City University of Hong Kong
Course Syllabus

offered by Department of Management Sciences
with effect from Semester A 2022 / 2023

Part I   Course Overview

Course Title:	Matrix-Analytic Methods in Stochastic Models
Course Code:	MS8954
Course Duration:	One Semester
Credit Units:	**3**
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II   Course Details

1.   **Abstract**

This course offers a brief introduction to matrix-analytic methods and their applications in queueing theory, inventory theory, supply chain management, telecommunications networks, reliability, finance mathematics, risk and insurance analysis, and biostatistics.   In the first half of the course, the basic theory on phase-type distributions, Markovian arrival processes, and matrix-geometric solutions is introduced.   In the second half of the course, applications of matrix-analytic methods in stochastic modeling (queueing, reliability, inventory, supply chain, etc.) are examined.

2.   **Course Intended Learning Outcomes (CILOs)**

No.	CILOs	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Learn matrix-analytic methods and apply them in the analysis of stochastic models.		√	√	√
2.	Develop efficient algorithm for computing performance measures and quantities.		√	√	√
		100%			

A1:   Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.
A2:   Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.
A3:   *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3.   **Teaching and Learning Activities (TLAs)**

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4			
1. Lecture	Introduce concepts and methods; Explain results and prove them;	✓	✓					
2. Assignment	Practice the use of techniques to solve problems, and to enhance the understanding of concepts and techniques; extend the skills.	✓	✓					

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4				
Continuous Assessment: 100%								
1. Assignments	✓	✓					60%	
2. Course project Write a course project report about MAM related research in certain area(s) and make possible extension of the theory.	✓	✓					40%	
Examination: ____% (duration: , if applicable)								
							100%	

5. Assessment Rubrics

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
Assignments		Strong evidence of knowing how to apply the key concepts of managing services into real life service operations scenarios.	Evidence of knowing how to apply the key concepts of managing services into real life service operations scenarios.	Some evidence of knowing how to apply the key concepts of managing services into real life service operations scenarios.	Little or no evidence of familiarity with the subject matter.
Course project		Strong evidence of original thinking; good organization, capacity to analyse and synthesize; superior grasp of subject matter; evidence of extensive knowledge base.	Evidence of grasp of subject, some evidence of critical capacity and analytic ability; reasonable understanding of issues; evidence of familiarity with literature.	Some evidence of grasp of subject, little evidence of critical capacity and analytic ability; reasonable understanding of issues.	Little evidence of familiarity with the subject matter; weakness in critical and analytic skills; limited or irrelevant use of literature.

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
Assignments		Strong evidence of knowing how to apply the key concepts of managing services into real life service operations scenarios.	Evidence of knowing how to apply the key concepts of managing services into real life service operations scenarios.	Some evidence of knowing how to apply the key concepts of managing services into real life service operations scenarios.	Sufficient familiarity with the subject matter to enable the student to progress without repeating the assignment.	Little or no evidence of familiarity with the subject matter.
Course project		Strong evidence of original thinking; good organization, capacity to analyse and synthesize; superior grasp of subject matter; evidence of extensive knowledge base.	Evidence of grasp of subject, some evidence of critical capacity and analytic ability; reasonable understanding of issues; evidence of familiarity with literature.	Some evidence of grasp of subject, little evidence of critical capacity and analytic ability; reasonable understanding of issues.	Sufficient familiarity with the subject matter to enable the student to progress without repeating the case report.	Little evidence of familiarity with the subject matter; weakness in critical and analytic skills; limited or irrelevant use of literature.

Part III   Other Information

1.   Keyword Syllabus

Part 1: Introduction to matrix-analytic methods

Part 2: From the exponential distribution to phase-type distributions
- Basic concepts and definitions
- Basic closure properties

Part 3: From the Poisson process to Markovivan   arrival processes
- Basic concepts and definitions
- Performance measures

Part 4: From the birth-and-death process to structured Markov chains
- Basic concepts and definitions
- Matrix-geometric solutions

Part 5: Applications in queueing theory and inventory management
- Basic queueing models and modeling techniques

Inventory-production system

2.   Reading List
2.1   Compulsory Readings

1.	He, Qi-Ming (2014). *Fundamentals of Matrix-Analytic Methods*, Springer, New York.

2.2   Additional Readings

1.	Neuts, M. F. (1981), *Matrix-Geometric Solutions in Stochastic Models – An Algorithmic Approach*, The Johns Hopkins University Press, Baltimore.
2.	Latouche, G. and V. Ramaswami (1999), *Introduction to Matrix Analytic Methods in Stochastic Modelling*, ASA & SIAM, Philadelphia, USA.
3.	Asmussen, S. (2003), *Applied Probability and Queues*, 2nd, Springer, New York.