11010COM 524500 Convex Optimization for Communications and Signal Processing

(通訊及信號處理之凸優化方法) **(Fall Semester 2021)**

(An on-line Skype course, https://join.skype.com/vmxf4x54kWfO**)**

Lecture hours: **W3,W4, F3,F4**, Classroom: **Delta 211**, 台達館 211

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

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

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

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

Convex Optimization *has been recognized as a powerful tool for solving many science and engineering problems. Over the last two decades, convex optimization has been successfully and extensively applied to various problems in signal processing such as blind source separation (BSS) for biomedical and hyperspectral image analysis, and in multiple-input multiple-output (MIMO) wireless communications and networking. Particularly, fourth generation (4G) wireless communication systems have been in operation, and various researches for fifth generation (5G) systems and future 6G, e.g., massive MIMO, millimeter wave wireless communications, full-duplex MIMO, energy harvesting, and multicell coordinated beamforming, have been intensively studied and reported in the open literature, where the convex optimization tool is extensively wielded, validating its central role in the development of 5G systems and to many interdisciplinary science and engineering applications. This course is to introduce convex optimization concepts and methods, available software and their applications.*

Background: Calculus and linear algebra are prerequisites, while matrix analysis is desirable.

Course Outline:

1. Background materials in linear algebra and matrix analysis
2. Convex sets
3. Convex functions
4. Convex optimization problems
5. Duality
6. Interior-point methods
7. Applications to communications/signal processing and other engineering problems

Textbook:

Chong-Yung Chi, Wei-Chiang Li, and Chia-Hsiang Lin, Convex Optimization for Signal Processing and Communications: From Fundamentals to Applications, CRC Press, Boca Raton, FL, 2017 (432 pages).

http://st-ebook.com.tw/bookcomment-2.aspx?BOKNO=TKCP00033 (科大文化圖書公司)

The material of the 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 used for my 2-week (32 lecture hours) or 3-week (48 lecture hours) invited short course entitled "****Convex Optimization for Signal Processing and Communications****" at many top ranked universities in Mainland China over the last decade, including* ***Shandong University****, Jinan (January 2010, November 2017),*

***Tsinghua University**, Beijing (August 2010 and August 2012), **Tianjin University**, Tianjin (August 2011), **Beijing Jiaotong University (BJTU)**, Beijing (July 2013, July 2015 and August 2017), **University of Electronic Science and Technology of China**, Chengdu (November 2013, September 2014 and September 2015), **Xiamen University**, Xiamen (December 2013), **Sun-Yet-Sen University (SYSU)**, Guangzhou (August 2015), and **Beijing University of Posts and Telecommunications**, Beijing (July 2016, July 2017, July 2018, July 2019), **Shandong Normal University**, Jinan (Aug. 2018), and **Xidian University** (Aug. 2019).*

References:

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

Homework: 25%
Final Exam: 50%
Term Project: 25%
Teaching assistant: **Michelle Lin (林孟萱)**, e-mail: michelle889886@gmail.com, Tel: X34033,
Office: EECS Building 706, Office hours: 14:00-16:00 Tuesday, 8:00-10:00 Thursday
Teaching assistant: **Chien-Wei Huang (黃健瑋)**, e-mail: s110064501@gmail.com, Tel: X34033,
Office: EECS Building 723, Office hours: 14:00-16:00 Tuesday, 13:30-15:30 Wednesday

Remarks:

1. The language of lecture is English.
2. *Nonlinear adjustment* will be made as needed for the final term grade.
3. No make-up for examinations under any circumstances.
4. Homework assignments must be handed in on the required date. Late assignments and plagiarism are not allowed. Dispose of in accordance with school regulations if found.
5. Due to the COVID-19, this course will be held online. Therefore, if students have any questions, please ask TAs in the Skype group during their office hours.

Digital Platforms:

1. Skype Group for online course: https://join.skype.com/vmxf4x54kWfO
2. Course website: https://www.ee.nthu.edu.tw/cychi/teaching/cvx_comm.php
3. Important information will be announced on NTHU EEclass website: https://eeclass.nthu.edu.tw/