GHENT UNIVERSITY

# Course Specifications

From the academic year 2015-2016 up to and including the

## Computational Solutions of Wave Problems (E022700)

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

Credits 6.0 Study time 180 h Contact hrs 67.5 h

Course offerings and teaching methods in academic year 2018-2019

| | | | |
|---|---|---|---|
| A (semester 2) | English | group work | 25.0 h |
| | | seminar: practical PC room classes | 15.0 h |
| | | lecture | 27.5 h |
| B (semester 2) | Dutch | seminar: practical PC room classes | 15.0 h |
| | | group work | 30.0 h |
| | | guided self-study | 22.5 h |

Lecturers in academic year 2018-2019

| | | |
|---|---|---|
| Botteldooren, Dick | TW05 | lecturer-in-charge |
| Rogier, Hendrik | TW05 | co-lecturer |

| Offered in the following programmes in 2018-2019 | crdts | offering |
|---|---|---|
| Bridging Programme Master of Science in Engineering Physics | 6 | A |
| Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems) | 6 | A |
| European Master of Science in Nuclear Fusion and Engineering Physics | 6 | A |
| European Master of Science in Nuclear Fusion and Engineering Physics | 6 | A |
| Master of Science in Engineering Physics | 6 | A |
| Master of Science in Engineering Physics | 6 | B |

Teaching languages

Dutch, English

Keywords

computational techniques, finite elements, finite differences, integral equations

Position of the course

The student learns about different techniques for solving wave equations mainly by personal contact with these techniques. The course starts from different application domains: electromagnetism, optics, acoustics, to derive a general problem description. Various solution methods are proposed, always refering to typical areas of application. The main focus remains numerical solution of wave-related problems. Other courses will generate insight and forward the knowledge required for designing electromagnetic, optic or acoustic systems.

Contents

- Introduction: Uniform theory of wave propagation and its relation to elektromagnetics, optics, acoustics, ..., Computational methods related to different application areas
- Solutions based on discretising difference equations: Frequency domain solution: finite elements, Pade, ..., Time domain solution: Finite difference time domain, finite volume time domain, ..., Physical boundary conditions and perfectly absorbing boundaries
- Integral equation techniques: Boundary integral methods: Greens functions, Fredholm 1&2, internal resonance, ..., Domain integration techniques
- High frequency approximations: Ray theory and diffraction theory, Basic diffractors

and non-specular reflection on rough and periodic surfaces
- Paraxial approximation: Basic idea, disretisation and spatial fourier transform techniques, wide angle

Initial competences

Wave equations for different areas of application

Final competences

1. Students have a thorough understanding of the possible computational methods for solving wave equations full wave or in approximate form.
2. Students have insight into how wave problems from very different disciplines reduce to a generic problem; they recognize the important parameters for selecting a particular computational solution method; frequency domain - time domain equivalence of boundary conditions; they recognize potential and limitations of ray theory and diffraction theory; emergence of non-specular reflections on periodic and rough surfaces; range of applicability of paraxial approximation of wave problems.
3. Students have the skills required to translate solutions of a generic wave problem to a specific discipline; to pick the most suitable computational technique for solving wave problems; to deploy finite element models in frequency domain, finite element and finite difference models in time domain; they are able to discretise boundary conditions in frequency and time domain approximations; to deploy boundary element approximations; and are able to approximate a wave problem with ray tracing techniques and to solve paraxial equations for typical situations.
4. Students obtain the skills to cooperate and communication within small groups on an open ended problem and learn to plan a joint undertaking that takes several months.
5. Students are able to take design decisions related to a large numerical project.

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

Guided self-study, group work, lecture, seminar: practical PC room classes

Extra information on the teaching methods

Projects; Computer-assisted problem solving; Classroom lectures

Learning materials and price

Annotated slides and additional scientific reading material.

References

see slides

Course content-related study coaching

Evaluation methods

end-of-term evaluation and continuous assessment

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

Open book examination, report

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

Open book examination, report

Examination methods in case of permanent evaluation

Skills test

Possibilities of retake  in case of permanent evaluation

examination during the second examination period is possible in modified form

Extra information on the examination methods

During examination period: oral open-book exam; graded project reports
During semester: graded computer exercises (4) spread over semester starting in third week. Second chance: Possible in adapted form

Calculation of the examination mark

Computer exercises throughout semester 30%, during examination period = discussion of project reports and theoretical questions 70%.