ECONOMICS 512
Fall 2016
Mathematical Economics
Zaier Aouani

It should be noted that this course syllabus provides a general plan for the course and deviations may be necessary.

Class meetings: Tuesday (T), Thursday (R) 3:00 pm - 4:15 pm, Room 321 Block 8

Office hours: Tuesday (T), Thursday (R) 4:30 pm - 6:00 pm, Room 117 Block 8

Course Webpage: http://moodle.nu.edu.kz

Contact:
E-mail zaier.aouani@nu.edu.kz
Office phone (7172) 70-90-69

Textbook: Mathematical Methods and Models for Economists, by Angel de la Fuente.

Readings: Mathematics for Economists, by Carl Simon and Lawrence Blume.

Course Description and Objectives:
The goal of this course is to help students understand and use the mathematics required for studying economics at the graduate level. The course will provide a comprehensive introduction to the mathematical tools most often used by economists in their research. To demonstrate the importance of mathematics in economics, mathematical concepts studied in this course will be illustrated with applications in economics. Topics may include: matrix algebra, calculus of several variables, eigenvalues and eigenvectors, systems of ordinary differential equations, steady states and their stability, optimization techniques under constraints (in finite as well as infinite dimensional spaces).

Learning Outcomes: After taking this course, students are expected to:
(1) Learn how to read and understand most current journal articles in economics without stumbling over the mathematics.
(2) Develop an initial understanding of how to frame economic modeling ideas in mathematical format.
(3) Be able to use a wide range of mathematical techniques to solve typical economic problems.
(4) Develop a set of problem-solving and analytical skills to solve a variety of problems in economics, finance, and other related fields of study.

Important dates to remember:
Last day to withdraw and receive a grade of W: October 19, 2016
Midterm Exam – Thursday, October 6, 2016
Final Exam – Thursday November 24, 2016 (last lecture of the semester).

All exams will be given *only once*. If you decide to take this course, it is important that you are able to take the exams on the above dates.

Course Evaluation: Grading will be based on homework assignments, one midterm exam, and a final examination (comprehensive) with the following weights:

Homework Assignments: 30%
Midterm Exam: 30%
Final Exam: 40%

A letter grade of the following: A, A-, B+, B, B-, C+, C, C-, D+, D and F, will be assigned to you on the basis of your cumulative score. The official NU grading scale will be followed.

Course Policies: Regular attendance is required. No late homework is accepted, no make-up exams are offered. Extenuating circumstances will be handled on an individual basis (absences, illness, emergencies, etc.).

Statement on Academic Honesty: Students are expected to abide by NU's policy on academic honesty, which is published in the student handbook.

If you have questions about academic honesty, please talk to me.

Tentative Schedule:

1. Logic and Sets
2. One-variable calculus
3. Linear algebra
4. Multivariable calculus: Differentiability (differential, first order development, Hessian, semi-definite matrices, second order development, etc.).
5. Optimization in Euclidean spaces
    a. Presentation, examples (micro, macro, statistics), vocabulary.
    b. Convexity: definition, convex combinations, examples (affine subset, simplex, convex cones). Convex functions.
    c. Topology in Euclidean spaces: norm, distance, continuity, closed subset, compactness in Euclidean spaces, open subset, boundary, interior points. Notion of level curves.
    d. Unconstrained optimization problems. One-dimensional case. First-order necessary condition, second-order sufficient condition, convex or concave optimization.
    e. The Euclidean case: existence results. Applications.
    f. Differentiable unconstrained optimization problems in Euclidean spaces: Existence results, first order necessary condition, second-order sufficient conditions. Concave or convex optimization. Examples.
    g. Constrained optimization with equality constraints. Lagrange multipliers. First order necessary condition. Sufficient conditions (convexity, concavity). Geometric interpretation.
    h. Constrained optimization problems: case of several inequality or equality constraints. Karush-Kuhn-Tucker. Qualification constraints (rank condition, affine case, etc.). First order necessary condition (KKT), second order necessary condition. Complementary slackness condition. Geometric interpretation.
6. Dynamic optimization
    a. Infinite dimensional normed spaces. Examples of norms in sequence spaces and functional spaces. Equivalence of norms in finite dimensional spaces. Consequence on the topology for a norm in finite dimensional space. Non-

compactness of a ball in infinite dimensional spaces (Riesz). Continuity of linear functions in normed space ands link with Lipschitz function.

b. Metric spaces. Compactness: definition with coverings, definition with subsequences, equivalence of these definitions. First properties (e.g. closed subset of a compact is compact). Examples of sequence spaces. Product metric on an infinite product of metric spaces, which induces the product topology. Compactness of an infinite product of compacta for this metric. Convergence for this metric (basically convergence component by components).
c. Complete spaces: Cauchy sequences, link with convergence, examples for sequence spaces, functional spaces, etc. Banach fixed-point theorem. Blackwell fixed-point theorem.
d. Dynamic programming with a finite horizon. Framework. Decision variables. Time consistency. Backward induction. Examples.
e. Dynamic programming with an infinite horizon. Bellman equation. Notion of correspondence. General discounted optimization problem under some feasibility conditions (with correspondences). Existence of a solution, using the previous tools (Blackwell). Properties of the value function. Some applications, for example to growth models.