Master's program in Economics and Development
Curriculum in Economics

July, 2015

1 Introduction

The Economics curriculum of the two-year Master of Sciences program in Economics and Development aims at providing students with the capacity to conduct theoretical and applied research in the fields of economics. Graduates will be able to collect and analyze quantitative and qualitative information from local, national and international datasets. Their knowledge of economic phenomena will enable them to relate micro and macro phenomena and to use theoretical and applied (including econometric) tools to analyse economic systems, evaluate and formulate economic policies. Courses aim at providing a sound background in economics and quantitative methods, but also allow a multidisciplinary approach (historical, legal etc).

The Master of Sciences in Economics and Development provides an ideal background for pursuing a PhD programme in Italy or abroad (in Economics and related topics) or for a medium-high level entry into research or professional jobs in the field of economics and economic policy. Notable careers include academic teaching and research, civil service appointments and posts in national and international organisations or in private economic consultancies.

Application form can be downloaded at:

www.unifi.it/upload/sub/studenti/1415/modulistica/
domanda_valutazione_accesso_magistrali_english.pdf

Contact people:

- Prof. Annalisa Luporini (annalisa.luporini@unifi.it);
- Prof. Antonio Villanacci (antonio.villanacci@unifi.it).

2 Prerequisites

2.1 Formal prerequisites

Applicants should have a final undergraduate grade with pass proceed (i.e. permit to proceed to graduate studies). Applicants who graduated in Italy should have a final grade of at least 99/110 (for foreign students: if the pass proceed is not indicated it will be calculated and should be equivalent to 99/110). Students who do not fulfil this requirement but are motivated to apply can do so but may be asked to sit for an interview (that could be done also using telematics techniques) or a test (admission decisions are taken by the Admission Committee).

As far as the credits (CFU) are concerned, the current academic entry requirements from a BA degree course are to have passed: at least 18 credits of Economics, 6 credits of Statistics, 6 credits of Mathematics. It is compulsory to have a very good working knowledge (written and oral) of the English Language (at least a B2 level of the Common European Framework, i.e., equivalent to a Cambridge First Certificate). Students who do not meet these academic requirements (in terms of credits or English knowledge), need to pass the "missing" exams before being formally admitted. The "missing" credits can be taken at the University of Florence (as individual exams) or at the University of origin of the potential candidate. To satisfy the English language proficiency requirements students need to:

- give evidence that their undergraduate degree course was taught entirely in English;
- certify their knowledge at a European B2 level (Cambridge First certificate, TOEFL, IELTS etc.);
- pass a B2 English language test organised by Dr. Ilona V. Cziraky (ilona.cziraky@unifi.it), who is in charge of the degree course's language admission test.
- graduates holding a University of Florence degree in Economia e commercio, Economia aziendale, SECI-OP, Statistica satisfy the English language requirement.

2.2 Background

It is important that the student is well acquainted with the topics listed below. Preliminary courses in Mathematics and Statistics will be offered, starting on the 7th of September. Attendance is indispensable for the understanding of core courses. See http://www.development-lm.unifi.it/vp-121-courses.html

MATHEMATICS.

Basic Point Set Theory, Real Numbers, Linear Algebra, Differential and Integral Calculus for Functions of one Real Variable.

STATISTICS AND ECONOMETRICS

Types of variables. Ratios. Statistical distributions. Graphics. Mode, median and analytical means. Variability. Heterogeneity. Skewness and kurtosis. Chebyshev inequality. Bivariate distributions. Indexes of association. Variance decomposition and dependence in mean. Covariance and correlation. Simple linear regression.

The basic notions of probability: random experiment; sample space; events; probability and its properties; conditional probability and its properties. The basic notions of random variables: definition; domain of a random variable; discrete and continuous random variables; distribution of a random variable in terms of its probability density function or cumulative distribution function;

expectation of random variables (mean, variance, standard deviation); linear transformations of random variables; multiple random variables.

ECONOMICS

Microeconomics. Consumption: budget constraint, preferences, utility, demand functions. Production: technology, cost curves, profit maximization, firm supply. Competitive market equilibrium, monopoly, oligopoly, elements of game theory. Pareto efficiency, externalities, public goods.
Macroeconomics. National accounting in an open economy: income, balance of payments, price indexes, interest rates, real and nominal exchange rates. IS-LM Model in an open economy, monetary and fiscal policy, exchange rate regimes (fix and flexible rates). AD-AS Model, prices, wages and employment.

2.3 Further information

- A detailed list of textbook covering all listed topics is available at

  http://www.economia.unifi.it/upload/sub/scuola-varie/syllabus-economics.pdf

- All the needed prerequisites are covered in standard courses at the Undergraduate (First Level) Programs in Economics (Corsi di Laurea "Economia e Commercio" and "Economia Aziendale") at the University of Florence (Università degli Studi di Firenze), as summarized in the table below.

Prerequisites	**Courses**
Macroeconomics	Macroeconomia
Microeconomics	Microeconomia
Statistics and Econometrics	Statistica 1 Introduzione alla Econometria
Mathematics	Matematica per le applicazioni Economiche 1 Matematica Finanziaria (only Integral calculus) Matematica per le applicazioni Economiche 2 is also highly recommended

3 Course Plans

Below we present a suggested course plan which does not require Teaching Committee approval.

First year - First semester

Course number	**Course Name**	**Number of Credits**
B020829	Microeconomics 1	9
B020835	Statistical Inference	6
B020834	Mathematics for Economics	9
	One out of the following two courses	
B020838	History of Economic Thought*	6
B019470	Economic History of Globalization**	6
		30 **total credits**

* In the academic year 2015/16, History of Economic Thought will be taught in the Second Semester.

** Economic History of Globalization starts on September 8, 2015. Classes are held at the Syracuse University, Piazza Savonarola 15.

First year - Second semester

Course number	**Course Name**	**Number of Credits**
B020830	Microeconomics 2	9
B020831	Macroeconomics 1	9
B019219	Corporate Governance and Financial Institutions	12 (6 + 6)
		30 **total credits**

Second year - First semester

Course number	**Course Name**	**Number of Credits**
B020832	Macroeconomics 2	9
B020839	Econometrics (Microecon.+ Macroecon.)	12 (6 + 6)
	One course in the "List of optional courses"	6
		27 **total credits**

Second year - Second semester

Course number	**Course Name**	**Number of Credits**
	One course in the "List of optional courses"	6
	One out of the following two courses	
B020836	Law and Economics	6
B019207	Financial Services and Markets Law	6
	One out of the following two courses	
B020842	Econometric Lab	6
B020843	Economic Lab	6
B024225	Thesis	15
		33 **total credits**

List of optional courses

Course number	Course name	Number of Credits	Semester
B019121	Economia Pubblica (taught in English)	6	First
B016453	Economics of Innovation	6	First
B020847	Health and Education Economics	6	First
B020837	International and Financial Economics	6	Second
B016435	International Economics II	6	First
B020853	Labour Economics	6	First
B020844	Topics in Mathematical Economics 1	6	First
B020845	Topics in Mathematical Economics 2	6	Second
B020842	Econometric Lab	6	Second
B020843	Economic Lab	6	Second
B019470	Economic History of globalization	6	First
B020838	History of Economic Thought	6	Second

4 Courses

CORPORATE GOVERNANCE AND FINANCIAL INSTITUTIONS

Corporate Governance
Instructor: Sara De Masi

The recent financial crisis and corporate scandals have put the light on how companies are managed. Corporate governance deals with the set of policies, process and customs by which an organization is directed. This course aims to provide a deep understanding of the fundamentals of corporate governance from a variety of angles – the board of directors, senior management, investors, media, regulators and society – and from an international perspective. After a highlight on the main corporate governance systems (Anglo-American, German and Italian), relevant theories and issues of corporate governance practices will be analyzed (e.g. ownership and control, conflict of interests, board of directors, institutional environments). Students will gain skills required for understanding corporate behaviors. They will be introduced to issues in corporate governance through lectures, class discussions and cases study.
Course overview: Corporate governance: systems around the world (outsider systems versus insider systems), main theories. Boards of directors: roles and functions, composition and gender diversity, CEO compensation and stock options, Corporate governance codes, Corporate governance in banks.

Tricker B., 2009, *Corporate Governance. Principle, Policies and Practices*, Oxford University Press.
Goergen M., 2012, *International Corporate Governance*, Pearson ed.
Thomsen S., Conyon M., 2012, *Corporate Governance: Mechanisms and Systems,* McGraw-Hill.

Financial Institutions
Instructor: Federica Ielasi

The course aims to give a complete view of the financial system and the recent innovations in the national and international regulation concerning the financial institutions. The first part of the course aims at analyzing several issues relating to fundamentals of financial markets and institutions, analyzing the main financial intermediaries: commercial banks, pension funds, investment companies. The second part of the course concerns the analysis of the main risks faced by financial institutions: credit risk, liquidity risk, interest rate risk, and insolvency risk. The last part of the course deepens the main methodologies for managing risks off the balance sheet with derivative securities, loan sales and securitization. The objectives of the course are to strengthen the knowledge about financial markets and institutions, to strenghten the skills associated with the comprehension of the function of financial markets and their recent evolution, both in the national and international field, and to strenghten the knowledge about models for measuring and managing financial risks.

Saunders, Cornett, 2015, *Financial Markets and Institutions*, 6th edition, McGraw-Hill.

ECONOMETRICS

Microeconometrics
Instructor: Calzolari Giorgio.

Elements of linear algebra. Vectors and matrices, linear dependence, rank, square matrices, inverse matrix,equation systems, idempotent matrices, projection matrices, trace.
Linear regression model. Algebraic assumptions and statistical assumptions, ordinary least squares estimation, coefficients and residuals, R-square, unbiasedness of estimated coefficents, estimation of the errors variance, variance-covariance matrix of estimated coefficients, Gauss-Markov theorem, standard errors, linear restrictions,t-test, F-test, specification tests, structural break, heteroskedasticity, autocorrelation.
Discrete choice, logit model. Linear panel data model (with "fixed" effects).

Computer laboratory. Use of GRETL (free software, open source).

Calzolari, G., 2012, *Econometric Notes,* MPRA Paper 64415, University Library of Munich, Germany (revised May 2015; pages 1-14).
Stock, J. H., and M. W. Watson, 2007, *Introduction to Econometrics,* (2nd edition), Reading, MA: Addison-Wesley Publishing Company, Inc.

Macroeconometrics
Instructor: Giampiero Gallo

Time-Series Models, Difference Equations and Their Solutions, Lag Operators. Stochastic Difference Equation Models, ARMA Models, Stationarity, Stationarity Restrictions for an ARMA (p, q) Model , The Autocorrelation Function, The Partial Autocorrelation Function, Sample Autocorrelations of Stationary Series, Box–Jenkins Model Selection, Properties of Forecasts, Seasonality, Structural Change, Combining Forecasts. Deterministic and Stochastic Trends, Removing the Trend, Unit Roots and Regression Residuals, The Monte Carlo Method, Dickey–Fuller Tests and extensions, Power and the Deterministic Regressors, Panel Unit Root Tests, Trends and Univariate Decompositions, Intervention Analysis, ADLs and Transfer Functions, Limits to Structural Multivariate Estimation, Introduction to VAR Analysis, Estimation and Identifcation, The Impulse Response Function, Structural VARs, Examples of Structural Decompositions, Overidentifed Systems, The Blanchard–Quah Decomposition. Linear Combinations of Integrated Variables, Cointegration and Common Trends, Cointegration and Error Correction, Testing for Cointegration: The Engle–Granger Methodology, Cointegration and Purchasing Power Parity, Characteristic Roots, Rank, and Cointegration.

W. Enders, 2014, *Applied Econometric Time Series*, 4th Edition, Wiley.

ECONOMETRICS LAB
Instructor: Giampiero Gallo

Introduction to a matrix based programming language (MATLAB). Basics: importing data, the command line, review of matrix algebra, storing the results. The Classical Linear Econometric Model in matrix form. OLS estimators and covariance matrix. Robust forms under heteroskedasticity and serial correlation. Testing linear and nonlinear restrictions. Residual diagnostics, auxiliary regressions. Simulation based analysis of estimators properties and departures from ideal conditions. The second half of the course will be devoted to the replication of the results from some published papers, both in macro and in micro applications.

Greene W, 2008, *Econometric Analysis Sixth Ed.,* Pearson.
Class notes, online videos, help manuals

ECONOMIA PUBBLICA (PUBLIC ECONOMICS)
Instructors: Alessandro Petretto and Lapo Filistrucchi

The course will cover some important topics in the field of modern public economics. In particular, the first part of the course will deal with a) the so-called Political economy, i.e. the study of the interaction between institutions, political organizations and the working of the economic system; b) the Economic analysis of the law, i.e. the study of the impact of the legal system, in particular of civil law, on economic efficiency. The second part of the course will focus instead on the so-called Political Economy of the Media, i.e. the study of how media markets function and how media markets affect the political process (and hence economic policies) and vice versa. To explore the functioning of media markets the basics of standard oligopolistic models of product differentiation will need to be recalled.

Feldstein M. and A.J. Auerbach (eds.), 2002, *Handbook of Public Economics*, Elsevier.
Anderson S., D. Stromberg, and J. Waldfogel (eds.), 2015, *Handbook of Media Economics*, Elsevier.

ECONOMIC HISTORY OF GLOBALISATION
Instructor: Luciano Segreto

The course aims to offer a general overview of the new international economic order following the end of Cold War. This period is frequently associated with the concept of globalization. The mainstream affirms that this process has been possible because of liberalization, deregulation and in general thanks to a massive reduction of the state intervention. This course will challenge this vision, offering a completely different image of the reasons and the instruments that permitted the transformation of the world economy in the last 25 years. Globalization is asking for more but also for a different state intervention. Emerging economies are building their future both on very old economic policies such as trade tariffs and on the support of the state in implementing the most advanced technologies in their economic structure. Transnational companies are sometimes bigger than the countries where they invest in but international or transnational institutions try to limit their power. China economic reforms and modernization appears to some extent a new form of state (authoritarian) capitalism. Russia more controversial transition to market economy did create a very similar model. Capital markets are more and more powerful, but national and supranational institutions work every day to increase levels of regulations and to make more efficient those already existing. Producers, consumers and traders of raw materials and commodities are acting as a sort of "hidden" power that states are trying to counterbalance and to regulate in order to keep a balance in this framework, where economic and financial aspects are continuously interfering and sometimes conflicting with the social dimension of the market.

Ravenhill J., 2011, *Global Political Economy*, Oxford UP.
Gilpin R., 2011, *The Challenge of Global Capitalism: The World Economy in the 21st Century*, Princeton UP.
Bhagwati J.N., 2007, *In Defense of Globalization*, Oxford UP.

ECONOMICS LAB
Instructor: Lapo Filistrucchi

In this course, students obtain hands-on experience with the application economics to real world cases. The course will focus on the application of industrial organization to real world competition policy and regulatory cases. By the end of the course students will have acquired some skills that are of value in jobs such as economic consultancies, independent authorities, research institutes or policy organizations.
In the first half of the course the lecturer will introduce the students to competition policy. In the second half of the course, the students will take over. In each class two students get a case, say, for concreteness, the EU vs Microsoft case. As part of the decision, the Commission forced Microsoft to sell a version of Windows without its Mediaplayer. One student has to defend this decision, the other has to make the case that the decision was wrong. The jury consists of the other students in the class.

Motta, M., 2004. *Competition Policy; Theory and Practice*, Cambridge University Press.

ECONOMICS OF HEALTH AND EDUCATION
Instructor: Lisa Grazzini

Both education and health are important determinants of human capital which is widely recognised as a key issue for individual well-being and economic development. On the education side, the course first explores the determinants of educational decisions. It investigates the basic model of education as a human capital investment, discussing the difference between the private and the social return of education, and the models of education as a signalling and a screening device. The roles of human capital for growth are then analysed, by taking also into account the channels through which education and growth may be linked to the process of democratization of a country. On the

health side, the course analyses the basic model of health as a human capital investment, stressing the importance of complementarities between health and education, and the optimal insurance policies with adverse selection and moral hazard. Finally, the impact of improved health on growth is investigated with a particular focus on the joint effect of the level and the accumulation of health on economic growth.

A full reading list will be available on http://e-l.unifi.it/ It will contain papers from international journals and some chapters of books as for example:
Checchi D., 2005, *The Economics of Education. Human Capital, Family Background and Inequality*, Cambridge University Press.
Hindriks, J., Myles, G.D., 2013, *Intermediate Public Economics*, MIT Press.

ECONOMICS OF INNOVATION
Instructor: Mauro Lombardi

The digital age we are living in: the second economy (Arthur), ubicomp (ubiquitous computing), "calm technology" (Weiser, 1991, 1993). The age of the spiritual machine (Kurzweil): what technology is. The starting point: the invention of invention (Landes, 1998). Technology and the Economy: some stylized facts. Taxonomy of innovations: radical, incremental, modular, architectural. Technological paradigms, technological trajectories, techno-economic landscapes. Different approaches to the analysis of production processes. Innovation processes between path dependence and path creation. Decision making processes: 1) standard mainstream paradigm, 2) evolutionary approach, the agents of techno-economic dynamics: individuals, firms, socio-technical systems. Basic concepts for the current Century (I): systems and complex systems. Basic concepts for the current Century (II): disruptive technologies, big data and data analytics, augmented reality, cloud computing and their consequences for business models.

Brian Arthur, 2009, *The Nature of Technology*, Free PressChandler.
Hagstrom, Solvell, 1999, *The dynamic firm. The role of technology, strategy, organization, and regions*, Oxford University.
Files and other material provided by the teacher.

FINANCIAL SERVICES AND MARKETS LAW
Instructor: Filippo Zatti

The course examines the EU's regulation of the capital markets. It considers the harmonized regulatory regime which applies to capital market actors across the Member States and which supports the integrated market. The topics covered include: the foundations of capital markets legislature in Europe focusing on the strategies adopted for market integration and on the role of law; the basics of capital markets law regarding capital markets, financial instruments, market participants and the regulatory authorities, including the role of the European Securities and Markets Authority; the regulation of insider dealing and market manipulation, other than short selling; the prospectus and disclosure regime; market access of investment firms and the passport for investment services; compliance in investment firms; financial analysts; rating agencies.

Veil R. (ed.), 2013, *Europan Capital Markets Law*, Oxford and Portland, Oregon.

HISTORY OF ECONOMIC THOUGHT
Instructor: Piero Bini

The course provides an overview of the main economic theories from Mercantilism (XVI-XVIII Centuries) and Classical Political Economy (XVIII-XIX Centuries), up to the most recent trends of economic thought. Specific attention will be paid to these economists: F. Quesnay, A. Smith, D. Ricardo. J. S. Mill, K. Marx, W. S. Jevons, C. Menger, L. Walras, A. Marshall, J. A. Schumpeter, J. M. Keynes, M. Friedman. In particular, as far as the contemporary economic thought is concerned,

we will point out theories and methodological stances which deal with money, business cycle and economic growth. We will also examine the institutional context of some political economy arguments. The last part of the course will be dedicated to outline the major scientific contributions by some leading Italian economists, since the unification of Italy in 1861 onward.
The course will benefit students who want to have a better understanding of contemporary economic theories by looking at their original formulation.

Landreth, H. and D. C. Colander, 2002, *History of Economic Thought*, fourth edition, Houghton Mifflin, Boston, MA.

INTERNATIONAL ECONOMICS 2
Instructor: Giorgia Giovannetti

The main aim of the course is to help understand specific features of the current wave of globalization as well as countries' and firms' reactions to it. The first part of the course, after an introduction on how to measure globalization, also accounting for the value added in each country, analyzes historical trends in integration (trade, capital, people, ideas) on the base of existing models of international trade (from Ricardo to models of heterogeneous firms). It also highlights the role of China and India in the global economy. The second part illustrates new issues raised by the globalization process, such as offshoring, outsourcing, and the theories recently developed to address them ("new new" trade theories). It also emphasises the role of imported inputs for the competitiveness of a country. Key topics include: globalization: useful definitions; statistical and economic indicators of globalization, specialization, imbalances; Ricardo's model of International Trade (brief); Hescker-Olin model; Imperfect competition models; geography models; New theory versus New New theory (Melitz); Movements of capital and workers; Offshoring and outsourcing; FDI and multinational. Other topics: R&D internationalization; Migrations; Trade policies and International agreements (TTIP).

Feenstra, R.C., Taylor, A., 2015, *International Economics*, 4th Edition.
Feenstra, R.C.,2015. *Advanced International Trade: Theory and Evidence*, second edition, Princeton University Press.

INTERNATIONAL AND FINANCIAL ECONOMICS
Instructor: Giulio Cifarelli

In the course the following topics shall be discussed: the foreign exchange market and the main financial markets; the efficient markets approach and the statistical properties of the financial time series; the monetary approach to the Balance of Payments and the portfolio balance approach; the exchange rate regimes and the "fear of floating" debate; the recent (excess) foreign exchange reserve policy of central banks; the theory of (ir)rational speculative bubbles; the recent financial crises and the literature on contagion; the relevance of speculation and the interaction between fundamentalists and chartists.

MacDonald R., 2007, *Exchange Rate Economics. Theories and Evidence*, Routledge, London, or
McKinnon R.I., 1979, *Money in International Exchange. The Convertible Currency System*, Oxford University Press, Oxford.

LABOUR ECONOMICS
Instructor: Gianna Claudia Giannelli

The purpose of the course is to give the theoretical and applied tools to understand the economics of labour markets with a special focus on the relationship with development. The first part illustrates how economic models are applied to labour market phenomena, such as labour supply and participation, labour demand by firms, and wage determination under different institutional settings. Furthermore, it is shown how alternative theories can be tested empirically and how economic

models can be applied to evaluate the employment effects of economic policies, such as reforms of the labour market and of the welfare system. The second part of the course explores key issues of labour markets in developing countries such as the introduction of a minimum wage, the distinction between formal and informal employment, rural and urban labour markets, the role of education and human capital, the determinants of returns to human capital investments, labour migration and remittances, discrimination and ethnicity, gender gaps, health and nutrition effects on labour productivity. The course is intended for both the curricula in economics and development.

Borjas G.J., 2013, *Labor Economics*, Mc Graw Hill
Cazes S. and Verick S.(Ed.), *Perspectives on Labour Economics for Development*, ILO, 2013

LAW AND ECONOMICS
Instructor: Filippo Zatti

The Law and Economics course aims to give an overview of the principles of European Economic Law in order to deepen the EU economic constitution and the founding principles of the Internal Market. As a consequence, class deals with the four basic freedoms of movement of goods, capital, persons and services as well as EU competition law.

MACROECONOMICS 1
Instructors: Marco Dardi and Vinicio Guidi

Intertemporal equilibrium of consumption and production plans in a macroeconomic deterministic environment. Saddle properties of dynamics in the vicinity of a steady state. Comparison with OLG models. Uncertainty, Bayesian expectations in general and rational expectations. Dynamics under rational expectations compared to adaptive expectations. Financial markets. Intertemporal portfolio choice according to utility-based and consumption-based CAPM. The contingent claims approach to financial markets. Completeness and efficiency in risk allocation.
Models of growth from Harrod-Domar to Solow and Swan; prices and markets during transition, technical progress, conditional convergence. Derivation of the propensity to save from intertemporal optimization in the Ramsey model. Endogenous growth. Proof of existence of an optimal growth path.

Wickens M., 2012, *Macroeconomic Theory: A Dynamic General Equilibrium Approach,* Princeton Univ. Press;
Barro and Sala-I-Martin, 2004, *Economic Growth*, Mc Graw-Hill;
Acemoglu D., 2009, *Introduction to Modern Economic Growth*, Princeton Univ. Press.

MACROECONOMICS 2
Instructors: Vinicio Guidi and Leonardo Boncinelli

The first part of the course aims at introducing students to the main issues about money and monetary policy. First, the main functions of money are discussed: money as a medium of exchange, money as a store of value, the optimal quantity of money. Then, monetary policy issues are taken into consideration, with a specific concern for the Euro area.
The second part of the course is devoted to the presentation of the New Keynesian framework. A basic model is first considered, with monopolistic competition and staggered price setting in goods markets, together with perfectly competitive labor markets. Perfect competition in goods markets and flexible prices is shown to be obtained as a limiting case of such a benchmark model. Starting from this, a number of directions are explored: (i) we derive implications for monetary policy, (ii) we analyze the difference between the optimal policy with and without commitment, (iii) we look at the effects of introducing rigidities also in the labor market, and (iv) we develop a small open economy version of the basic model.

Two lectures on *Fiscal and monetary policy in the EU* will be held by Marco Buti, Director-General for Economic and Financial Affairs at the European Commission.

Heijdra B. J. , 2009, *Foundations of Modern Macroeconomics*, Oxford University Press, [ch. 11]
Wickens M., 2012, *Macroeconomic Theory: A Dynamic General Equilibrium Approach* [ch. 8, 13]
Galì J., 2008, *Monetary Policy, Inflation, and the Business Cycle: an introduction to the New Keynesian Framework* , Princeton University Press.

MATHEMATICS FOR ECONOMICS
Instructor: Franco Gori

Complements of Linear Algebra, Complements of Real Numbers Theory, Metric Spaces, Linear Normed Spaces, Differentiable Curves in Rn, Real Functions of Several Real Variables, Vector Valued Functions of n Real Variables, Ordinary Differential Equations, Systems of Ordinary Differential Equations, Systems of Linear Differential Equations, Nonlinear Dynamical Systems: Local Analysis.

Apostol T., 1991, *Calculus, volume 1 and 2*, Wiley.
Arnold V., 1992, *Ordinary Differential Equations*, Springer.
M. Hirsch, S. Smale, 1974, *Differential Equations, Dynamical Systems and Linear Algebra,* Academic Press.

MICROECONOMICS 1
Instructors: Michele Gori and Domenico Menicucci

Consumer theory: preference relations, utility functions, commodity space,representation of preferences via utility functions, budget set and consumer problem, demand function, differential characterization of demand vectors, marginal rate of substitution. General equilibrium theory: competitive equilibrium in pure exchange economies, Walras' law, the case of two consumers and two commodities and Edgeworth's box, existence of equilibria, differential characterization of equilibria, Pareto optimality and welfare theorems, differential characterization of Pareto optimal allocations. Social choice theory: social choice functions and correspondences, simple majority and May's theorem, social welfare functions, Arrow's impossibility theorem. Choice under uncertainty: expected utility theory, money lotteries and risk aversion, first and second order stochastic dominance between payoff distributions. Game theory: basic elements of non-cooperative games, simultaneous-move games, dominant and dominated strategies, Nash equilibrium in pure and mixed strategies. Market power: monopoly pricing and price discrimination, oligopoly models.

Mas-Colell, A., Whinston, M.D., Green, J.R., 1995. *Microeconomic Theory*, Oxford University Press.

MICROECONOMICS 2
Instructors: Vittorio Emanuele Ferrante & Annalisa Luporini

The basic elements for the representation of strategic games, and solutions of games through dominance and Nash equilibria were introduced in Microeconomics 1. In the first part of Micro 2, equilibrium notions are rehearsed, and extensive games are introduced. Subsequently, the notion of imperfect information is considered, together with the framework of Bayesian games. Nash equilibria are studied in the latter contexts, with a few natural refinements such as sequential equilibria and "weak" sequential equilibria. The course is advanced, but will be eminently practical: emphasis will be put on acquiring the ability to solve games, rather than on memorizing mathematical proofs of the theoretical apparatus. The second part of the course is devoted to the economics of information. Game theoretic methods and models are used to study the consequences of informational

asymmetries and in particular the following topics. Adverse selection: effects on market equilibrium and public intervention. Signaling: the education signaling game. Screening in a competitive market. Principal-agent problem with i) hidden actions and ii) hidden information.

Osborne, M.J., Rubistein, A., 1994. *A Course in Game Theory*, available at
http://books.osborne.economics.utoronto.ca.
Mas-Colell, A., Whinston, M.D., Green, J.R., 1995. *Microeconomic Theory*, Oxford University Press (in particular, Chapters 13 and 14).

TOPICS IN MATHEMATICAL ECONOMICS 1
Instructor: Andrey Sarychev

Dynamic and polidynamic systems; control systems. Main problem settings.
Introduction to ordinary differential equations (ODE): continuity and differentiability of solutions with respect to the right-hand side. Vector fields and flows. Stability for ODE. Elements of convex analysis.
Controllability: rank controllability criterion for linear systems. Linearization principle for nonlinear systems. High-order controllability conditions. Frobenius and Rashevsky-Chow theorems. Stabilization of linear control systems. Non-linear control systems: linearization principle and stabilization. Necessary condition for existence of continuous stabilizing feedback control. Stabilization by means of time-variant feedback.
Optimal Control theory; Lagrange, Mayer and Bolza problems. Existence of optimal control; relaxed controls. Linear-quadratic (LQ) problem. Necessary optimality criterion: Pontryagin Maximum Principle. Linear time-optimal control; bang-bang optimal controls. Sufficient optimality conditions: Hamilton-Jacobi equation and Dynamic Programming. Fields of extremals. High-order optimality conditions. Optimal control problems with infinite horizon.

Bressan, A., Piccoli, B., 2007, *Introduction to the Mathematical Theory of Control*, American Institute of Mathematical Sciences.
Lee, E.B., Markus, L., 1967, *Foundations of Optimal Control Theory*, J.Wiley & Sons.

TOPICS IN MATHEMATICAL ECONOMICS 2
Instructor: Antonio Villanacci

Review of linear and nonlinear systems of difference and differential equations.
General topology: Cardinality of sets; definition of topological space and examples; basis and subbasis; sequences; Continuity and different characterizations; topologies generated by functions; metric spaces; first and second countable spaces; separation axioms; compact spaces and characterization in Euclidean, metric and topological space; product spaces, box and product topology; connected spaces; function spaces; pointwise and uniform convergence; the space of continuous functions; compact open topology.
Measure theory: Lebesgue measure theory in $\mathbb{R}^n$; Lebesgue measurable functions; differentiation and integration; Lebesgue integrals and L^p spaces.
Functional analysis: normed spaces; Banach space; separable spaces; quotient spaces; equivalent norms; linear continuous functions; images of complete spaces and isometries; finite dimensional space; dual spaces;basic differential calculus in Banach spaces; basic notions of Calculus of Variations and Optimal Control.
Dynamic programming: examples of economic models; optimality principle; value function; policy function; necessary and sufficient conditions for optimality; Euler equation; local stability; introduction to stochastic programming.

Villanacci, A., (2015). *Mathematics for Economics 3*, in progress (it will be available at the beginning of the course).

STATISTICAL INFERENCE
Instructor: Fabrizio Cipollini

Special r.v.'s: Bernoulli, Binomial, Poisson, Continuous Uniform, Normal, Gamma, Chi-squared, Student-T, Fisher-F, Beta. Transformation of r.v.'s. Transformations.
Introduction to Statistical Inference: Concepts of population, sample, parameter, statistics and estimator, statistics value and estimate, sample distribution of a statistic and related synthetic indices.
Point Estimation: The Maximum Likelihood (ML) method. Properties of estimators. The Cramer-Rao bound. Asymptotic properties. Asymptotic properties of ML estimators.
Interval Estimation: Definition of interval estimate (confidence interval), confidence level, size of the interval. The Pivot method for finding confidence intervals.
Hypothesis testing: Motivations, framework, definitions of statistical hypothesis and of statistical test. Table of decisions, type I and type II errors, significance level and power of a test. The Neyman-Person lemma and ensuing remarks. Power of the test. The p-value. The likelihood ratio test.
Linear Regression Model: Model definition and corresponding properties; the Least Squares (LS) and the ML methods for estimating the parameters. Deviance decomposition and R2 index; predictions of the conditional mean and of the dependent variable for a given value of the independent variable.
Complementary Topics.

Wasserman, L., 2004. *All of Statistics: A Concise Course in Statistical Inference*, Springer. ISBN: 978-0-387-21736-9.