Syllabus
Convex Analysis (MATH 580)

KFUPM – Department of Mathematics & Statistics
2015-2016 (151)
Instructor: Nicolas Hadjisavvas

Course Description: Convex sets. Relative interior. Separation of convex sets. Convex functions. Examples of convex functions. Characterization of convex functions. Normal cone, tangent cone. Asymptotic cone. Advanced properties of convex sets: Caratheodory, Radon, Helly theorems, Farkas lemma. Continuity and differentiability of convex functions. Subgradients and subdifferential. Convex optimization: Optimality conditions, constraint qualification.

Reading material Textbook: B.S. Mordukhovich, *An Easy Path to Convex Analysis and Applications.* Morgan and Claypool (2014).
Other books: J.B. Hirriart Urruty and C. Lemaréchal: *Fundamentals of Convex Analysis*. Springer (2001). (Comprehensive and well-written).
J.M. Borwein and A.S. Lewis: *Convex Analysis and Nonlinear Optimization.* Springer (2006). (Research level).
T. Rockafellar, *Convex Analysis*. Princeton University Press (original edition 1970, re-edited many times). The absolute classic: 19.500 citations!

Objectives/Learning Outcomes: The course aims to familiarize the students with the theory of convex sets and functions, and with their applications to extremum problems.

Credit hours: 3

Evaluation scheme: Homework 140 points, 1st and 2nd exam 130 points each, final comprehensive exam 200 points.
Total: 600 points

Grading scale

Grade	**Range**
A^+	540 – 600
A	498 – 539
B^+	450 – 497
B	414 – 449
C^+	384 – 413
C	348 – 383
D^+	320 – 347
D	300 – 319

Course schedule

Week	Topic
23/8–27/8	Convex sets. Convex functions.
30/8–03/9	Convex functions (continued). Relative interior.
06/9–10/9	The distance function. Separation of convex sets.
13/9–17/9	Normal cones. Continuity of convex functions.
29/9–01/10	Subdifferential.
04/10–08/10	Subdifferential (continued).
11/10–15/10	Subdifferential calculus.
18/10–22/10	Fenchel conjugate. Differentiability of convex functions.
25/10–29/10	Advanced properties of convex sets: Caratheodory theorem, Farkas lemma.
01/11–05/11	Radon theorem. Helly theorem. Tangent cones. Mean value theorem.
08/11–12/11	Asymptotic cones.
15/11–19/11	Lower semicontinuity and existence of minimizers.
22/11–26/11	Optimality conditions.
29/11–03/12	Subgradient methods in optimization.
06/12–10/12	Applications
14/12	Revision