Two-year Master Degree on Quantitative Finance and Insurance

Reference Background for the Interview and for Attendance

The interview is not an oral examination, but a general discussion meant to assess whether the applicant masters all tools and knowledge included in this Reference Background, with particular emphasis on mathematics and statistics.

The syllabus should be a reference also for applicants exempted from the interview.

Mathematics

Elements of logic and set theory. Hints on connectives and quantifiers, implications. Sets, subsets, operations on sets, Cartesian product, numerical sets. Real numbers, real line, intervals, neighbourhoods. Open and closed sets.

Functions of one variable. Definition of domain, range, image, graph of a function. Elementary functions. Injective, surjective, inverse, composite functions. Bounded, monotone, convex functions. Optimum of a function. Economic and financial applications.
Limits and continuity. Definition of limit. Calculation of limits and fundamental theorems. Elementary limits and indeterminacies. Continuous functions and related theorems. Economic and financial applications.
Differential calculus and applications. Concept of derivative and its geometric meaning, higher order derivatives, rules of differentiation. Differentiation of elementary functions, of the inverse function and chain rule. Differential calculus theorems. Monotony and convexity tests. Optimum problems.

Linear algebra. Vectors, matrices and operations. Economic and financial applications.

Integral calculus. Riemann integral, primitive functions, indefinite integral. Fundamental theorems of integral calculus.

Functions of two or more variables. Definition and domain. Continuity, partial derivatives and differentiability. Gradient, Hessian matrix. Unconstrained optimum problems.

Textbooks:
- S. Cerreia-Vioglio, M. Marinacci, E. Vigna, *Principles of Mathematics for Economics*, to be published by Springer, 2018.
- A. Chiang, *Fundamental Methods of Mathematical Economics*, McGraw-Hill

For an alternative in Italian see:

E. Castagnoli, M. Marinacci, E. Vigna, *Principi di Matematica per l'Economia*, EGEA Milano, 2017. ISBN: 978-88-238-2246-7.

Probability

Elements of combinatorics.
Different foundations of probability calculus and properties.
Conditioned probabilities, total probabilities, Bayes' theorem.
Definition of random variable. Law of probability, cumulative probability distribution function, expected value and higher moments.
Discrete random variables.
Continuous random variables, probability density function.
Monotonic transformation of a random variable. Hints on random vectors, joint and marginal cumulative probability distribution functions. Independent random variables. Sum of independent

random variables. Variance and covariance of a linear combination of random variables. Moment generating function and its properties.

Suggested Textbook: Sheldon M. Ross, *A First Course in Probability,* Prentice Hall.

For an alternative in Italian see:

Sheldon M. Ross, *Calcolo delle Probabilità,* Apogeo 2007

Statistics

Data Analysis: frequency distributions, graphical representations, descriptive indices
Elementary probability calculus: probability measures, conditional probabilities, main properties
Random variables: continuous and discrete random variables, double random variables, fundamental random variables and central limit theorem.
Introduction to statistical inference: sampling and sampling distribution, point estimate, confidence intervals and hypothesis testing.
Hints on regression model.

Suggested Textbook: T.H. Wonnacott, R.J. Wonnacott, *Introductory Statistics*, John Wiley & Sons
Or, for students of the Torino School of Economics:

For an alternative in Italian see:

A.C. MONTI , *Introduzione alla Statistica*, Seconda Edizione, Edizioni Scientifiche Italiane, Napoli, 2008.

Financial Mathematics

Interest rate: definition and measurement. Simple and compound interest.

Annuities. Accumulated and present value of an annuity.
Loan repayment and amortization schedule. Sinking fund.
Different return indices of an investment, net present value and interest rate of return.
Term structure of interest rates, spot rates and forward rates.
Duration of a portfolio and immunization property. Portfolio volatility and convexity.

Suggested Textbook: Samuel A. Broverman, *Mathematics of Investment and Credit,* ACTEX 2010, Chapters 1-7

Investments /Capital Markets

The Investment Environment: Markets and Instruments, How Securities are Traded, Investment Companies, Interest Rates and Risk Premiums

Portfolio Theory: the Mean Variance Model

CAPM

Suggested Textbook: Z. Bodie, A. Kane, A.J. Marcus, *Investments*, McGraw-Hill, First 9 chapters

Microeconomics

Markets and prices: supply and demand. Consumer behaviour. Individual and market demand. Choice under uncertainty. Production. The cost of production. Profit maximization and competitive supply. Analysis of competitive markets. Market power: Monopoly and monopsony. Pricing with market Power. Monopolistic competition and oligopoly. Markets for factor inputs. Investment, time and capital markets. General equilibrium and economic efficiency. Markets with asymmetric information. Externalities and public goods.

Suggested Textbook: Robert. S. Pindyck Daniel L. Rubinfeld, *Microeconomics*, Chapters: 1-12; 14-18

Macroeconomics

The goods market. The financial market. Goods and financial markets: the IS-LM model. The labour market. The AS-AD model. The Phillips curve. Inflation, activity and money growth. Expectations. Financial markets and expectations. Expectations: consumption and investment. Expectations: output and policy. Openness in goods and financial markets. Output, the interest rate and the exchange rate. Exchange rates: adjustments, crises and regimes. Pathologies: high unemployment, high inflation, transition in Eastern Europe and the Asian crisis. Policy making: monetary and fiscal policies.

Suggested Textbook: Blanchard, O., *Macroeconomics* (all the chapters apart from section three (X-XII))

Accounting

The firm, its environment and characteristics
The balance sheet
Functions and functional areas: planning, marketing, production and logistics, research and development, finance, organization and human resources, accounting and cost management.
VAT and financial accounting.
Accounting data.
Closing and reopening of accounts in financial accounting: accounting data schemes.

Suggested Textbook: P. Kimmel, J. Weygandt, D. Kieso, *Financial Accounting: Tools for Business Decision Making*, John Wiley & Sons

For an alternative in Italian see:

 AA.VV., *Lezioni di Economia Aziendale*, G.Giappichelli Ed.- Torino, 1996,

- Section 1 and 2

G.Ferrero, F.Dezzani, P.Pisoni, L.Puddu, *Contabilità e bilancio d'esercizio*, Giuffrè, Milano, 2004

- Section 1: only points 4 and 5.
- Section 2: Subsection 6, excluding 6.3, 6.4, 6.8, 6.10, 6.11, 6.18, 6.22, 6.23, 6.24, 6.25, 6.26.2, 6.28, 6.29, 6.30.
- Section Three.