REGULATIONS FOR THE DEGREE OF MASTER OF DATA SCIENCE (MDASC)

For students admitted in 2022-23 and thereafter

(See also General Regulations and Regulations for Taught Postgraduate Curricula)

Any publication based on work approved for a higher degree should contain a reference to the effect that the work was submitted to the University of Hong Kong for the award of the degree.

Admission requirements

MD1 To be eligible for admission to the courses leading to the degree of Master of Data Science a candidate

(a) shall comply with the General Regulations and the Regulations for Taught Postgraduate Curricula;

(b) shall hold

(i) a Bachelor's degree with honours of this University, or

(ii) another qualification of equivalent standard from this University or another University or comparable institution acceptable for this purpose; and

(c) shall pass a qualifying examination if so required; and

(d) shall have taken at least one university or post-secondary certificate course in each of the following three subjects (calculus and algebra, computer programming and introductory statistics) or related areas.

Qualifying examination

MD2 (a) A qualifying examination may be set to test the candidate's formal academic ability or his ability to follow the courses of study prescribed. It shall consist of one or more written papers or their equivalent and may include a project report.

(b) A candidate who is required to satisfy the examiners in a qualifying examination shall not be permitted to register until he has satisfied the examiners in the examination.

Period of study

MD3 The curriculum shall normally extend over one and a half academic years of full-time study or two and a half academic years of part-time study. Candidates shall not be permitted to extend their studies beyond the maximum period of registration of three academic years of full-time study or four academic years of part-time study, unless otherwise permitted or required by the Board of the Faculty.

Course Exemption and advanced standing

MD4 (a) In recognition of studies completed successfully before admission to the curriculum, advanced standing of up to 12 credits may be granted to a candidate with appropriate qualification and professional experiences, on production of appropriate certification, subject to the approval of the Board of the Faculty. Credits gained for advanced standing shall not be included in the calculation of the GPA but will be recorded on the transcript of the candidate. The candidate should apply before commencement of first year of study via the Department and provide all the supporting documents.

(b) For cases of having satisfactorily completed more than 12 credits of another course or courses equivalent in content to any of the compulsory courses as specified in the syllabuses, candidates may, on production of appropriate certification, be exempted from the compulsory course(s), subject to approval of the Board of the Faculty. Candidates so exempted must replace the number of exempted credits with electives course(s) in the curriculum of the same credit value.

Award of degree

MD5 To be eligible for the award of the degree of Master of Data Science, a candidate shall

(a) comply with the General Regulations and the Regulations for Taught Postgraduate Curricula; and

(b) successfully complete the curriculum in accordance with the regulations set out below.

A candidate who fails to fulfill the requirements within the maximum (i) three academic years for full-time mode of study or (ii) four academic years for part-time mode of study shall be recommended for discontinuation under the provisions of General Regulation G12, except that a candidate is granted permission to extend period of study by the Board of the Faculty in accordance with Regulation MD3.

Completion of curriculum

MD6 To successfully complete the curriculum, a candidate shall satisfy the requirements prescribed in TPG 6 of the Regulations for Taught Postgraduate Curricula; follow courses of instruction; and satisfy the examiners in the prescribed courses and in any prescribed form of examination in accordance with the regulations set out below.

Assessments

MD7 (a) In any course where so prescribed in the syllabus, coursework or a project report may constitute part or whole of the examination for the course.

(b) The written examination for each module shall be held after the completion of the prescribed course of study for that module, and not later than January, May or August immediately following the completion of the course of study for that module.

MD8 If during any academic year a candidate has failed at his/her first attempt in a course or courses, but is not required to discontinue his/her studies by Regulation MD9, the candidate may be permitted to make up for the failed courses in the following manner:

(a) undergoing re-assessment/re-examination in the failed course or courses to be held before the next academic year; or

(b) for repeating the course and re-examination in the failed course or courses in the next academic year; or

(c) for elective courses, taking another course in lieu and satisfying the assessment requirements.

MD9 Failure to undertake the examination of a course as scheduled shall normally result in automatic failure in that course. A candidate who, because of illness, is unable to be present at the written examination of any course may apply for permission to present himself/herself at a supplementary examination of the same course to be held before the beginning of the following academic year. Any such application shall be made on the form prescribed within seven calendar days of the examination concerned.

MD10 A candidate may be required to discontinue his/her studies if he/she

(a) during any academic year has failed in half or more than half the number of credits of all the courses to be examined in that academic year; or

(b) has failed at a repeated attempt in any course; or

(c) has exceeded the maximum period of registration.

Grading

MD11 Individual courses shall be graded according the letter grading system as determined by the Board of Examiners.

(a) Letter grades, their standards and the grade points for assessment as follows:

Grade	Standard	Grade Point
A+	**Excellent**	4.3
A		4.0
A-		3.7
B+	**Good**	3.3
B		3.0
B-		2.7
C+	**Satisfactory**	2.3
C		2.0
C-		1.7
D+	**Pass**	1.3
D		1.0
F	**Fail**	0

or

(b) 'Distinction', 'Pass' or 'Fail'.

Courses which are graded according to (b) above will not be included in the calculation of the GPA.

MD12 On successful completion of the curriculum, candidates who have shown exceptional merit at the whole examination may be awarded a mark of distinction, and this mark shall be recorded in the candidates' degree diploma.

SYLLABUSES FOR THE DEGREE OF
MASTER OF DATA SCIENCE
(MDASC)

The Department of Statistics and Actuarial Science and Department of Computer Science jointly offer a postgraduate curriculum leading to the degree of Master of Data Science, with two study modes: the one and a half academic years' full-time mode and the two and a half academic years' part-time mode. The curriculum is designed to provide graduates with training in the principles and practice of data science. Candidates should have knowledge of calculus and algebra, computer programming and introductory statistics and should have taken at least one university or post-secondary certificate course in each of these three subjects or related areas.

STRUCTURE AND EVALUATION

Each student must complete at least 72 credits of courses. Courses with 6 credits are offered in the first and second semesters while courses with 3 credits are normally offered in the summer semester. If a student selects a course whose contents are similar to a course (or courses) which he/she has taken in his/her previous study, the Department may not approve the selection in question.

CURRICULUM
(applicable for both full-time and part-time modes)

Compulsory Courses (36 credits)	
COMP7404	Computational intelligence and machine learning
DASC7011	Statistical inference for data science
DASC7104	Advanced database systems
DASC7606	Deep learning
STAT7102	Advanced statistical modelling
STAT8003	Time series forecasting
Disciplinary Electives (24 credits)*	
with at least 12 credits from List A and at least 12 credits from List B	
List A	
COMP7105	Advanced topics in data science
COMP7305	Cluster and cloud computing
COMP7409	Machine learning in trading and finance
COMP7503	Multimedia technologies
COMP7506	Smart phone apps development
COMP7507	Visualization and visual analytics
COMP7906	Introduction to cyber security
FITE7410	Financial fraud analytics
ICOM6044	Data science for business
List B	
STAT6008	Advanced statistical inference
STAT6013	Financial data analysis
STAT6015	Advanced quantitative risk management
STAT6016	Spatial data analysis
STAT6019	Current topics in statistics
STAT7008	Programming for data science
STAT8017	Data mining techniques

STAT8019	Marketing analytics
STAT8306	Statistical methods for network data (3 credits)
STAT8307	Natural language processing and text analytics (3 credits)
STAT8308	Blockchain data analytics (3 credits)

*Students who have completed the same courses in their previous studies in HKU, e.g. Master of Statistics or Master of Science in Computer Science may, on production of relevant transcripts, be permitted to select up to 24 credits of disciplinary electives from either List A or List B above if they are not able to find any untaken options from either of the lists of disciplinary electives.

Capstone requirement (12 credits)

DASC7600	Data science project (12 credits)

All courses should be 6-credit bearing unless otherwise stated.

COURSE DESCRIPTION

Compulsory Courses

COMP7404 Computational intelligence and machine learning (6 credits)

This course will teach a broad set of principles and tools that will provide the mathematical, algorithmic and philosophical framework for tackling problems using Artificial Intelligence (AI) and Machine Learning (ML). AI and ML are highly interdisciplinary fields with impact in different applications, such as, biology, robotics, language, economics, and computer science. AI is the science and engineering of making intelligent machines, especially intelligent computer programs, while ML refers to the changes in systems that perform tasks associated with AI. Ethical issues in advanced AI and how to prevent learning algorithms from acquiring morally undesirable biases will be covered.

Topics may include a subset of the following: problem solving by search, heuristic (informed) search, constraint satisfaction, games, knowledge-based agents, supervised learning, unsupervised learning; learning theory, reinforcement learning and adaptive control and ethical challenges of AI and ML.

Pre-requisites: Nil, but knowledge of data structures and algorithms, probability, linear algebra, and programming would be an advantage.

Assessment: coursework (50%) and examination (50%)

DASC7011 Statistical inference for data science (6 credits)

Computing power has revolutionized the theory and practice of statistical inference. Reciprocally, novel statistical inference procedures are becoming an integral part of data science. By focusing on the interplay between statistical inference and methodologies for data science, this course reviews the main concepts underpinning classical statistical inference, studies computer-intensive methods for conducting statistical inference, and examines important issues concerning statistical inference drawn upon modern learning technologies. Contents include classical frequentist and Bayesian inferences, computer-intensive methods such as the EM algorithm, the bootstrap and the Markov chain Monte Carlo, large-scale hypothesis testing, high-dimensional modeling, and post-model-selection inference.

Assessment: coursework (40%) and examination (60%)

DASC7104 Advanced database systems (6 credits)

The course will study some advanced topics and techniques in database systems, with a focus on the aspects of database systems design & algorithms and big data processing for structured data. Traditional topics include: query optimization, physical database design, transaction management, crash recovery, parallel databases. This course will also survey some recent developments in selected areas such as NoSQL databases and SQL-based big data management systems for relational (structured) data.

Assessment: coursework (50%) and examination (50%)

DASC7606 Deep learning (6 credits)

Machine learning is a fast growing field in computer science and deep learning is the cutting edge technology that enables machines to learn from large-scale and complex datasets. Ethical implications of deep learning and its applications will be covered and the course will focus on how deep neural networks are applied to solve a wide range of problems in areas such as natural language processing, and image processing. Other applications such as financial predictions, game playing and robotics may also be covered. Topics covered include linear and logistic regression, artificial neural networks and how to train them, recurrent neural networks, convolutional neural networks, generative models, deep reinforcement learning and unsupervised feature learning.

Prerequisites: Basic programming skills, e.g., Python is required.

Assessment: coursework (40%) and examination (60%)

STAT7102 Advanced statistical modelling (6 credits)

This course introduces modern methods for constructing and evaluating statistical models and their implementation using popular computing software, such as R or Python. It will cover both the underlying principles of each modelling approach and the model estimation procedures. Topics from: (i) Linear regression models; (ii) Generalized linear models; (iii) Model selection and regularization; (iv) Kernel and local polynomial regression; selection of smoothing parameters; (v) Generalized additive models; (vi) Hidden Markov models and Bayesian networks.

Assessment: coursework (50%) and examination (50%)

STAT8003 Time series forecasting (6 credits)

A time series consists of a set of observations on a random variable taken over time. Such series arise naturally in climatology, economics, finance, environmental research and many other disciplines. In additional to statistical modelling, the course deals with the prediction of future behaviour of these time series. This course distinguishes different types of time series, investigates various representations for them and studies the relative merits of different forecasting procedures.

Assessment: coursework (40%) and examination (60%)

Disciplinary Electives

COMP7105 Advanced topics in data science (6 credits)

This course will introduce selected advanced computational methods and apply them to problems in data analysis and relevant applications.

Assessment: coursework (50%) and examination (50%)

COMP7305 Cluster and cloud computing (6 credits)

This course offers an overview of current cloud technologies, and discusses various issues in the design and implementation of cloud systems. Topics include cloud delivery models (SaaS, PaaS, and

IaaS) with motivating examples from Google, Amazon, and Microsoft; virtualization techniques implemented in Xen, KVM, VMWare, and Docker; distributed file systems, such as Hadoop file system; MapReduce and Spark programming models for large-scale data analysis, networking techniques in hyper-scale data centers. The students will learn the use of Amazon EC2 to deploy applications on cloud, and implement a SPARK application on a Xen-enabled PC cluster as part of their term project.

Prerequisites: Students are expected to install various open-source cloud software in their Linux cluster, and exercise the system configuration and administration. Basic understanding of Linux operating system and some programming experiences (C/C++, Java or Python) in a Linux environment are required.

Assessment: coursework (50%) and examination (50%)

COMP7409 Machine learning in trading and finance (6 credits)

The course introduces our students to the field of Machine Learning, and help them develop skills of applying Machine Learning, or more precisely, applying supervised learning, unsupervised learning and reinforcement learning to solve problems in Trading and Finance.

This course will cover the following topics. (1) Overview of Machine Learning and Artificial Intelligence, (2) Supervised Learning, Unsupervised Learning and Reinforcement Learning, (3) Major algorithms for Supervised Learning and Unsupervised Learning with applications to Trading and Finance, (4) Basic algorithms for Reinforcement Learning with applications to optimal trading, asset management, and portfolio optimization, (5) Advanced methods of Reinforcement Learning with applications to high-frequency trading, cryptocurrency trading and peer-to-peer lending.

Assessment: coursework (65%) and examination (35%)

COMP7503 Multimedia technologies (6 credits)

This course presents fundamental concepts and emerging technologies for multimedia computing. Students are expected to learn how to develop various kinds of media communication, presentation, and manipulation techniques. At the end of course, students should acquire proper skill set to utilize, integrate and synchronize different information and data from media sources for building specific multimedia applications. Topics include media data acquisition methods and techniques; nature of perceptually encoded information; processing and manipulation of media data; multimedia content organization and analysis; trending technologies for future multimedia computing.

Assessment: coursework (50%) and examination (50%)

COMP7506 Smart phone apps development (6 credits)

Smart phones have become an essential part of our everyday lives. The number of smart phone users worldwide today surpasses six billion and is forecast to further grow by more than one billion in the next few years. Smart phones play an important role in mobile communication and applications.

Smart phones are powerful as they support a wide range of applications (called apps). Most of the time, smart phone users just download their favorite apps remotely from the app stores. There is a great potential for software developer to reach worldwide users.

This course aims at introducing the design and technical issues of smart phone apps. For example, smart phone screens are usually smaller than computer monitors while smart phones usually possess more hardware sensors than conventional computers. We have to pay special attention to these aspects in order to develop attractive and successful apps. Various modern smart phone apps development environments and programming techniques (such as Java for Android phones and Swift for iPhones) will also be introduced to facilitate students to develop their own apps.

Students should have basic programming knowledge.

Mutually exclusive with: COMP3330 Interactive mobile application design and programming

Assessment: coursework (60%) and examination (40%)

COMP7507 Visualization and visual analytics (6 credits)

This course introduces the basic principles and techniques in visualization and visual analytics, and their applications. Topics include human visual perception; color; visualization techniques for spatial, geospatial and multivariate data, graphs and networks; text and document visualization; scientific visualization; interaction and visual analysis.

Assessment: coursework (50%) and examination (50%)

COMP7906 Introduction to cyber security (6 credits)

The aim of the course is to introduce different methods of protecting information and data in the cyber world, including the privacy issue. Topics include introduction to security; cyber attacks and threats; cryptographic algorithms and applications; network security and infrastructure.

Mutually exclusive with: ICOM6045 Fundamentals of e-commerce security

Assessment: coursework (50%) and examination (50%)

FITE7410 Financial fraud analytics (6 credits)

This course aims at introducing various analytics techniques to fight against financial fraud. These analytics techniques include, descriptive analytics, predictive analytics, and social network learning. Various data set will also be introduced, including labeled or unlabeled data sets, and social network data set. Students learn the fraud patterns through applying the analytics techniques in financial frauds, such as, insurance fraud, credit card fraud, etc.

Key topics include: Handling of raw data sets for fraud detection; Applications of descriptive analytics, predictive analytics and social network analytics to construct fraud detection models; Financial Fraud Analytics challenges and issues when applied in business context.

Required to have basic knowledge about statistics concepts.

Assessment: coursework (60%) and examination (40%)

ICOM6044 Data science for business (6 credits)

The emerging discipline of data science combines statistical methods with computer science to solve problems in applied areas. In this case we focus on how data science can be used to solve business problems especially those in electronic commerce. By its very nature e-commerce is able to generate large amounts of data and data mining methods are quite helpful for managers in turning this data into knowledge which in turn can be used to make better decisions. These data sets and their accompanying quantitative methods have the potential to dramatically change decision making in many areas of business. For example, ideas like interactive marketing, customer relationship management, and database marketing are pushing companies to utilize the information they collect about their customers in order to make better marketing decisions.

This course focuses on how data science methods can be applied to solve managerial problems in marketing and electronic commerce. Our emphasis is developing a core set of principles that embody data science: empirical reasoning, exploratory and visual analysis, and predictive modeling. We use these core principles to understand many methods used in data mining and machine learning. Our strategy in this course is to survey several popular techniques and understand how they map into these core principles. These techniques are illustrated with case studies. However, the emphasis is not on the software for implementing these techniques but on understanding the inputs and outputs of these techniques and how they are used to solve business problems.

Assessment: coursework (65%) and examination (35%)

STAT6008 Advanced statistical inference (6 credits)

This course covers the advanced theory of point estimation, interval estimation and hypothesis testing. Using a mathematically-oriented approach, the course provides a formal treatment of inferential problems, statistical methodologies and their underlying theory. It is suitable in particular for students intending to further their studies or to develop a career in statistical research. Contents include: (1) Decision problem – frequentist approach: loss function; risk; decision rule; admissibility; minimaxity; unbiasedness; Bayes' rule; (2) Decision problem – Bayesian approach: prior and posterior distributions, Bayesian inference; (3) Estimation theory: exponential families; likelihood; sufficiency; minimal sufficiency; completeness; UMVU estimators; information inequality; large-sample theory of maximum likelihood estimation; (4) Hypothesis testing: uniformly most powerful (UMP) test; monotone likelihood ratio; UMP unbiased test; conditional test; large-sample theory of likelihood ratio; confidence set; (5) Nonparametric inference; bootstrap methods.

Assessment: coursework (40%) and examination (60%)

STAT6013 Financial data analysis (6 credits)

This course aims at introducing statistical methodologies in analyzing financial data. Financial applications and statistical methodologies are intertwined in all lectures. Contents include: recent advances in modern portfolio theory, copula, market microstructure, stochastic volatility models and high frequency data analysis.

Assessment: coursework (40%) and examination (60%)

STAT6015 Advanced quantitative risk management (6 credits)

This course covers statistical methods and models of risk management, especially of Value-at-Risk (VaR). Contents include: Value-at-risk (VaR) and Expected Shortfall (ES); univariate models (normal

model, log-normal model and stochastic process model) for VaR and ES; models for portfolio VaR; time series models for VaR; extreme value approach to VaR; back-testing and stress testing.

Assessment: coursework (40%) and examination (60%)

STAT6016 Spatial data analysis (6 credits)

This course covers statistical concepts and tools involved in modelling data which are correlated in space. Applications can be found in many fields including epidemiology and public health, environmental sciences and ecology, economics and others. Covered topics include: (1) *Outline* of three types of spatial data: point-level (geostatistical), areal (lattice), and spatial point process. (2) *Model-based geostatistics*: covariance functions and the variogram; spatial trends and directional effects; intrinsic models; estimation by curve fitting or by maximum likelihood; spatial prediction by least squares, by simple and ordinary kriging, by trans-Gaussian kriging. (3) *Areal data models*: introduction to Markov random fields; conditional, intrinsic, and simultaneous autoregressive (CAR, IAR, and SAR) models. (4) *Hierarchical modelling* for univariate spatial response data, including Bayesian kriging and lattice modelling. (5) *Introduction* to simple spatial point processes and spatio-temporal models. Real data analysis examples will be provided with dedicated R packages such as geoR.

Assessment: coursework (50%) and examination (50%)

STAT6019 Current topics in statistics (6 credits)

This course includes two modules.

The first module, *Causal Inference*, is an introduction to key concepts and methods for causal inference. Contents include 1) the counterfactual outcome, randomized experiment, observational study; 2) Effect modification, mediation and interaction; 3) Causal graphs; 4) Confounding, selection bias, measurement error and random variability; 5) Inverse probability weighting and the marginal structural models; 6) Outcome regression and the propensity score; 7) The standardization and the parametric g-formula; 8) G-estimation and the structural nested model; 9) Instrumental variable method; 10) Machine learning methods for causal inference; 11) Other topics as determined by the instructor.

The second module, Functional data analysis, covers topics from: 1) Base functions; 2) Least squares estimation; 3) Constrained functions; 4) Functional PCA; 5) Regularized PCA; 6) Functional linear model; 7) Other topics as determined by the instructor.

Assessment: coursework (100%)

STAT7008 Programming for data science (6 credits)

In the big data era, it is very easy to collect huge amounts of data. Capturing and exploiting the important information contained within such datasets poses a number of statistical challenges. This course aims to provide students with a strong foundation in computing skills necessary to use R or Python to tackle some of these challenges. Possible topics to be covered may include exploratory data analysis and visualization, collecting data from a variety of sources (e.g. Excel, web-scraping, APIs and others), object-oriented programming concepts and scientific computation tools. Students will learn to create their own R packages or Python libraries.

Assessment: coursework (100%)

STAT8017 Data mining techniques (6 credits)

With the rapid developments in computer and data storage technologies, the fundamental paradigms of classical data analysis are mature for change. Data mining techniques aim at helping people to work smarter by revealing underlying structure and relationships in large amounts of data. This course takes a practical approach to introduce the new generation of data mining techniques and show how to use them to make better decisions. Topics include data preparation, feature selection, association rules, decision trees, bagging, random forests and gradient boosting, cluster analysis, neural networks, introduction to text mining.

Assessment: coursework (100%)

STAT8019 Marketing analytics (6 credits)

This course aims to introduce various statistical models and methodology used in marketing research. Special emphasis will be put on marketing analytics and statistical techniques for marketing decision making including market segmentation, market response models, consumer preference analysis and conjoint analysis. Contents include market response models, statistical methods for segmentation, targeting and positioning, statistical methods for new product design.

Assessment: coursework (40%) and examination (60%)

STAT8306 Statistical methods for network data (3 credits)

The six degree of separation theorizes that human interactions could be easily represented in the form of a network. Examples of networks include router networks, the World Wide Web, social networks (e.g. Facebook or Twitter), genetic interaction networks and various collaboration networks (e.g. movie actor coloration network and scientific paper collaboration network). Despite the diversity in the nature of sources, the networks exhibit some common properties. For example, both the spread of disease in a population and the spread of rumors in a social network are in sub-logarithmic time. This course aims at discussing the common properties of real networks and the recent development of statistical network models. Topics may include common network measures, community detection in graphs, preferential attachment random network models, exponential random graph models, models based on random point processes and the hidden network discovery on a set of dependent random variables.

Assessment: coursework (100%)

STAT8307 Natural language processing and text analytics (3 credits)

The textual data constitutes an enormous proportion of unstructured data which is characterized as one of ‘V’s in Big Data. The logical and computational reasonings are applied to transform large collection of written resources to structured data for use in further analysis, visualization, integration with structured data in database or warehouse, and further refinement using machine learning systems. This course introduces the methodology of text analytics. Topics include natural language processing, word representation, text categorization and clustering, topic modelling and sentiment analysis. Students are required to possess basic understanding of Python language.

Pre-requisites: Pass in STAT8017 Data mining techniques and DASC7606 Deep learning or equivalent

Assessment: coursework (100%)

STAT8308 Blockchain data analytics (3 credits)

In this course, we start by studying the basic architecture of a blockchain. Then we move on to several major applications including (but not limited to) cryptocurrencies, fintech and smart contracts. We conclude by examining the cybersecurity issues facing the blockchain ecosystems.

Assessment: coursework (100%)

Capstone Requirement

DASC7600 Data science project (12 credits)

Candidate will be required to carry out independent work on a major project under the supervision of individual staff member. A written report is required.

Assessment: written report (75%) and oral presentation (25%)
