**OUTLINE OF THE FIRST YEAR COURSES OF THE PHD PROGRAM AT THE EUI**

**BACKGROUND COURSE ON MATHEMATICS** (Prof. Villanacci): The course topics are briefly listed below. 1. Linear algebra: Vector spaces; linear functions; linear functions and matrices; systems of linear equations. 2. Some topology in metric spaces: metric spaces; functions on metric spaces. 3. Differential calculus in Euclidean spaces: partial derivatives and directional derivatives; differentiability; some theorems; implicit function theorem. 4. Nonlinear programming: concave functions; maximization problems with equality and inequality constraints; the implicit function theorem and comparative statics analysis. Preliminary lecture notes by the instructor are available online on the courses page:

Mathematics Course Prerequisites
Mathematics Course Syllabus

Students should be familiar with the topics usually taught in basic courses on Calculus and Linear Algebra. Those topics are covered, for example, in the texts listed below. Apostol, T. M., (1967), *Calculus*, Volume 1, 2nd edition, John Wiley & Sons, New York, NY: Chapters 1-7 included, 9-10. Clark, C., (1982), *Elementary Mathematical Analysis*, 2nd edition, Wadsworth Publisher of Canada, Ltd., Belmont, CA. Appendix 1. Villanacci, A., (2016), Basic Linear Algebra, Metric Spaces, Differential Calculus and Nonlinear Programming1, available on line: Chapters 1, 2 and 3; Sections 5.1 and 5.2

**MICROECONOMICS** (Profs. Calzolari/Levine/Aboutalebi): This sequence is an introduction to the standard tools used in microeconomic analysis covering both traditional topics and also more modern ones. Courses contemplate regular problem sets. The first block reviews the theories of consumer and producer choice and provides an introduction to general equilibrium analysis and welfare economics. The second block covers game theory and discusses a number of paradigmatic economic applications. The third block is an introduction to information economics with applications to the economics of contracts.

Courses are based on material in the form of handouts, original articles, and some graduate textbooks: A. Mas-Colell, M.D. Whinston and J.R. Green, *Microeconomic Theory*, Oxford University Press, 1995; D.M. Kreps, *Microeconomic Foundations I: Choice and Competitive Markets*, Princeton University Press, 2013; G.A. Jehle and P.J. Reny, *Advanced microeconomic theory*, Addison-Wesley, 2001; B. Salanié, *The Economics of Contracts: A Primer,* MIT Press, 1997; R. Gibbons, *A Primer in Game Theory*, New York : Harvester Wheatsheaf, 1992.

**MACROECONOMICS** (Profs. Cooper/Bueren/Challe/Monge-Naranjo):
The first course studies the role of money in the economy using overlapping generations models. These models also enable us to study in detail the role of monetary policy in stabilizing the economy. It finally introduces the latest generation heterogeneous agents model with money. The second course introduces dynamic programming techniques with the stochastic growth model and (real) business cycle fluctuations as the main applications. We also study in detail how investment, consumption and labour supply respond to aggregate shocks. The relationship between the efficient and equilibrium allocations is another central topic of the course. The third course studies environments where agents are ex post heterogenous either due to idiosyncratic productivity shocks (first part) or due to labor market frictions (second part). First, we present equilibria both with complete and incomplete markets to study the joint distribution of income, consumption and wealth.

Then, on the labor market side, we introduce search frictions to account for unemployment and wage patterns both in steady-state and over the cycle. New efficiency considerations will be discussed.

Books used: T.F. Cooley, *Frontiers of Business Cycle Research* (1995), Princeton U. Press; J. Galí, *Monetary Policy, Inflation and the Business Cycle* (2003), Princeton U. Press; L. Ljungqvist and T.J. Sargent, *Recursive Macroeconomic Theory* (2004) MIT Press; C. Walsh, *Monetary Theory and Policy* (2003), MIT Press; R.E. Lucas, N.L. Stokey and E.C. Prescott: *Recursive Methods in Economic Dynamics* (1989), Harvard University Press; C. Pissarides, *Equilibrium Unemployment Theory* (2nd edition, 2000), MIT Press.

**STATISTICS AND ECONOMETRICS** (Profs. Ichino/Alan/Bueren&Cooper):
The sequence is divided into three parts and you can find an overview at this link.
The first part (taught by Andrea Ichino and Tiziano Arduini) is an introduction to probability, statistics and econometrics with emphasis on the topics that students need to know and master well for the sequence of more advanced econometrics courses that will follow in the PhD programme at the EUI. A knowledge of calculus and of some elementary statistics and matrix algebra is required. Students who have doubts on whether they satisfy these prerequisites should talk to the instructors to arrange special training. The first part of the course (8 lectures) is an introduction to the axiomatic foundations of probability theory and to the basics of univariate and bivariate statistics. The focus will be on probability theory and on the mathematical structure for measures of uncertainty. Later, the concept of random variables will be introduced, and its properties will be discussed. Many examples illustrating the basic concepts will be provided.
The second part will offer an introduction to the basic tools that an econometrician needs: the most popular estimation methods; inference and hypothesis testing; asymptotics; simple and multiple regression; causality and instrumental variables methods. Examples and applications will be used in the lectures and particularly in the exercise classes, to illustrate the theoretical content of the course.
The second part (taught by Sule Alan) presents principles for the formulation, estimation, and evaluation of econometric models, including discrete dependent variable models; count data models, duration analysis, panel data and a discussion of issues with standard errors in the presence of clusters.
The third part (taught by Jesus Bueren and Russell Cooper) focuses on time series analysis. The concepts of stationarity and ergodicity are covered and used to introduce laws of large numbers and central limit theorems that are applicable to serially dependent time series data. The course covers autoregressive moving average (ARMA) processes, vector autoregressive (VAR) models, unit root and co-integrated processes, and panel data models with fixed effects. The course will also cover simulated method of moments and generalized method of moments with applications to economic dynamics.

Books used: J.D. Angrist and J.-S. Pischke, *Mostly Harmless Econometrics: An Empiricist's Companion* (2009), Princeton University Press; J. D. Angrist and J-S Pischke: *Mastering 'Metrics: The Path from Cause to Effect* (2014), Princeton University Press; G. Casella and R.L. Berger *Statistical Inference*, 2nd edition, 2002; F. Canova, *Methods for Applied Macroeconomic Research*, Princeton, 2007; H. Lütkepohl, J. Hamilton, *Time Series Analysis*, Princeton, 1994; J. Wooldridge, *Econometric Analysis of cross section and panel data,* MIT Press, 2nd edition, 2002; Adda and Cooper, *Dynamic Economics,* MIT press.