GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Partial Differential Equations (C000802)

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

Credits 6.0 **Study time 165 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 1)	English	Gent	seminar
			lecture

Lecturers in academic year 2024-2025

Ruzhansky, Michael	WE16	lecturer-in-charge
Van Bockstal, Karel	WE16	co-lecturer

Offered in the following programmes in 2024-2025	crdts	offering
Master of Science in Teaching in Science and Technology(main subject Mathematics)	6	A
Master of Science in Mathematics	6	A
Exchange Programme in Mathematics (master's level)	6	A

Teaching languages

English

Keywords

PDE's, modelling, existence and uniqueness of solutions, variational approximation

Position of the course

This course offers an overview of vital topics, problems and solution methods in the study of partial differential equations (PDEs). The following aspects of this theory, which are of particular interest for the different options within the master of mathematics, will be treated in a balanced way: modelling of physical problems with PDÉs and the qualitative analysis of elliptic, parabolic and hyperbolic PDÉs. Each of the problems treated in the course will be approached from these different points of view, each time with the appropriate emphasis.

Contents

1. Ordinary Differential Equations (ODEs)
- Laplace and Fourier transform method for solving ODEs

2. Basics for PDEs
- Introduction to PDEs, well-posedness
- Classification linear PDEs second-order: elliptic, parabolic, hyperbolic PDEs
- Derivation of PDEs

3. Function spaces
- Regularity of domain
- Weak derivative
- Sobolev spaces, embedding theorems, Green's formulas, Poincarè-Friedrichs' inequality

4. Elliptic problems
- Harmonic functions: properties, Poisson equation, Green function ball
- Variational framework: derivation weak formulation, existence and uniqueness weak solution (Lax-Milgram lemma), regularity solution, examples
- Spectral method: Helmholtz equation, Sturm-Liouville eigenvalue problem
- Galerkin method

5. Parabolic problems
- Derivation heat equation from physical conservation laws, porous media flow
- Maximum principle for heat operator
- Cauchy problem 1D
- Method of separation of variables for heat equation
- Rothe's method: well-posedness heat equation

6. Hyperbolic problems
- Derivation vibrating string
- Method of characteristics for first-order hyperbolic PDEs
- Cauchy problem 1D
- Method of separation of variables for wave equation
- Rothe's method: well-posedness wave equation

Initial competences

Mathematical analysis, linear algebra, function spaces

Final competences

1 The students are able to make a distinction between respectively parabolic, hyperbolic and elliptic PDEs, their respective boundary and initial conditions, and the behaviour of the solution.
2 The students are able to model basic physical problems with PDEs.
3 The students are able to apply and analyse the theoretical results for each type of PDE and to employ the classical and variational techniques for solving PDEs.
4 The students are able to apply basic solution methods for solving PDEs.

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: Syllabus'
Indicative price: € 10
Optional: no

Type: Other

Name: Matlab-files, Maple-worksheets and Java applets'
Indicative price: Free or paid by faculty
Optional: no
Additional information: All the material will be available via Ufora.

References

Lecture notes will be provided. Other reference works are
Principles of Mathematical Modeling - Ideas, Methods, Examples. A.A. Samarskii & A.P. Michaelov, Taylor & Francis, 2002.
Partial Differential Equations, Methods and Applications. R.C. McOwen, Prentice Hall, 2003
Partial differential equations. L.C. Evans, American Mathematical Society, 1998.

Course content-related study coaching

- Individual coaching by appointment
- interactive coaching via Ufora: Forum (students among themselves, students-lecturer)

Assessment moments

continuous assessment

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

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

Examination methods in case of permanent assessment

Participation, Presentation, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible

Calculation of the examination mark

Non-periodic evaluation 100%