Year of entry: 2021/22

Programme Specification

1	**Awarding body**	University of London						
2	**Teaching Institution**	**Birkbeck College**						
3	**Programme Title(s)**	**MSc Quantitative Risk Management with Machine Learning**						
4	**Programme Code(s)**	TMSQRMML_C						
5	***UCAS code (if applicable)***	N/A						
6	**Home Department**	Economics, Mathematics and Statistics						
7	**Exit Award(s)**	PG Cert (passing 60 credits at level 7) and PG Diploma (passing 120 credits)						
8	**Duration of Study** (number of years)	1 year FT or 2 years PT						
9	**Mode of Study**	FT	✓	PT	✓	DL		
10	**Level of Award (FHEQ)**	7						
11	**Other teaching depts or institution**	N/A						
12	**Professional, Statutory Regulatory Body(PSRB) details**	N/A						
13	**QAA Benchmark Statement**	N/A						

14	**Programme Rationale & Aims**
	The recent economic crises have created a great deal of uncertainty in the financial markets and demand is growing globally for experts who have the technical skills to measure and manage financial risk. Statistical and machine learning tools are now imperative pre-requisites for professionals working in the sector. The MSc in Quantitative Risk Management with Machine Learning has been designed to address the demand for individuals with expertise in this field by equipping students with the theoretical background and statistical and computational methods needed to tackle practical real-world problems. Upon successfully completing the course, students will have the expertise to: • Identify and manage the major sources of risk in the financial markets. • Understand the role of financial derivative products; their use (and misuse) and how they are priced. • Analyse financial data and specifically, build risk models, detect trends in data, test a given hypothesis and forecast future values. • Build an investment portfolio (of risky assets) and carefully monitor its performance through time. • To implement mathematical and statistical investigations using both Python and R programming languages.

	In summary, the student will be prepared for a variety of challenging and rewarding roles in the financial sector, e.g. a risk analyst for an investment bank, a portfolio manager, an investment strategist for a bank, pension fund or hedge fund.

15	**Entry Criteria**
	A second-class honours degree (2:2) or above in a quantitative subject, such as mathematics, physics, statistics, economics or engineering. Alternatively, a merit or higher in our MSc Finance. Applications are reviewed on their individual merits and professional qualifications and/or relevant work experience will be taken into consideration positively. We actively support and encourage applications from mature learners.

16	**Learning Outcomes**
	In general, at the end of the programme, students should have a comprehensive overview of the field of quantitative risk management. They should understand and be able to apply quantitative tools (especially statistical and machine learning applications) to tackle problems in this field and conduct independent applied research, as witnessed by the completion of a dissertation. Specific learning outcomes: • Demonstrate an understanding of the main international guidelines on good risk management practice. • To describe and apply different measures of financial risk and define what is meant by a coherent measure of risk. • The ability to analyse financial data using statistics and determine the main characteristics of a financial time series. • Obtain estimates of parameters and determine their statistical properties. • Substantial knowledge and understanding of the mean variance framework for classical portfolio theory. • The ability to derive the CAPM and APT pricing models. • The ability to formulate and test financial risk models. • Substantial knowledge of the derivatives market and their role in risk management. • The ability to price standard options in the Black-Scholes framework. • The ability to solve valuation problems using the binomial tree approach. • The ability to implement basic numerical techniques (such a binomial tree pricing) in the form of a computational algorithm. • To be able to code scientific methods using the Python and R programming languages. • Substantial knowledge of the theory that underpins supervised and unsupervised statistical learning. • Demonstrate and awareness of different sources of credit risk.

	• Substantial knowledge of the different approaches to modelling and managing credit risk. • An advanced ability to critically review current literature, pose new questions and carry out a research project.

17	**Learning, teaching and assessment methods**
	The majority of teaching is delivered in the form of the traditional chalk-and-talk lectures. Given the formal content of the courses this method gives the lecturers the opportunity to clarify each step of a complex derivation, react instantly to clarification queries and vary the pace of the lecture where appropriate. While lecturing is the primary method of delivery, it is by no means the only one. An important aspect of learning involves solving problems and, to this end, many of the lectures will be augmented by supporting classes to discuss solutions to problem sets. Courses which contain a significant programming component can be taught in a computer lab where the convenor can demonstrate the implementation of computational methods, set short tasks and allow the students to write their own code. Most courses make use of substantial hand-outs that are designed to help students digest the material developed in lectures. Specific directions to textbooks, academic papers or extensive lecture notes help the students obtain a clear idea of the material. Lectures also specify precise objectives at the outset and this is particularly helpful in calibrating oneself with the state of the course especially if work commitments force absence. An important ingredient of learning is private study. Apart from the reading lists the programme requires students to produce independent project work, aiding development of analytic, quantitative as well as written communication skills. Learning is further assisted by review sessions; these are important as they also provide guidance on examination technique. The following methods of assessment are used: • Unseen 3 hour examination • Assessed coursework • Dissertation For each module the bulk (generally around 80%) of the assessment comes from unseen examinations. These are typically held in June, thus giving as much time as possible for assimilation of the material, promoting an overall understanding and engagement with the curriculum. The contribution (around 20%) from the coursework ensures that, throughout the year, students get practice, and are given feedback, in tackling and solving problems independently without time pressure of examinations. The modules are assessed on a scale on which 50% represents a pass mark, 60-69% a merit and 70% or above yields a distinction. The dissertation is assessed similarly as Fail, Pass, Merit or Distinction. The range of questions and problems set within examinations and coursework are structured to balance theory and practice, to address the individual learning outcomes and to discriminate between different levels of achievement. Our assessment strategy also takes into consideration that students can exhibit a wide range of aptitudes and abilities in

	different aspects of the course. Thus the assessment is designed to ensure a good coverage of the curriculum so that all students have the opportunity to demonstrate their strengths. Examination papers and dissertations are marked independently by two markers who then compare marks and produce agreed final marks. All marks are moderated by an external examiner who is also asked to comment on the suitability of the assessment.

18	**Programme Description**
	The programme consists of 180 credits from the following core/compulsory modules taken as shown in the programme structure section below. • **BUEM027S6: Quantitative Techniques. Level 6. Compulsory.** Aim: To review the necessary mathematical and statistical background for the courses of the MSc. Topics. Calculus, applied linear algebra, optimization theory (method of Lagrange multipliers) and probability theory. • **BUEM052H7: Mathematics of Financial Derivatives. Level 7. Compulsory** Aim: To teach the principal mathematical and numerical techniques used to value financial derivatives. Topics: introduction to financial derivatives their uses and properties, stochastic processes, Brownian motion, stochastic calculus, the Black Scholes framework for European options, the volatility smile and the binomial pricing method applied to American and Barrier options • **BUEM111H7: Financial Data Science with Python. Level 7. Compulsory.** Aim: The aim of this module is to provide students with the ability to program in Python with particular focus on the computational techniques in financial data analysis, financial mathematics and machine learning. Topics: Programming in Python: basic operators, data type and structures, control flow, functions, modules, classes. Data analysis with pandas and plot visualization with matplotlib. Randomness and simulations in Python. Optimization and integration in Python. Introduction to Machine Learning techniques in Python. • **BUEM053H7: Market Risk Management. Level 7. Core**. Aim: To provide an introduction to modern market risk management theory and practice, developing problem solving skills in risk management applications and becoming conversant with up-to-date techniques used by financial institutions. Topics: measuring financial losses, Value at Risk (VaR) and Tail Value at Risk (TVaR) – definitions, theoretical properties and calculations, time series analysis for risk managers, stylized facts of asset returns, risk models featuring jumps and stochastic volatility, GARCH family of risk models, VaR for derivatives, extreme value theory applied to VaR, simulation methods and back-testing. • **BUEM051H7. Credit Risk Management. Level 7. Core.** Aim: Same as those for 'Market Risk Management' Topics: essential mathematics for credit risk, credit risk modelling using (i) structural models (as illustrated by Merton's model and its extensions) (ii) industry standard

models (as illustrated by CreditMetrics and/or KMV) (iii) the reduced form models (as illustrated by Jarrow and Turnbull), credit derivatives and valuation of credit value adjustments CVA.

- **EMMS016S7. Statistical Analysis. Level 7. Core.**
  Aim: To provide a solid grounding in the fundamental theory and practice of statistical modelling, and the analysis of observational and experimental data based on continuous, normally distributed, data
  Topics: Review of basic statistical concepts, multiple linear regression, inference for linear models, model fitting and diagnostics, regression, the R programming language.
- **BUEM054H7: Portfolio Theory. Level 7. Compulsory**
  Aim: To teach the mathematical theory that forms the foundations of modern finance.
  Topics: Basics of utility theory, measuring financial returns, the mean variance framework for portfolio analysis, the derivation of CAPM and APT pricing models, applications of CAPM and APT, multifactor risk models and principal component analysis.
- **EMMS022H7: Statistical Learning. Level 7. Compulsory**
  Aim: To teach the statistical theory that underpins both supervised and unsupervised learning.
  Topics: Linear regression, generalized linear models, support vector machines, learning theory, cross validation, regression trees, cluster analysis, hierarchical methods, factor analysis and principal component analysis.

19	**Programme Structure**			
Full-Time programme -1 Year				
Year 1				
Level	**Module Code**	**Module Title**	**Credits**	**Status***
6	BUEM027S6	Quantitative techniques	30	Compulsory
7	BUEM052H7	Mathematics of Financial Derivatives	15	Compulsory
7	BUEM111H7	Financial Data Science with Python	15	Compulsory
7 7 7	BUEM053H7 BUEM051H7 EMMS013S7*	Market Risk Management Credit Risk Management **Or** Mathematical Risk Management* **Depending on time-tabling constraints students will take either EMMS013S7 OR both BUEM053H7 AND BUEM051H7*	15 15 30	Core Core Core
7	EMMS016S7 [EMEC026S7/ BUEM077S7]	Statistical Analysis **Or one of** [Econometrics/Econometrics of Financial Markets] *Depending on time-tabling constraints students will take either EMMS016S7 OR one of EMEC026S7/BUEM077S7*	30	Compulsory
7	BUEM054H7	Portfolio Theory	15	Compulsory
7	EMMS022H7	Statistical Learning	15	Compulsory
7	BUEM115S7	Dissertation MSc Quantitative Risk Management with Machine Learning	30	Compulsory

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Part-Time programme – 2 years				
Year 1				
Level	**Module Code**	**Module Title**	**Credits**	**Status***
6	BUEM027S6	Quantitative techniques	30	Compulsory
7	BUEM052H7	Mathematics of Financial Derivatives	15	Compulsory
7	BUEM111H7	Financial Data Science with Python	15	Compulsory
7	EMMS016S7 [EMEC026S7/ BUEM077S7]	Statistical Analysis **Or one of** [Econometrics/Econometrics of Financial Markets] *Depending on time-tabling constraints students will take either EMMS016S7 OR one of EMEC026S7/BUEM077S7*	30	Compulsory
Year 2				
Level	**Module Code**	**Module Title**	**Credits**	**Status***
7	BUEM054H7	Portfolio Theory	15	Compulsory
7	EMMS022H7	Statistical Learning	15	Compulsory
7 7 7	BUEM053H7 BUEM051H7 **Or** EMMS013S7*	Market Risk Management Credit Risk Management Mathematical Risk Management **Depending on time-tabling constraints students will take either EMMS013S7 or both of BUEM053H7 AND BUEM051H7.*	15 15 30	Core Core Core
7	BUEM115S7	Dissertation MSc Quantitative Risk Management with Machine Learning	30	Compulsory

Status*

CORE – Module must be taken and passed by student
COMPULSORY – Module must be taken, mark can be reviewed at sub-exam board
OPTIONAL – Student can choose to take this module

24	**Programme Director**	Simon Hubbert
25	**Start Date *(term/year)***	Autumn 2013
26	**Date approved by TQEC**	Spring 2013
27	**Date approved by Academic Board**	Summer 2013
28	**Date(s) updated/amended**	Mar 2019 for 2020/21