GHENT UNIVERSITY

Course Specifications

From the academic year 2020-2021 up to and including the academic year

Queueing Analysis and Simulation (E011322)

Due to Covid 19, the education and assessment methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

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

Credits 6.0 **Study time 180 h** **Contact hrs** 60.0h

Course offerings and teaching methods in academic year 2021-2022

A (semester 1)	English	Gent	seminar: coached exercises	30.0h
			lecture	30.0h
B (semester 1)	Dutch	Gent	self-reliant study activities	30.0h
			seminar: coached exercises	30.0h

Lecturers in academic year 2021-2022

Walraevens, Joris	TW07	lecturer-in-charge
De Turck, Koen	TW07	co-lecturer

Offered in the following programmes in 2021-2022	**crdts**	**offering**
Bridging Programme Master of Science in Electrical Engineering(main subject Communication and Information Technology)	6	A
Bridging Programme Master of Science in Computer Science Engineering	6	B
Bridging Programme Master of Science in Computer Science Engineering	6	A
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	A
Master of Science in Electromechanical Engineering(main subject Control Engineering and Automation)	6	A
Master of Science in Electromechanical Engineering(main subject Electrical Power Engineering)	6	A
Master of Science in Electromechanical Engineering(main subject Maritime Engineering)	6	A
Master of Science in Electromechanical Engineering(main subject Mechanical Construction)	6	A
Master of Science in Electromechanical Engineering(main subject Mechanical Energy Engineering)	6	A
Master of Science in Computer Science Engineering	6	B
Master of Science in Computer Science Engineering	6	A

Teaching languages

English, Dutch

Keywords

Queueing systems; Stochastic modelling; Performance evaluation of computer and communication systems; Markov chains; Simulation.

Position of the course

This course introduces basic concepts of queueing analysis and simulation for assessing the performance of computer and communication systems. Specifically, the course discusses techniques for dimensioning queues and buffers and for the estimation of loss probabilities, blocking probabilities and delays in such queues.

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.

- 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.
- Networks of queueing systems: Reversibility of Markov chains; Burke's theorem; Jackson networks.
- Pseudo random number generators: Generic description and desirable properties of pseudo random number generators; Linear congruential generators; Inversion method; Box-Mueller algorithm; Acceptance-Rejection method.
- Simulation: Monte Carlo simulation; Simulating trajectories of discrete and continuous-time Markov chains; Discrete-event simulation; Confidence intervals; Batch-means method; Comparison of scheduling disciplines for queues.
- Variance reduction techniques: Antithetic method; Reduction by conditioning; Reduction by control variates; Importance sampling.

Initial competences

Basic probability theory and statistics; elements of stochastic processes in general, and Markov chains in particular

Final competences

1 To master mathematical solution techniques for queueing problems
2 To construct a simulation program and to process simulation results
3 To select the most suitable models, methods and techniques for specific queueing problems
4 To assess the performance of queueing systems quantitatively and qualitatively

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

Lecture, Self-reliant study activities, Seminar: coached exercises

Learning materials and price

Course material: English syllabus + slides (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)

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 examination with open questions

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

Written examination with open questions

Examination methods in case of permanent assessment

Report

Possibilities of retake in case of permanent assessment

examination during the second examination period is not possible

Extra information on the examination methods

During the semester, the students are asked to write a brief report for a small number of short assignments. If the totallity of points they earn on these assignments influences the total points positively, these points are taking into account; otherwise only the points on the exam make up the total score of the students.

Calculation of the examination mark

Final score = maximum(score PE,90%score PE+10% score NPE)