary conditions and sufficient conditions for optimality
        iii. Analyze optimization algorithms in terms of properties including descent, convergence, and order of convergence
        iv. Make precise statements about optimization problems and their solutions
    b. Student Outcomes
        1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
        2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and welfare, as well as global, cultural, social, environmental, and economic factors
        3. An ability to communicate effectively with a range of audiences
        4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
        6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
        7. An ability acquire and apply new knowledge as needed, using appropriate learning strategies

7. Topics Covered
    Unconstrained and constrained optimization theory
    Algorithms and search methods for optimization, and their analysis (includes: quasi-Newton, recursive least squares, genetic algorithm)
    Optimization of dynamic systems
    Examples from various engineering applications
    Examples of application in optimal control, parameter estimation, optimal design, neural

network training, optimal pricing and investment planning
SONC and SOSC
Multi-dimensional algorithms
Gradient methods: convergence of fixed step size algorithm, steepest descent algorithm
Conjugate direction methods: form, properties, conjugate gradient formulas
Constrained optimization: basic form with equality and inequality constraints. Intro to linear programs, geometric view, standard form
Linear programming: converting to standard form
Moving from one BFS to an adjacent BFS
Weak duality lemma, duality theorem, duality and Simplex algorithm, complementary slackness
General multivariable Lagrange condition
Minimizing quadratic subject to linear constraint
KT condition for equality and inequality constraints
Convex optimization problems