Math 590 Syllabus

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

Course title: Special topics in mathematics (Special topics in Nonlinear Analysis with applications to fixed point theory, optimization and variational inequalities)

Course Description: Triangulations and the Sperner lemma. Brower and Schauder fixed-point theorems. Variational inequalities and complementarity problems. Multivalued mappings. Kakutani's fixed point theorem. KKM theorem. Minimax inequalities, Ky Fan's theorems. Monotone operators. Multivalued variational inequalities.

Reading material There is no textbook for this course, so the students should take notes. However, a good part of the material can be found in:
K.C. Border: *Fixed-point theorems with applications to economics.*
Other, more advanced texts: (a) F. Facchinei, J. S. Pang: *Finite dimensional variational inequalities and complementarity problems*, vol. I. Springer (2003)
(b) C. Berge: *Topological Spaces: Including a Treatment of Multi-Valued Functions, Vector Spaces and Convexity.* Dover (2010)

Objectives/Learning Outcomes: The course aims to familiarize the students with several interconnected results with many applications in various fields: Fixed point theorems of various kinds, the KKM and Ky Fan's Lemma, minimax problems, and variational inequalities.

Credit hours: 3

Evaluation scheme: Homework 120 points, mid-term exam 150 points, final comprehensive exam 230 points.
Total: 500 points.

Grading scale

Grade	**Range**
A^+	450 – 500
A	415 – 449
B^+	375 – 414
B	345 – 374
C^+	320 – 344
C	290 – 319
D^+	267 – 289
D	250 – 266

Course schedule

Week	Topic
23/8–27/8	Simplices, triangulations, and Sperner's lemma.
30/8–03/9	The Knaster-Kuratowski-Mazurkiewicz lemma. Introduction to fixed point theorems. Banach's fixed point theorem.
06/9–10/9	Brower's fixed point theorem in a simplex, and in more general sets. Schauder's fixed point theorem.
13/9–17/9	Variational inequalities in $\mathbb{R}^n$. Complementarity problems.
29/9–01/10	Some elements of topology and functional analysis.
04/10–08/10	Some elements of topology and functional analysis (continued).
11/10–15/10	Multivalued mappings: Definitions and basic properties.
18/10–22/10	Ky Fan's lemma. Fan's minimax inequality.
25/10–29/10	Sion's minimax theorem. The Kakutani fixed point theorem. (Mid-term exam)
01/11–05/11	Kakutani-Fan-Glicksberg theorem. Variational inequalities for multivalued mappings.
08/11–12/11	Existence of solutions for variational inequalities: the Browder theorem.
15/11–19/11	A review of convex analysis in Banach spaces. Monotone operators.
22/11–26/11	Basic properties of monotone operators. Generalized monotone operators.
29/11–03/12	Existence of solutions of generalized monotone variational inequalities.
06/12–10/12	Coercive and noncoercive variational inequalities.
14/12	Revision