

# **Short course on the “Essentials of Mathematics and Probability”, i.e., “What you should be familiar with to better exploit the QFI program”**

## **Preface**

There are students coming from different academic experiences and it is not easy for the instructors to decide “where to start from”, that is what is *supposed to be* the common knowledge of the participants on fundamental topics such as Mathematics and Probability. To avoid misunderstanding and help students to consolidate their background, we have decided to offer our students a course on the essentials of Mathematics and Probability. We expect that most students will consider such a course a good opportunity either to refresh their knowledge or to enlarge it, in order to be well equipped for the official lectures on the more advanced topics. We hope you will fully benefit of the lectures you are offered.

## **Contents**

### **Mathematics / Calculus**

Functions. Global/local maximum and minimum. Infimum, supremum. Concavity and convexity of functions of one or more variables. Limits of functions of one and more variables. Continuity, derivability and differentiability of functions of one or more variables. Polynomial expansions (Taylor’s and Mc Laurin’s expansions) of one or more variables. Necessary and sufficient conditions for local maxima and minima of differentiable functions of one or more variables. Criteria for concavity and convexity of differentiable functions of one or more variables. Constrained optimization, Lagrange multipliers. Numerical sequences, convergence and divergence criteria. Numerical series and series of functions, uniform convergence, radius of convergence. Riemann integral, integrability of continuous functions, and monotonic functions. Improper integrals. Mean value theorem for integrals. Fundamental theorem of calculus. Computation of indefinite and definite integrals by means of different methods such as: immediate integrals, integrals by parts, integrals by substitution, integrals of rational functions. Riemann-Stieltjes integral.

Instructor: **Alberto TURIGLIATTO**

### **Probability.**

Classical approach, frequentist, subjectivist and axiomatic of probability. Probability distributions of discrete random variables: Bernoulli, binomial, Poisson, geometric, negative binomial. Probability density functions and distributions functions of the continuous random variables: uniform, normal, negative exponential, gamma, Weibull, lognormal, Pareto. Mixed random variables. Moments of a random variable, moment generating function and its existence. Monotonic function of a random variable. Multivariate probability distributions. Covariance matrix and correlation coefficients.

Instructor: **Cecilia SCARINZI**

Torino, July 5, 2016