GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2022-2023

Internet of Things (E019170)

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

Credits 6.0	**Study time 180 h**	**Contact hrs**	57.5h

Course offerings and teaching methods in academic year 2022-2023

A (semester 1)	English	Gent	guided self-study	1.25h
			group work	1.25h
			seminar: coached exercises	2.5h
			practicum	25.0h
			lecture	15.0h

Lecturers in academic year 2022-2023

Hoebeke, Jeroen	TWO5	lecturer-in-charge
De Poorter, Eli	TWO5	co-lecturer

Offered in the following programmes in 2022-2023	**crdts**	**offering**
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	A
Master of Science in Computer Science	6	A
Master of Science in Computer Science Engineering	6	A
Master of Science in Computer Science Engineering	6	A
Master of Science in Information Engineering Technology	6	A
Exchange Programme in Computer Science (master's level)	6	A
Exchange Programme Information Engineering Technology	6	A

Teaching languages

English

Keywords

Internet of Things (IoT), embedded systems, wireless networks, embedded web services, positioning, IoT security, open standards.

Position of the course

At an amazing pace, new devices, mainly embedded devices, are being connected to the Internet. This revolution will transform the traditional human-centric internet to an Internet of Things (IoT), thereby enabling a whole new range of intelligent services in domains such as manufacturing, health, smart homes, logistics, etc. The aim of this course is to give insight in the wide variety of platforms, wireless communication technologies and network protocols that are available to realize this Internet of Things.

Contents

1 Introduction to IoT
2 IoT hardware platforms and operating systems:
3 Wireless communication technologies for IoT: physical layer and MAC layer aspects, wireless IoT standards including LPWAN technologies (LoRa, SigFox, IEEE 802.11ah, NB-IoT), IEEE 802.15.4(e), BLE and BLE meshing
4 IP-connected smart objects and networks: IPv6 protocol stack for constrained devices, the 6LoWPAN adaptation layer, routing in multi-hop sensor networks
5 Embedded web services and Web of Things: HTTP for constrained devices, the Constrained Application Protocol, discovery, device management (LWM2M), data models (LWM2M and IPSO)
6 Other relevant standardization bodies and protocols: Open Connectivity

Foundation, publish-subscribe (MQTT), Thread, initiatives of big industrial players, etc.
7 Tracking, tracing and positioning
8 IoT Security: threats and attacks, protection
9 Recent evolutions in IoT: open standards on top of LPWAN, management of constrained networks, Industrial IoT

Initial competences

Having followed with success the bachelor course Communication Networks (E008620), or having followed with success the courses Computernetwerken I: basisprotocollen (E761020) and Computernetwerken II: netwerkbeheer (E761031), or having acquired the envisaged competences through an alternative way.

Final competences

1 To describe the operation of current standards for IoT communication.
2 To understand and discuss the strengths and weaknesses of existing IoT communication solutions
3 To assess the impact of implementation decisions for an IoT system (e.g. choice of communication technology, interaction model, etc.)
4 To design communication protocols tailored to the constraints of embedded devices.
5 To evaluate the performance of an IoT communication solution.
6 To implement, assess and report on a recent IoT technology.
7 To be able to follow and understand future developments in the IoT domain.
8 To translate the requirements of a targeted IoT system into a concrete solution

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

Practicum, Group work, Guided self-study, Lecture, Seminar: coached exercises

Extra information on the teaching methods

- Lecture: chapters 1, 2, 3, 7, 8, 9
- Guided self-study: chapters 4, 5, 6 (knowledge clips)
- Seminar: coached exercises
- Practicum
  - MAC protocol design (online)
  - Low-power wide area networking: LoRaWAN simulation study (online)
  - Embedded web service technology: hands-on
  - Analysis of the IETF protocol stack for embedded devices using simulator (online)
  - Publish-suscribe paradigm using MQTT and Arduino: hands-on
  - Bluetooth Low Energy: hands-on
- Group work
  - Exploration of an IoT topic of choice (3 possible choices)

["*because of COVID19, modified forms of work can be rolled out if this proves necessary*"]

Learning materials and price

Handouts + notes of lectures (made available via the electronic learning platform), videos of chapters 4, 5 and 6 for self-study. Estimated price: 15 EUR.

References

- Fundamentals of Wireless Sensor Networks - Theory and Practice, Wiley, 2010.
- Interconnecting Smart Objects with IP – The Next Internet, J.-P. Vasseur and A. Dunkels, Morgan Kaufmann, 2010.
- Building the Web of Things, Dominique Guinard and Vlad Trifa, 2016.
- Wireless Positioning Technologies and Applications, Second Edition, Alan Bensky, Artech House, 2016.

Course content-related study coaching

- Interactive support through the electronic learning platform (forum, e-mail)

- Personal: through electronic appointment

Assessment moments

end-of-term and continuous assessment

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

Written examination, Open book examination

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

Written examination, Open book examination

Examination methods in case of permanent assessment

Report, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is not possible

Extra information on the examination methods

During examination period
- Part 1: Written closed-book exam
- Part 2: Written open-book exam
- Second chance: possible

During semester:
- Graded practicum
- Graded project work
- Second chance: not possible

Calculation of the examination mark

- Evaluation throughout semester as well as during examination period
- Special conditions
  - Evaluation throughout semester: 40% of the points for the practicum, 10% of the points for the project
  - Evaluation during examination period: 50% of the points
  - Second chance for evaluation throughout the semester is not possible. Points for evaluation throughout semester are transferred in case of second chance.
  - When the student obtains less than 8/20 for the evaluation during the examination period, they can no longer obtain a pass mark for the course unit as a whole. If the total score does turn out to be a mark of ten or more out of twenty, this is reduced to the highest fail mark (i.e. 9/20)