City University of Hong Kong
Course Syllabus

offered by Department of Electrical Engineering
with effect from Semester A in 2024/2025

Part I Course Overview

Course Title:	Queueing Theory with Telecommunications Applications
Course Code:	EE6610
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P6
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	CS2363 Computer Programming, or equivalent, and, either EE3313 Applied Queueing Systems or MA3160 Probability &Stochastic Processes; or equivalent.
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course aims to provide students with an understanding of probability and queueing models and their analyses, simulation and numerical algorithms, and their use in modelling of practical present and future telecommunications traffic and networking applications. An important focus is how such models can lead to cost effective provision of telecommunications services. This course also aims to stimulate students' appreciation in the potential to make research contributions in this area and to provide preparation for research degrees in telecommunications applications of probability models and queueing theory.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Apply probability and queueing theory to practical problems.		✓		
2.	Develop analytical results of key performance measures, such as blocking probability and queue size and delay statistics, from first principles.		✓	✓	✓
3.	Use tools and program computer simulations of queueing systems including evaluation of confidence intervals.		✓		
4.	Calculate link capacity dimensioning in telecommunications networks, and analyze such networks to evaluate their performance.		✓	✓	✓
		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 real-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. Learning and Teaching Activities (LTAs)

(LTAs designed to facilitate students' achievement of the CILOs.)

LTA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4			
Lectures	Provide knowledge of the general concepts of probability and queueing modelling. All aspects of the course are covered.	✓	✓	✓	✓			2 hrs/wk
Tutorials	With help from the lecturer, TAs, tutors and their peers, students improve their achievements in all 4 CILOs.	✓	✓	✓	✓			1 hr/wk
Group Learning	This activity (see details below) facilitates students' achievement of all 4 CILOs.	✓	✓	✓	✓			
Tests and final exam and related preparations	All four CILOs are tested and examined, so their preparations facilitate students' achievements of these 3 CILOs.	✓	✓	✓	✓			

The course is enriched by what is called *Group Learning* where challenging assignments requiring programming or analyses (or both) are posed to the students. Then the students participate in a social network, using CityU e-learning platform, to solve the problems together. The e-platform is also used for the students to pose questions and other students contribute suggestions and solutions. Participation in this social network is part of the coursework assessment. At the end of the semester, students are required to submit a report on their participation in the Discussion Board throughout the semester on which they are assessed. The Group Learning involves competition – whoever solves the problem first obtains the higher mark. However, the number of opportunities (problem posed by the course leader or by students themselves) is large, so all students have opportunities to excel. It also provides opportunities for students to help each other. Students have freedom in choosing their own problems, but the problems must be closely related to the EE6610 curriculum. Assessment on the Group Learning weekly activities and report are based on novelty, initiative, accuracy, contribution, and presentation. Through Group Learning, the students will experience *discovery learning* by performing simulations and analyses and discover certain effects for themselves, and sharing and discussing them with others via the e-learning platform. They will then use the feedback gained for further understanding and improvement of their work quality.

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4				
Continuous Assessment: <u>50%</u>								
Mid-term test	✓	✓	✓	✓			15%	
Group Learning that involves assessment of weekly participation and contributions, and final report	✓	✓	✓	✓			35%	
Examination: <u>50%</u> (duration: 2hrs , if applicable)								
Examination	✓	✓	✓	✓			50%	
							100%	

Remark:

To pass the course, students are required to achieve at least 30% in coursework and 30% in the examination.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	1.1. Ability to apply probability and queueing theory to practical problems. 1.2. Ability to develop analytical results of key performance measures from first principles. 1.4 Ability to obtain link capacity dimensioning in telecommunications networks, and analyze such networks to evaluate their performance.	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Mid-term test	1.1. Ability to apply probability and queueing theory to practical problems. 1.2. Ability to develop analytical results of key performance measures from first principles. 1.3. Ability to write simulations of queueing systems including evaluation of confidence intervals. 1.4 Ability to obtain link capacity dimensioning in telecommunications networks, and analyze such networks to evaluate their performance.	High	Significant	Moderate	Basic	Not even reaching marginal level
3. Group Learning	In these tasks, students learn together online, solve problem, write code, and share and discuss their work using Canvas/Discussions. These learning activities help the students make progress towards achieving the following learning objectives. 1.1. Ability to apply of probability and queueing theory to practical problems.	High	Significant	Moderate	Basic	Not even reaching marginal level

	1.2. Ability to develop analytical results of key performance measures from first principles. 1.3. Ability to program computer simulations of queueing systems including evaluation of confidence intervals. 1.4 Ability to obtain link capacity dimensioning in telecommunications networks, and analyze such networks to evaluate their performance. Assessment will be based on: self-learning, novelty, initiative, accuracy, contribution, academic ethics, continuous participation and presentation.					

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Examination	1.1. Ability to apply of probability and queueing theory to practical problems. 1.2. Ability to develop analytical results of key performance measures from first principles. 1.4 Ability to obtain link capacity dimensioning in telecommunications networks, and analyze such networks to evaluate their performance.	High	Medium	Low	Not even reaching marginal level
2. Mid-term test	1.1. Ability to apply of probability and queueing theory to practical problems. 1.2. Ability to develop analytical results of key performance measures from first principles. 1.3. Understanding of the principles of queueing simulations and ability to evaluate confidence intervals. 1.4 Ability to find optimal link capacity in telecommunications networks.	High	Medium	Low	Not even reaching marginal level
3. Group Learning	In these tasks, students learn together online, solve problem, write code, and share and discuss their work using Canvas/Discussions. These learning activities help the students make progress towards achieving the following learning objectives.	High	Medium	Low	Not even reaching marginal level

	1.1. Ability to apply of probability and queueing theory to practical problems. 1.2. Ability to develop analytical results of key performance measures from first principles. 1.3. Ability to program computer simulations of queueing systems including evaluation of confidence intervals. 1.4 Ability to obtain link capacity dimensioning in telecommunications networks, and analyze such networks to evaluate their performance. Assessment will be based on: self-learning, novelty, initiative, accuracy, contribution, academic ethics, continuous participation and presentation.				

6. Constructive Alignment with Programme Outcomes

PILO	How the course contributes to the specific PILO(s)
1	In this course, the students will develop and demonstrate ability to understand fundamental performance issues such as throughput, loss and delay of telecommunications networks which will enable them to describe current trends and future evolutions of networking technology.
2	In this course, the students will develop and demonstrate ability to analyze and evaluate the performance of optical and wireless telecommunications technologies. Performance measures will include delay, blocking probability and throughput.
3	In this course, the students will develop and demonstrate ability to apply knowledge of probability, stochastic processes, queueing theory and statistics to analysis, evaluation and dimensioning of telecommunications networks.
4	The focus of the course is on the development of understanding of the fundamentals of probability and queueing theory and the ability to develop new models and analytical results of key queue size and delay statistics from first principles, evaluate performance of telecommunications network and to be able to provision resources in these networks, such that they meet QoS requirements subject to traffic demand. Traffic is described by its statistical behavior and the QoS requirements are packet/ message/ page-download delay and acceptable loss levels. In assessed activities, the students will be required to make decisions on system parameters, such as link capacities and buffer sizes to meet QoS specifications for given traffic load.
5.	In the lectures, tutorials, Group Learning activities, test and exam, students will be challenged with research problems relevant to developments of new telecommunications technologies that are designed to meet QoS requirements of various services. They will be required to develop models which can lead to a solution of such problems.
6	Although this is not a direct part of the assessment, lectures and tutorials are interactive and students are given many opportunities to talk in public and improve their oral communications skills. Part of the assessment of the Group Learning report is its presentation. Also the Group learning activities themselves that involve discussions and interactions help the students improve their written and communication skills.

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

probability, stochastic processes, queueing theory; teletraffic; Little's Formula, Markov chains; M/M/1, M/M/∞, M/M/k, M/M/k/k; queues with finite buffer, state dependent queueing models; D/D/1, D/D/k, D/D/k/k, M/G/1, processor sharing, priority queues; queueing networks; discrete event simulations; Markov chain simulations, confidence intervals, numerical algorithms; traffic modelling; telecommunications applications to circuit and packet switched networks, and to mobile networks.

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Moshe Zukerman, "Introduction to Queueing Theory and Stochastic Teletraffic Models", (Classnotes) It is available on CityU Website: http://www.ee.cityu.edu.hk/~mzu/classnotes.pdf

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	D. Bertsekas and R. Gallager, Data Networks, Prentice Hall, Englewood Cliff, New Jersey 1992.