UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Quantitative Risk Management

**2627-2-F1602M018**

## Learning objectives

The course aims to give the main tools for the risk measurement and management, both from a theoretical and a numerical point of view.
Starting from the regulation associated with the Basel Accord, the main risk measures (Value at Risk, Conditional Value at Risk or Expected Shortfall, and coherent risk measures) will therefore be introduced, and some related concepts and applications will be developed.
Some numerical applications will be provided so that the theoretical insights can actually lead to an increase of the student's practical ability.

**Expected Learning Outcomes (Dublin Descriptors):**

**Knowledge and understanding**

Students will have a solid knowledge and understanding of the main topics covered during the course, such as different risk measurement methodologies and their applications.

**Applying knowledge and understanding**
Students will be able to effectively apply the knowledge acquired during the course to concrete risk measurement and management problems. In particular, they will be able to use Matlab and VBA to develop pricing functions of financial instruments and relative Greeks in view of their risk measurement and of the corresponding problems (backtesting, stress testing, …). They will also be able to use the Bloomberg terminal for downloading data and carrying out risk analysis.

**Making judgements**
Students will develop good independent judgement and ability to model and solve complex problems related to the topics of this course.

**Communication skills**
Students will acquire clear and rigorous financial language and be able to effectively communicate their acquired

knowledge.

**Learning skills**
Students will develop an independent study method that will be useful in their future work or in case of more advanced studies.

## Contents

- Definition of risk measure and brief overview of the Basel Accord.
- Value at Risk (VaR) and its computation methods.
- Axiomatic definition of coherent risk measure.
- Conditional Value at Risk (CVaR) and its computation methods.
- Portfolio optimization with risk measures.
- Acceptance set of a risk measure and relation with utility theory.
- Capital Allocation Problem.
- Systemic risk measures.
- Creating a pricing library in VBA.
- Calculating the risk of a complex portfolio comprising shares, fx products, bonds and derivatives.

## Detailed program

*Preliminaries. *
Review on probability theory, quantiles, first and second order stochastic dominance and portfolio theory.

*Risk measures and portfolios of derivatives. *
Definition of a risk measure. Definition of Value at Risk (VaR) and outline of the Basel Committee rules. Examples of computation of VaR for discrete and continuous distributions. Properties of VaR. Computation of VaR for portfolios of stocks under the assumption of normality of the yields of the stocks. Delta and Delta-Gamma approximations of the computation of the VaR of derivatives portfolios (under the assumption of normality of the yield of the underlyings). Outline of the estimation of the Variance-Covariance matrix. Historical simulations and Monte Carlo Method for the computation of VaR. Backtesting and Stress Testing. Drawbacks and applications of VaR.

*Coherent risk measures, CVaR and optimization. *
Axiomatic definition of a coherent risk measure. Conditional Value at Risk (CVaR): definition, examples and coherence. Application of CVaR to portfolio optimization. Acceptance set of a risk measure and representation of risk measures via acceptance sets.
Coherent (and convex) risk measures, shortfall, distorted and entropic risk measures. Relation between risk measures and utility theory.

*Applications. *
Capital allocation problems and systemic risk measures.

*Numerical aspects. *
Creating a pricing library in VBA. Calculating the risk of a complex portfolio comprising shares, fx products, bonds and derivatives.

## Prerequisites

Basic notions of mathematical analysis, probability theory, and informatics.

## Teaching methods

The course consists in:

- 6 cfu (42 hours) of lectures;
- 2 cfu (14 hours) of computer lab lectures.

Around 80% of the course will be done in erogative mode, the remaining 20% in interactive mode.

The lessons will be held mainly in presence with traditional lectures and exercises. A small percentage (anyway, smaller than 30%) could be taken online (in streaming) in case of necessity.

## Assessment methods

The exam is composed of a written part (composed by open questions and exercises) for the 6-credit module and an oral examination for the 2-credit module. The final score is the weighted average of the above scores.

The exam can be replaced - if agreed by the student - by the development and discussion of an assignment (divided into two parts, as in the course), which must be submitted and discussed by January 2027. Students wishing to undertake the assignment must notify the lecturers by 30 November 2026.

## Textbooks and Reading Materials


- Artzner, Delbaen, Eber and Heath (1999): “Coherent measures of risk”, Mathematical Finance.
- Danielsson, J. (2011). Financial risk forecasting: the theory and practice of forecasting market risk with implementation in R and Matlab. John Wiley & Sons.
- Duffie, Pan (1997): “An Overview of Value at Risk”.
- Follmer, Schied (2004): Stochastic Finance. An introduction in Discrete Time. De Gruyter. http://search.ebscohost.com.proxy.unimib.it/login.aspx?direct=true&db=nlebk&AN=388088&site=ehost-live&scope=site
- Hull (2000):“Options, futures and other derivatives”; Prentice Hall.
- Jorion (2000): “Value at Risk”, Mc Graw Hill.
- McNeil, Frey, Embrechts (2015): “Quantitative risk management: concepts, techniques and tools-revised edition”, Princeton university press.
- Rosazza Gianin, Sgarra (2023): “Mathematical Finance: Theory Review and Exercises”. Springer

- Wilmott (2003): “Introduzione alla Finanza Quantitativa”, Egea.
- Simon Benninga, Tal Mofkadi (2022): “Financial Modeling”, MIT Press Ltd.
- Staunton, M., and Jackson, M. (2001). “Advanced modelling in finance using Excel and VBA”, Wiley.
- Michael Alexander, Dick Kusleika, John Walkenbach (2016). “Excel 2016 Power Programming with VBA”, Wiley.


## Semester

First semester.

## Teaching language

Italian.

## Sustainable Development Goals

QUALITY EDUCATION | DECENT WORK AND ECONOMIC GROWTH | INDUSTRY, INNOVATION AND INFRASTRUCTURE