Course Number and Title: Math 651-601, Optimization (I)

Texts: Optimization by Vector Space Methods, by D. G. Luenberger
Meeting Time and Place: TR 11:10-12:25 pm at BLOC 121
Instructor: Prof. Jianxin ZHOU, **Office**: Blocker 641J, **E-mail**: j-zhou@tamu.edu
Office Hours: TR 2:30-3:45 pm or by Appointment
Description: A two semester course to study a rather unified theory for Optimization and Equilibrium in Infinite Dimensional Spaces
Prerequisite: Linear algebra, calculus and analytic geometry, Math 410 or approval of instructor
Backbone of Approach: Applied analysis (calculus of variations/convex, equilibrium analysis...)
Grading Policy: homeworks 80% and final presentation 20%

Topics Covered in the First Semester:

- Chapt.1 Introduction
- Chapt.2 Linear Spaces: convexity, linear independence, compactness normed spaces
- Chapt.3 Hilbert Space: approximation, projection theorem, Gram-Schmidt procedure, Fourier series, dual approximation
- Chapt.4 Hilbert space of random variables, the least squares estimate, minimum-variance (unbiased) estimate, recursive estimate
- Chapt.5 Dual Spaces: alignment and orthogonal complements, hyperplane, duality in minimum norm problems
- Chapt.6 Linear Operators and Adjoints: duality relations for convex cones, the normal equations, the dual problems, Pseudoinverse operators

Topics Covered in the Second Semester:

- Chapt.7 Optimization of Functionals: Gateaux and Frechet differentials, derivatives, Euler-Lagrange Equations, convex functionals, conjugate functionals, dual optimization problems, min-max theorem of game theory. Other topics in optimal design will be added
- Chapt.8 Global Theory of Constrained Optimization: positive cone, Lagrange multipliers, sensitivity analysis, duality
- Chapt.9 Local Theory of Constrained Optimization: Inverse function theorem, equality constraints, inequality constraints, Kuhn-Tucker theorem, Pontryagin maximum principle
- Chapt.10 Iterative Methods of Optimization: successive approximation, Newton's method, descent methods, conjugate direction methods, projection methods, the primal-dual method, penalty function methods

Other Topics: Active-set method, working-set method, equilibrium theory, convergence analysis.

What are the differences from this class to other optimization classes on campus?

(1) My teaching methodology:

a) I will focus more on "why" than "how". So that it will help to build some mathematical foundation for you to study NEW optimization problems in the future.

b) Since in the class, half of them are Math students and the other half are from outside, to fit both students, I will try to balance our study on Optimization Theory, Their Applications and Optimization Algorithms.

c) Homework problems are very helpfull for this class however some of them are quite hard, thus hints or discussions will be provided.

(2) Class contents: Infinite dimension vs fininite dimension.

a) An objective function can be a function of functions, called functional, so a solution is a function rath than just a point. Then we are concerned with not only the function values but also their derivatives in a process to search for a solution.

b) An optimality condition for an optimization problem may depend on the derivative of the objective functional and also a norm defined on the space. They can be very different between a finite dimesional propblem and an infinite dimensional problem, and change the existence of a solution to the problem or the performance and convergence of an optimization method.

(3) My suggestion: Since I have provided all the lecture notes, you may focus on the lectures, do not take lecture notes, instead, you may print the lecture notes beforehand and then add your comments to them.

TAMU Policy Statements: Academic Integrity: The Aggie Honor Code states: An Aggie does not lie, cheat or steal, or tolerate those who do. Information about the Honor Council Rules and Procedures can be found at the website of the Aggie Honor System Office. Americans with Disabilities Act (ADA): Texas A&M University is committed to providing equi- table access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or call 979-845-1637. Disabilities may include (but are not limited to) attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.