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| **COURSE NAME** | **Brush up in *Advanced Mathematics*** |
| **PROFESSOR** | **Prof. Piotr Zwiernik**<br>**Practicals: Malachy Gavan** |
| **PROGRAM** | *Brush-up Courses 2019-2020 - Master Program in Economics* |

**COURSE OUTLINE**

The goal of this brush-up course is to give a streamlined overview of the basic notions of real analysis. This course is required for advances courses in microeconomics, macroeconomics, and econometrics. The course focuses on presenting the most important definitions, with emphasis on introducing rigorous mathematical thinking.

Each day there will be a problem session run by Dmitrii Tikhonenko. These sessions will focus on rigorously solving some of the exercises from the notes. The progress of students will be monitored.

The content of the course:

**Introduction**
a. basic mathematical notation
b. mathematical logic
c. proofs

**Part 1: Metric spaces**
a. real sequences and convergence
b. basic topology: open and closed sets

**Part 2: Real functions**
a. functions of several variables
b. functional limits
c. continuous functions
d. compact sets.

**Part 3: Convexity**
a. convex sets
b. convex/concave and quasi-convex functions

**Part 4: Basic fixed-point theorems**
a. Banach's fixed-point theorem
b. Brouwer's fixed-point theorem

**Part 5: Differentiation**
a. vector spaces and linear transformations
b. derivative
c. directional derivative
d. Lagrange multipliers

The course is based on the lecture notes that will be made available before the summer.

## REFERENCES

Some other potentially useful resources include:

W. Rudin, "*Principles of Mathematical Analysis*", McGraw-Hill 1976.
This is a concise textbook with a rigorous treatment of real analysis. Our notes follow closely some parts of this book but differ from it largely for example in the way topology and compactness is treated.

E. Ok, "*Real Analysis with Economic Applications*", Princeton University Press 2007.
This is a book written for economists and contains some examples.

A. de la Fuente "*Mathematical Methods and Models for Economists*", Cambridge University Press 2000.
Like Ok's book, this is written for economists which affects the presented material. We will follow this book in its treatment of correspondences.

The mathematical appendix in: A. Mas-Colell, M. D. Whinston and J. R. Green, "Microeconomic Theory", Oxford University Press 1996.
This appendix gives a stream-lined overview of many of the relevant concepts. May be useful to organize the material.