

**COURSE OF STUDY Master's Degree in Economics, Finance and Business (EFI) and
in Statistics and Methods for Economics and Finance (SMEF)**

ACADEMIC YEAR 2025-2026

ACADEMIC SUBJECT Mathematical Models for Finance

General information	
Year of the course	<i>Second year</i>
Academic calendar (starting and ending date)	<i>First semester (08/09/2025-19/12/2025)</i>
Credits (CFU/ETCS):	8
SSD	STAT-04/A
Language	<i>Italian</i>
Mode of attendance	<i>Optional</i>

Professor/ Lecturer	
Name and Surname	Giovanni Villani
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Telephone	
Department and address	<i>Department of Economics and Finance</i>
Virtual room	<i>TEAMS x35m79h</i>
Office Hours (and modalities: e.g., by appointment, on line, etc.)	Monday at 15.00 using TEAMS (on line)

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
<i>200</i>	<i>56</i>		<i>144</i>
CFU/ETCS			
<i>8</i>	<i>8</i>		

Learning Objectives	<i>The student must be able, at the end of the course, to choose, based on risk and return, the optimal financial portfolio according to the individual's needs in terms of risk aversion/propensity. He will also have to be able to determine the price of the most important derivative instruments.</i>
Course prerequisites	<i>Knowledge of the RIC discounting and capitalization tools; calculation of derivatives and integrals; know how to optimize a function in n variables; knowledge of linear algebra.</i>

Teaching strategie	<i>Lectures and exercises related to the topics covered in class. At the end of each CFU, the exercises will consist in carrying out the exams of the previous sessions.</i>
Expected learning outcomes in terms of	
Knowledge and understanding on:	<i>The student must be able, at the end of the course, to choose, based on risk and return, the optimal financial portfolio according to the individual's needs in terms of risk aversion/propensity. He will also have to be able to determine the price of the most important derivative instruments.</i>
Applying knowledge and	<i>The student must be able, even through Excel, to get to solve the problems of</i>

understanding on:	<i>choosing the optimal portfolio and determining the price of derivatives according to the binomial models, monte carlo and Black-Scholes</i>
Soft skills	<ul style="list-style-type: none"> • <i>Making informed judgments and choices:</i> the student must have the ability to connect the knowledge acquired during the course and to deal with complex problems through the models, the logical and formal tools made available during the course. • <i>Communicating knowledge and understanding:</i> the student will have to acquire clear and effective communication skills, thanks to a good command of the vocabulary concerning the topics covered during the course • <i>Capacities to continue learning:</i> the student must have developed good learning skills, which allow them to autonomously deepen the knowledge acquired during the course by tackling personalized study paths.
Syllabus	<p>A) Valuation of operation under conditions of uncertainty.</p> <p>1) Elements of probability calculation. Discrete and continuous random variable. Distribution function. Expected value of a discrete random variable. Variance and standard deviation. Covariance. Correlation coefficient. Conditional probability. Independent events. Uncorrelated random variables.</p> <p>2) Criteria for evaluating random quantities. The mean value criterion and fair games. Limits to the mean value criterion. The St. Petersburg paradox. The utility function. The utility of uncertain sums. The concept of certain equivalent. Risk aversion.</p> <p>3) The stochastic dominance of the first order and of the second order. The criterion mean-variance. The risk-return analysis.</p> <p>4) Portfolio theory. Risky and non-risky investments. The case of two titles. The case of n risky assets. The case of n risky and one non-risky stocks. The market equilibrium model.</p> <p>B) Valuation of derivatives.</p> <p>5) Introduction to stochastic processes. Basic definitions. Incremental processes independent. Martingale. Brownian motion. Stochastic differential. Ito's lemma. Stochastic differential equations.</p> <p>6) Evaluation of financial options. Options overview. Call and put parity relationship. Uniperiod binomial model. Cox-Ross-Rubinstein model.</p> <p>7) The Black and Scholes model. The Monte Carlo method for the evaluation of options.</p> <p>8) Valuation of "futures" and "swap" contracts.</p>
Content knowledge	
Texts and readings	G. Castellani, M. De Felice, F. Moriconi. "Manuale di Finanza Vol III. Modelli 1) stocastici e contratti derivati". Eds Il Mulino.
Notes, additional materials	https://www.uniba.it/it/docenti/villani-giovanni https://www.uniba.it/it/docenti/biancardi-marta
Repository	

Assessment	
Assessment methods	Written and oral exam.
Assessment criteria	The written test consists in carrying out some exercises on the main topics of the course. For example: pricing of derivatives using the binomial method, Black and Scholes formula and Montecarlo simulation; minimum variance portfolio formed by n risky securities; stochastic dominance. The oral part of the exam can be taken by the student who will have reported, in the written test, an evaluation of at least 18/30. The oral part of the exam will ascertain the level of the overall preparation on all the topics of the program. For a sufficient assessment, the student will have to demonstrate knowledge of concepts (through their definitions) and links between the various topics, as well as an understanding of mathematical reasoning.
Final exam and grading criteria	<ul style="list-style-type: none"> • <18 Fragmentary and superficial knowledge of the contents, errors in applying the concepts, deficient exposition; • 18-20 Sufficient but general content knowledge, simple exposition, uncertainties in the application of theoretical concepts; • 21-23 Appropriate but not in-depth knowledge of content, ability to apply theoretical concepts, ability to present content in a simple way; • 23-26 Appropriate and broad knowledge of contents, good ability to apply knowledge, ability to present contents in an articulated way. • 27-29 Broad, complete and in-depth knowledge of the contents, good application of the contents, good capacity for analysis and synthesis, safe and correct presentation. • 30-30L Very broad, complete and in-depth knowledge of the contents, well-established ability to apply the contents, excellent capacity for analysis, synthesis and interdisciplinary connections, mastery of exposition.
Further information	
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