

## Queueing Theory (E011320)

**Course size** *(nominal values; actual values may depend on programme)*

**Credits 6.0**

**Study time 180 h**

**Course offerings in academic year 2024-2025**

A (semester 1)	English	Gent
C (semester 1)	Dutch	Gent

**Lecturers in academic year 2024-2025**

Walraevens, Joris	TW07	lecturer-in-charge
Wittevrongel, Sabine	TW07	co-lecturer

**Offered in the following programmes in 2024-2025**

	<b>crdts</b>	<b>offering</b>
<a href="#">Master of Science in Teaching in Science and Technology(main subject Mathematics)</a>	6	A
<a href="#">Master of Science in Business Engineering(main subject Data Analytics)</a>	6	A
<a href="#">Master of Science in Business Engineering (Double Degree)(main subject Data Analytics)</a>	6	A
<a href="#">Master of Science in Industrial Engineering and Operations Research(main subject Manufacturing and Supply Chain Engineering)</a>	6	A
<a href="#">Master of Science in Business Engineering (Double Degree)(main subject Operations Management)</a>	6	A
<a href="#">Master of Science in Business Engineering(main subject Operations Management)</a>	6	A
<a href="#">Master of Science in Industrial Engineering and Operations Research(main subject Transport and Mobility Engineering)</a>	6	A
<a href="#">Master of Science in Electrical Engineering</a>	6	C
<a href="#">Master of Science in Industrial Engineering and Operations Research</a>	6	C
<a href="#">Master of Science in Mathematics</a>	6	A

**Teaching languages**

English, Dutch

**Keywords**

Queueing systems; Stochastic modeling; Continuous-time and discrete-time models; Performance measures

**Position of the course**

This course introduces basic concepts of classical elementary queueing theory in continuous time, as well as more advanced queueing theory in discrete time. Specifically, the course discusses techniques for the dimensioning of waiting rooms and buffers and for the estimation of loss probabilities, blocking probabilities and delays.

**Contents**

- Introduction: Queues in communication networks and computers; Stochastic modelling; Terminology of queueing systems; Kendall notation.
- Birth-death queueing systems: Poisson arrivals see time averages; Global and detailed balance equations; Erlang's formulas.
- Waiting times: Little's law; Waiting time analysis of first-come-first-served birth-death queueing systems; Laplace-Stieltjes transform approach.
- Networks of queueing systems: Reversibility of Markov chains; Burke's theorem; Jackson networks.
- Quasi-birth-death queueing systems: Phase-type distribution; Markovian arrival process; Numerical solution of quasi-birth-death Markov chains.
- Queues with generally distributed service times: Mean-value analysis; Transform

- analysis; Calculation/approximation of performance measures from transforms.
- Discrete-time queueing models and telecommunications
  - Elementary buffer analysis in discrete time: typical techniques and results
  - Analysis of more advanced buffer models in discrete time (with a more-dimensional state description): correlated arrival processes, variable transmission times, output interruptions, priority systems

### Initial competences

Basic probability theory and statistics; elements of stochastic processes

### Final competences

- 1 To master mathematical solution techniques for queueing problems
- 2 To select the most suitable models, methods and techniques for specific queueing problems
- 3 To assess the performance of queueing systems quantitatively and qualitatively
- 4 To know and apply general operational queueing-theoretic laws

### Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

### Conditions for exam contract

This course unit cannot be taken via an exam contract

### Teaching methods

Seminar, Lecture, Independent work

### Study material

Type: Syllabus

Name: Queueing Theory

Indicative price: € 10

Optional: no

Language : English

Available on Ufora : Yes

Online Available : No

Available through Student Association : Yes

Additional information: English syllabus that is made available in pdf form via the electronic learning platform and that can be purchased in paper form via VTK (price in 2023-2024 was 9,00 euro for members and 12,50 euro for non-members); some additional course material is made available via the electronic learning platform

### References

- M. Harchol-Balter, "Performance Modeling and Design of Computer Systems: Queueing Theory in Action" (Cambridge University Press, 2013)
- L. Kleinrock, "Queueing Systems, Volume 1, Theory" (Wiley, New York, 1975)
- H. Bruneel, B.G. Kim, "Discrete-time models for communication systems including ATM" (Kluwer Academic Publishers, Boston, 1993)

### Course content-related study coaching

### Assessment moments

end-of-term and continuous assessment

### Examination methods in case of periodic assessment during the first examination period

Written assessment with open-ended questions

### Examination methods in case of periodic assessment during the second examination period

Written assessment with open-ended questions

### Examination methods in case of permanent assessment

Assignment

### Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

### Extra information on the examination methods

During the semester, the students are asked to write brief reports for a small number of assignments. These assignments count for 4 of the 20 points of the grade in total.

The exam is a written closed book exam.

**Calculation of the examination mark**

Final score = 80% score PE+20% score NPE