EE6610: QUEUEING THEORY WITH TELECOMMUNICATIONS APPLICATIONS

Effective Term
Semester A 2026/27

Part I Course Overview

Course Title
Queueing Theory with Telecommunications Applications

Subject Code
EE - Electrical Engineering
Course Number
6610

Academic Unit
Electrical Engineering (EE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
CS2363 Computer Programming, or equivalent, and, either EE3313 Applied Queueing Systems or MA3160 Probability &Stochastic Processes; or equivalent.

Equivalent Courses
EE8405 Queueing Theory with Telecommunications Applications

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to provide students with an understanding of probability and queueing models, their analyses, simulation, and numerical algorithms, and their use in modelling practical present and future telecommunications traffic and networking applications. An important focus is on how such models can lead to cost-effective provision of telecommunications services. This course also aims to stimulate students' appreciation of 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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Apply probability and queueing theory to practical problems.		x		
2	Develop analytical results of key performance measures, such as blocking probability and queue size and delay statistics, from first principles.		x	x	x
3	Use tools and program computer simulations of queueing systems including evaluation of confidence intervals.		x		
4	Calculate link capacity dimensioning in telecommunications networks, and analyze such networks to evaluate their performance.		x	x	x

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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Provide knowledge of the general concepts of probability and queueing modelling. All aspects of the course are covered.	1, 2, 3, 4	2 hrs/wk
2	Tutorials	With help from the lecturer, TAs, tutors and their peers, students improve their achievements in all 4 CILOs.	1, 2, 3, 4	1 hr/wk

3	Group Learning	This activity (see details below) facilitates students' achievement of all 4 CILOs.	1, 2, 3, 4	
4	Tests and final exam and related preparations	All four CILOs are tested and examined so their preparations facilitate students' achievements of these 3 CILOs.	1, 2, 3, 4	

Additional Information for LTAs

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 the 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 (problems 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 of the Group Learning weekly activities and report is based on novelty, initiative, accuracy, contribution, academic ethics, 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.

The use of GenAI is allowed in Group Learning and also in the part of the test and exam where all online tools are allowed to be used.

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Mid-term test	1, 2, 3, 4	15	See comments on use of Gen AI	Yes
2	Group Learning that involves assessment of weekly participation and contributions, and final report	1, 2, 3, 4	35	See comments on use of Gen AI	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Mid-term test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Group Learning (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

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.
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.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B) Medium

Marginal

(B-, C+, C) Low

Failure

(F) Not even reaching marginal level

Assessment Task

Mid-term test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B) Medium

Marginal

(B-, C+, C) Low

Failure

(F) Not even reaching marginal level

Assessment Task

Group Learning (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

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.
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.

Excellent

(A+, A, A-) High

Good

(B+, B) Medium

Marginal

(B-, C+, C) Low

Failure

(F) Not even reaching marginal level

Additional Information for AR

Constructive Alignment with Programme Outcomes

PILO 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.

PILO 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.

PILO 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.

PILO 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.

PILO 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.

PILO 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

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.

Reading List

Compulsory Readings

	Title
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

Additional Readings

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