# MATH-305 Introduction to partial differential equations

Nobile Fabio				
Cursus	Sem.	Туре	Language of	English
Mathematics	BA5	Opt.	teaching	Linglish
			Credits	5
			Session	Winter
			Semester	Fall
			Exam	Oral
			Workload	150h
			Weeks	14
			Hours	4 weekly
			Lecture	2 weekly
			Exercises	2 weekly
			Number of positions	

#### Summary

This is an introductory course on Elliptic Partial Differential Equations. The course will cover the theory of both classical and generalized (weak) solutions of elliptic PDEs.

#### Content

• Laplace equation; mean value property; maximum principle; fundamental solution; Dirichlet problem; Poisson integral and Newtonian potential; regularity theory in Holder spaces;

· General second order linear elliptic equations; maximum principle; a priori bounds;

• Sobolev spaces; weak derivatives and their properties; density results; extension results; traces; imbedding theorems; Poincaré inequalities;

• Weak solutions of general elliptic equations; Lax Milgram theorem; existence and uniqueness results; regularity theory in Sobolev spaces; compactness results and non coercive problems;

#### Learning Prerequisites

Required courses Analysis I-IV

Recommended courses Measure and Integration; Functional Analysis I

#### Learning Outcomes

By the end of the course, the student must be able to:

- Classify different types of PDEs
- Define different notions of solutions
- Analyze the properties of solutions of PDEs
- Prove existence and regularity results of solutions of elliptic PDEs

## **Transversal skills**

- Use a work methodology appropriate to the task.
- Demonstrate a capacity for creativity.



• Demonstrate the capacity for critical thinking

#### **Teaching methods**

Ex cathedra lectures, exercises in classroom

#### **Assessment methods**

Oral exam

Dans le cas de l'art. 3 al. 5 du Règlement de section, l'enseignant décide de la forme de l'examen qu'il communique aux étudiants concernés

## Resources

Virtual desktop infrastructure (VDI)

No

## Bibliography

• David Gilbarg, Niel S. Trudinger, Elliptic Partial Differential Equations of Second Order, Springer-Verlag, 2nd edition, 2001.

• Lawrence C. Evans. Partial Differential Equations, AMS-Graduate Studies in Mathematics, 2nd edition, 2010.

- Haïm Brézis, Functional Analysis, Sobolev Spaces and Partial Differential Equations, Springer, 2011
- Fritz John, Partial Differential Equations, Springer-Verlag, 4th edition, 1982

## Ressources en bibliothèque

- Partial Differential Equations / Fritz John
- Functional Analysis, Sobolev Spaces and Partial Differential Equation / Haïm Brézis
- Partial Differential Equations / Lawrence C. Evans
- Elliptic Partial Differential Equations of Second Order / David Gilbarg & Niel S. Trudinger

#### **Notes/Handbook**

Lecture notes available on the webpage

#### Moodle Link

• https://go.epfl.ch/MATH-305

#### **Prerequisite for**

• Master courses on theory of PDEs: Equations aux dérivées partielles d'évolution, Calculus of variations, Optimal Transport, Dispersive PDEs, Theory of stochastic calculus, Nonlinear Schrödinger equations, Distributions and interpolation spaces; Introduction to general relativity; Introduction to stochastic PDEs

• Bachelor / Master courses on numerical approximation of PDEs: Numerical Approximation of PDEs; Numerical methods for conservation laws; Computational finance; Numerical integration of stochastic differential equations; Numerics for fluids, structures & electromagnetics;