10510COM 524500 Optimization for Communications (通訊之最佳化方法)

Lecture hours: **W3,W4,F3,F4** Classroom: **Delta 210**, 台達館

(Fall Semester 2017)

Instructor: **祁忠勇** (Chong-Yung Chi), Office: Room 966, 台達館

Office hours: **13:30 pm-15:30 pm (Tuesday & Thursday)**

http://www.ee.nthu.edu.tw/cychi/

Tel: 03-5731156 or ext. 31156, E-mail:cychi@ee.nthu.edu.tw

Convex analysis and optimization *along with available software has been recognized as a powerful tool for solving a wide range of science and engineering problems. Over the last decade, convex optimization has been employed successfully in solving various problems in signal processing and communications engineering, as we recently have applied it to Blind Source Separation (BSS) and biomedical and hyperspectral image analysis in signal processing, as well as coherent/noncoherent detection and channel estimation, space-time coding, distributed signal processing, beamforming, and resource allocation in multiple-input multiple-output (MIMO) Communications and Networking. More successful applications are emerging and rapidly growing, specifically such as analytical chemistry for the former, and physical-layer secrecy and cooperative communications for the latter, and many new interdisciplinary science and engineering applications. This course is to introduce convex optimization concepts and methods, available software and their applications.*

Background: A good background in linear algebra and matrix theory is desirable.

Course Outline:

1. Background materials in linear algebra and matrix theory
2. Convex sets
3. Convex functions
4. Convex optimization problems
5. Duality
6. Unconstrained minimization
7. Interior-point methods
8. Applications to engineering problems
9. Selected topics from recent optimization methods for communications/signal processing

Textbook and Lecture Notes:

Boyd and Vandenberghe, *Convex Optimization*, Cambridge University Press, Cambridge, 2004. E-book can be downloaded from: http://www.stanford.edu/~boyd/cvxbook/

Chong-Yung Chi, W.-H. Li, and C.-H. Lin, Convex Optimization for Signal Processing and Communications: From Fundamentals to Applications, CRC Press, Boca Raton, FL, 2017. (432 pages) (Book Introduction

http://st-ebook.com.tw/bookcomment-2.aspx?BOKNO=TKCP00033)

These lecture notes, currently being written as a textbook, systematically introduces how to efficiently and effectively solve an ***optimization problem****, from the fundamental theory, problem definition, reformulation into a convex problem, analysis, algorithm implementation, to cutting edge researches (like an exploration journey rather than pure mathematics) in signal processing and communications. It has been successfully used as the textbook of* ***COM 5245 (Optimization for Communications)*** *every year since 2008. Furthermore, it has been used for my 32-hour (over 2 weeks) invited short course entitled "****Convex Optimization for Signal Processing and Communications****" at many top ranked universities in Mainland China over the last 5 years, including* ***Shandong University****, Jinan (January 2010),* ***Tsinghua University****, Beijing (August 2010 and August 2012),* ***Tianjin University****, Tianjin (August 2011),* ***Beijing Jiaotong University (BJTU)****, Beijing (July 2013),* ***University of Electronic Science and Technology of China,*** *Cheng-Du (November 2013 and September 2014), and* ***Xiamen University****, Xiamen (December 2013). I recently offered this short course at* ***BJTU****, July 2015, at* ***Sun-Yet-Sen University (SYSU),*** *Guangzhou, August 2015, and at* ***UESTC*** *Sept. 2015. added*

References:

Giuseppe Calafiore and Laurent El Ghaoui, *Optimization Models*, University Press, Cambridge, 2014.

R. Fletcher, *Practical Methods of Optimization*, John Wiley and Sons,1988.

D. P. Bertsekas, *Convex Analysis and Optimization*, Athena Scientific,2003.

D. P. Bertsekas, *Convex Optimization Theory*, Athena Scientific, 2009.

Daniel P. and Yonina C. Eldar (Editors), *Convex Optimization in Signal Processing and Communications*, Cambridge University Press, Cambridge, 2010.

Grading:

TA: **Yao-Rong Syu**, e-mail: roy50408@gmail.com; **Office hours: Wednesday 14:00-16:00**

TA: **Amin Jalili**, e-mail: a.jalily@gmail.com; Office hours: **Wednesday 14:00-16:00**

(Office: EECS Building 706, Tel: X34033)

Homework: 15%;

Midterm Exam: 30%; (written examination in class)

Final Exam: 30%; (written examination in class)

Term Project: 25% (no more than 2 persons per group)

Remarks:

1. The language of instruction is English.
2. Homework must be handed in by the deadline by yourself. The score will be multiplied by **a factor of 0.7 per day passing the deadline**.
3. *Nonlinear adjustment* will be made as needed for the final term grade.
4. Course website: http://www.ee.nthu.edu.tw/cychi/courses-e.html
5. No make-up for mid-term and final examinations under any circumstance.