

# CS5580 Convex Optimization: Theory

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## 1 Scope & Syllabus

This is primarily a foundational course on the theory of convex optimization. The focus however is on topics which might be useful for machine learning and computer vision researchers. Accordingly, some advanced/specialized topics are included:

### I. Analysis

1. Convex Analysis: Convex Sets, Convex Functions, Dual definitions for Convex Sets and Functions, Calculus with convex functions.
2. Optimality of Convex Programs: 1st order necessary and sufficient conditions, KKT conditions.
3. Lagrange, Conic, Fenchel Duality

### II. Standard Programs

1. Linear, Quadratic Programs
2. Conic Programs (SOCP, SDP)
3. Geometric Programs

Reference text books for the theory part are: [6], [5] (Appendix, Chp1); for the subsequent part: [5] (Chp2-3), [1]. Also, the following lighter to follow references provide good insights into the subject [4, 2, 3]. The following skills are expected to be acquired by students studying this course: recognizing convex problems, and re-casting problems as convex ones, playing with duality and artifacts of calculus etc.

## Evaluation Scheme

This course follows common evaluation and (relative) grading across all batches (e.g., MDS/regular etc.). Relative grading will be done based on performance in:

| Date                         | Duration | Percentage                                |
|------------------------------|----------|---|
| 04-Feb-2019 (Mon)            | 60 min.  | 15% (Open book/laptop)                    |
| 13-Mar-2019 (Wed)            | 60 min.  | 15% (Open book/laptop)                    |
| 26-Apr-2019 (Fri)            | 60 min.  | 15% (Open book/laptop)                    |
| Final Exam (for all batches) | 180 min. | 55% (Closed book/laptop; No cheat-sheets) |

In addition to the above, practice-problems will be given, which will not be evaluated and do not contribute to grading (directly). Bonus marks may be given to students who ask/answer interesting questions during or outside lectures.

In case you are auditing this course, then 100% attendance is an additional requirement over and above the institute recommendation.

## Contact

The course page is at <http://www.iith.ac.in/~saketha/teaching/cs5580.html>. The instructor can be contacted via email: saketha at iith. The typical working hours of the instructor are 8:30am to 12:45pm and 2:15pm to 5:15pm. His office is C-519. You are welcome to drop-by anytime for clarifying doubts during these working hours. Technical interaction (outside and in lecture hours) is highly encouraged.

## References

- [1] A. Ben-Tal and A. Nemirovski. *Lectures on Modern Convex Optimization: Analysis, Algorithms and Engg. Applications*. MPS-SIAM Series on Optimization, 2001.
- [2] S. Boyd. Video Lectures on Convex Optimization - 1. Available at <http://www.stanford.edu/class/ee364a/videos.html>, 2007.
- [3] S. Boyd. Video Lectures on Convex Optimization - 2. Available at <http://www.stanford.edu/class/ee364b/videos.html>, 2007.
- [4] S. Boyd and L. Vandenberghe. *Convex Optimization*. Cambridge University Press, 2004.
- [5] A. Nemirovski. Lectures On Modern Convex Optimization. Available freely at [www2.isye.gatech.edu/~nemirovs/Lect\\_ModConvOpt.pdf](http://www2.isye.gatech.edu/~nemirovs/Lect_ModConvOpt.pdf), 2005.
- [6] R. T. Rockafellar. *Convex Analysis*. Princeton University Press, 1996.