

MATHEMATICS IN ECONOMICS AND FINANCE, UNDERGRADUATE STUDY PROGRAMME

COURSE DESCRIPTIONS

Course name: MICROECONOMICS

Number of ECTS credits: 6

Content:

Microeconomic analysis is a fundamental course in economics where students learn the decision making process on the level of consumers and firms. Students will learn what are the constraints consumers and firms face and how to analyse their decision making by using mathematics. The course is a fundament for further study of economics.

We begin with the analysis of consumer behaviour by formulating his preferences and constraints using mathematics in order to learn how to solve the problem of optimal consumer choice. Then we proceed to discuss the decision making of the firms. We study structure of the cost function, properties of production function and profit function. Again we use mathematics to find the optimal choice for problem of the firm. Next we study the market economy with demand and supply function also properties of market equilibrium are being defined. After the fundamental definitions we move to investigate different market structures, such as perfect competition, monopoly, oligopoly (Cournot, Stackelberg and Bertrand model) and market structure with dominant firm and followers. The analysis of market structures is further upgraded by game theory.

The second part of the course includes the theory of general equilibrium, theory of asymmetric information, modelling externalities into market economy and analysis of public goods and regulations.

Course name: FINANCE

Number of ECTS credits: 6

Content:

This course will allow students to examine not only the origins and nature of money, but also the institutions and markets that have evolved to enable the exchange of goods and services worldwide. It will provide an overview of the fundamental principles that form the foundations of money and banking systems. The course covers fundamentals of monetary history, financial markets and institutions, the main instruments of monetary policy, and concludes with a discussion of the theory and implementation of monetary policies. By focusing on the big picture via core principles, students learn the rationale for financial rules and institutional structure so that even when the financial system evolves, students' knowledge will not be out of date. By reading and presenting recent articles from financial journals and through debates on important issues, students will also get familiar with current financial and economic events, and what is more, with the tools mastered during the lectures they should also be able to provide some solutions.

Course name: MACROECONOMICS

Number of ECTS credits: 6

Content:

Macroeconomic analysis is a fundamental course in Economics where students learn how to analyse the most basic macroeconomic concepts and relations between them. By using

mathematical methods, they will be able to understand different theoretical approaches in economics and the consequences of the economic policy making.

Course begins with the study of properties of different forms of production functions followed by static and dynamic analysis of GDP. Using matrix algebra IS-LM model will be investigated. Mathematical and economic properties of Harrod, Domar and Solow growth models are studied extensively and neoclassical growth model is being introduced. However, we will discuss only neoclassical growth models which can be solved analytically. We will also study the role of expectations in economy by analytically solving models with adaptive and rational expectations. One of the most important segments of macroeconomic analysis is an analysis of business cycles. Keynesian business cycles, Friedman-Lucas model and technological business cycles will be analysed by showing methodological and mathematical differences between the three concepts. Special emphasis will be given on monetary policy. Topics like quantitative theory of money, Cambridge equation of money demand and relation between Solow growth model and money market will be covered.

Macroeconomic analysis is strongly based on some advanced mathematical methods such as differential and difference equations which will not be discussed mathematically rigorously. Instead we will be interested in the application of these methods in macroeconomic analysis.

Course name: STOCHASTIC PROCESSES I

Number of ECTS credits: 6

Content:

Stochastic processes are a field of probability important for applications in numerous fields. The starting point for the understanding is the treatment of Markov chains in discrete time. The students will become familiar with concepts like strong Markov property, ergodic properties of Markov chains, reversibility and other. With the introduction of sojourn times we pass on to Markov chains in continuous time which is a step in the direction of continuous time stochastic processes.

Martingales are a central concept in modern probability theory. Examples of martingales will be presented first followed by the two fundamental theorems on optional stopping and the convergence theorem. These two results in turn lead to many results like martingale inequalities, convergence theorems for random sums and similar.

Brownian motion is a fundamental object in stochastic processes in continuous time. The construction question will be treated, path properties examined, the strong Markov property will be presented along with the reflection principle. In the end we will look at a few continuous time martingales related to Brownian motion.

Course name: FINANCIAL TOPICS IN ENGLISH

Number of ECTS credits: 6

Content:

The course is designed to cover various topics in finance. The purpose of the course is to enable students to familiarise themselves with the English terminology used in the fields of finance and economics. Familiarity with the English terminology in these fields is essential for understanding the literature, since the vast majority of the literature in these fields is written in English.

The students obtain a hands-on experience with the key English terms from the literature and their usage. Each lecture is in English and deals with a particular topic from finance, which enables students to get acquainted with the topic itself, the English terminology used in

conjunction with that topic, and typical phrases used in discussing that particular topic. The goal of the course is not only to ensure the passive understanding of the terminology, but also to foster the active use of this terminology, both spoken and in writing.

Course name: ECONOMETRICS

Number of ECTS credits: 6

Content:

"The real world of economics, business, and government is a complicated and messy place. Econometrics helps us to sort out sound ideas from crazy ones and to find quantitative answers to important quantitative questions.

Econometrics opens the window on our complicated world that lets us see the relationships on which people, business, and governments base their decisions." (J. H. Stock and M. W. Watson, Introduction to Econometrics)

This course prepares students for empirical research in economics, and also equips them for specialization in econometric theory, business, and other social sciences. The course starts with a review of the statistical and probability foundations of econometrics and introduces regression analysis. More specifically, it covers the following topics: linear and nonlinear regression, omitted variable bias, sample selection, simultaneous causality, regression with panel data, regression with a binary dependent variable, and instrumental variable regression. Econometric theory is supported by numerous empirical examples that equips students, using the statistical software STATA, with essential skills for empirical testing of economic theory.

After the course student will be able to handle large databases, test the relevance of theoretical economic models, "intuitively" look for statistical relations in the data and evaluate the impact of existing policies, develop alternatives, and implement them. These are all skills increasingly demanded by public and financial institutions and businesses worldwide. An absolute must for students who want to successfully compete in the global labour market.

Course name: FINANCIAL MATHEMATICS

Number of ECTS credits: 6

Content:

Pricing financial instruments is based on a few economic principles and on mathematical models that are derived on the basis of such principles. The subject first introduces the economics basics e.g. present value, arbitrage, efficiency of capital markets, equilibrium and optimality.

In the second half mathematical models are introduced and examined. Their role in pricing financial instruments is investigated, and their relevance to real capital markets is addressed. The mathematical build-up of models and the derivation of pricing formulae then follows. Fundamental results such as the fundamental theorem of option pricing are derived and proved. Mathematical tools such as dynamic programming and Bellman equations are proved.

Course name: MATHEMATICAL MODELING

Number of ECTS credits: 6

Content:

- *Introduction.* What is mathematical modeling? The role of mathematical models in natural sciences and economics. Types of mathematical models.
- *Programming tools.* A short overview of Octave/Scilab.

- *Optimization*. Critical point, minimum, maximum, saddle. Taylor's formula for scalar fields. Local extrema and local extrema under constraints. Newton's method. Applications: discrete catenary, truss stability etc.
- *Calculus of variations*. Standard problem of variation calculus. Isoperimetric problems. Applications: catenary, brachistochrone, truss oscillations, etc.
- *Linear programming*. What is a linear program? Examples of linear programs: optimal diet, flow in a network etc. Forms of linear programs. The fundamental theorem of linear programming. Simplex method. Duality. Integer linear programming and LP relaxation. Applications.
- *Differential equations and systems of differential equations as mathematical models in natural sciences*. Motivational examples. Equilibrium. (Linear) Stability of equilibria. Phase portraits. The basics of Poincare-Bendixon theory. The basics of bifurcation theory. Applications: epidemic models, models of competition, models of symbiosis, predator-prey dynamics, molecular kinetics, basic neurological models, models in economics.

Course name: EU ECONOMIC TRENDS

Number of ECTS credits: 6

Content description:

1. Introduction: About E(M)U
 - a. Origin (who, when, why)
 - b. EU economy in the world
 - c. Is there a problem of intergovernmentalism
 - d. Fiscal Union: is it feasible?
2. EU growth drivers
 - a. Human capital and migration
 - b. External balance as a driver for economic growth
 - c. Building up a Capital markets union
 - d. Sovereign debt and rating agencies
 - e. EU TFP
 - f. RD, technology and innovation (growth or job disruption?)
 - g. The burden of public finance
3. EU challenges
 - a. Youth unemployment and an ageing world
 - b. Ethics and Islamic finances
4. EU strategies
 - a. Brexit and its consequences
 - b. EU enlargement to SEE
 - c. Governance and the role of supranational EU: a strategic game play