

34963 - ACPDE - Advanced Course in Partial Differential Equations

Coordinating unit:	200 - FME - School of Mathematics and Statistics
Teaching unit:	749 - MAT - Department of Mathematics
Academic year:	2017
Degree:	MASTER'S DEGREE IN ADVANCED MATHEMATICS AND MATHEMATICAL ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits:	7,5
Teaching languages:	English

Teaching staff

Coordinator:	XAVIER CABRE VILAGUT
Others:	Segon quadrimestre: XAVIER CABRE VILAGUT - A MATTEO COZZI - A

Prior skills

Basic knowledge of Partial Differential Equations.
Basic knowledge of Mathematical Analysis (undergraduate level).

Requirements

Undergraduate courses in Partial Differential Equations and in Mathematical Analysis.

Degree competences to which the subject contributes

Specific:

1. RESEARCH. Read and understand advanced mathematical papers. Use mathematical research techniques to produce and transmit new results.
2. MODELLING. Formulate, analyse and validate mathematical models of practical problems by using the appropriate mathematical tools.
3. CALCULUS. Obtain (exact or approximate) solutions for these models with the available resources, including computational means.
4. CRITICAL ASSESSMENT. Discuss the validity, scope and relevance of these solutions; present results and defend conclusions.

Transversal:

5. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
6. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
7. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
8. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
9. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

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Teaching methodology

Classes will combine theoretical aspects and proofs with resolution of concrete problems and exercises. Further reading from the bibliography will be given often.

Learning objectives of the subject

Understand the classical methods to solve the Laplace, heat, and wave equations.
Understand the role of Sobolev norms and compact embeddings to solve PDEs and find spectral decompositions.
Learn the main methods available to solve nonlinear PDEs, through simple cases.

Study load

Total learning time: 187h 30m	Hours large group:	60h	32.00%
	Self study:	127h 30m	68.00%

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Content

Classical methods for the Poisson and heat equations	Learning time: 47h Theory classes: 15h Self study : 32h
Description: Maximum principles and Green's functions for the Poisson and heat equations.	
Sobolev spaces and variational methods	Learning time: 47h Theory classes: 15h Self study : 32h
Description: Basic properties of Sobolev spaces. Weak or variational formulation of boundary problems for linear elliptic PDEs.	
Evolution equations	Learning time: 46h 45m Theory classes: 15h Self study : 31h 45m
Description: Parabolic equations. Galerkin method. Semigroups. Nonlinear conservation laws.	
Introduction to nonlinear PDEs	Learning time: 46h 45m Theory classes: 15h Self study : 31h 45m
Description: Calculus of Variations. Nonlinear eigenvalue problems. Semi-linear elliptic equations.	

Qualification system

The evaluation of the course is based:

- on the weekly resolution of problems proposed in class (15%);
- a midterm exam (35%);
- a final comprehensive exam (50%).
- eventually, there could be the possibility of a final project in order to improve the grade.
- the active participation during the course will be a requirement for the evaluation of the final exam.

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Bibliography

Basic:

Evans, Lawrence Craig. Partial differential equations. Providence, Rhode Island: American Mathematical Society, 1998. ISBN 0821807722.

Salsa, Sandro. Partial differential equations in action : from modelling to theory [on line]. Milan: Springer, 2008 Available on: <<http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10231792&p00>>. ISBN 9788847007512.

Brézis, H. Análisis funcional : teoría y aplicaciones. Madrid: Alianza, 1984. ISBN 8420680885.

Complementary:

Struwe, Michael. Variational methods : applications to nonlinear partial differential equations and hamiltonian systems [on line]. 2nd rev. and substantially expanded ed. Berlin: Springer, 1996 Available on: <<http://dx.doi.org/10.1007/978-3-540-74013-1>>. ISBN 3540520228.

Gilbarg, David; Trudinger, Neil S. Elliptic partial differential equations of second order. 2nd ed., rev. third printing. Berlin: Springer-Verlag, 1998. ISBN 354013025X.

Zuily, C. Problems in distributions and partial differential equations [on line]. Paris: North-Holland, 1988 Available on: <<http://site.ebrary.com/lib/upcatalunya/detail.action?docID=10259031>>.

Necas, Jindrich. Introduction to the theory of nonlinear elliptic equations. Chichester: John Wiley & Sons, 1986. ISBN 0471908940.