



COURSE PROGRAMME

1. Information about the programme

1.1 University	University "Alexandru Ioan Cuza" of Iasi
1.2 Faculty	Faculty of Mathematics
1.3 Department	Department of Mathematics
1.4 Domain	Mathematics
1.5 Cycle	Masters
1.6 Programme / Qualification	Applied Mathematics

2. Information about the course

2.1 Course Name	Numerical analysis of PDE						
2.2 Course taught by	Assoc. Prof. PhD. IONUT MUNTEANU						
2.3 Seminary / laboratory taught by	Assoc. Prof. PhD. IONUT MUNTEANU						
2.4 Year	I	2.5 Semester	II	2.6 Type of evaluation*	E	2.7 Course type**	Op

*E - Exam / C - Colloquium / V - Verification

**OB - Obligatory / OP - Optionally / F - Facultative

3. Total hours (estimated per semester and activities)

3.1 Number of hours per week	4	3.2 course	2	3.3 seminary/ laboratory	2
3.4 Total number of hours	56	3.5 course	28	3.6 seminary/ laboratory	28
Distribution					hours
Individual study using textbooks, course notes, bibliography items, etc.					60
Supplementary study (library, on-line platforms, etc.)					25
Individual study for seminary/laboratory, homeworks, projects, etc.					30
Tutoring					0
Examination					4
Other activities					0
3.7 Total hours of individual activity*					119
3.8 Total hours per semester					175
3.9 Credit points					7

4. Pre-requisites - Curriculum (if necessary)

Capitole speciale de analiza functionala, Ecuatii cu derivate partiale (curs Master, anul I)
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5. Conditions (if necessary)

5.1 Course	Amfiteatru/Sala de curs
5.2 Seminary / Laboratory	Laborator de informatica

6. Objectives

Insusirea de catre studenti a metodei elementului finit pentru analiza numerica a problemelor eliptice, parabolice si hiperbolice si implementarea algoritmilor studiati in FreeFem (mediu de programare dedicat, <http://www.freefem.org/>)

La finalizarea cu succes a acestei discipline, studenții vor fi capabili să:

§ Explice ideile principale ce stau la baza analizei numerice a ecuatiilor cu derivate partiale prin metoda elementului finit;

§ Descrie metoda elementului finit si rezultatele fundamentale corespunzatoare de analiza numerica a ecuatiilor cu derivate partiale; § Utilizeze mediul de programare FreeFem pentru simularea rezultatelor teoretice si implementarea algoritmilor studiati;

§ Analizeze situatii concrete pentru care sa fie capabili sa aplice metodele studiate la curs

7. Specific competencies/Learning outcomes

- conducts scientific research
- communicates scientific findings
- promotes knowledge transfer
- carries out interdisciplinary research activities

8. Contents

8.1 Course	Teaching methods	Remarks (number of hours, references)
Introducere. Prezentarea generala a teoriei variationale a ecuatiilor cu derivate partiale (recapitulare a materiei studiate anterior) si a metodei elementului finit.	Expunere, problematizare, demonstratia	2 [1,3]
Probleme eliptice abstracte. Formularea variationala (T. Lax-Milgram). Metoda elementului finit si estimarea erorii.	Expunere, problematizare, demonstratia	4 [1,2,3]
Spatii Sobolev si teoremele fundamentale de scufundare, de urma, de compactitate a operatorilor de scufundare si de urma. Inegalitati de tip Poincare.	Expunere, problematizare, demonstratia	2 [1,2,3]
Probleme eliptice la limita cu conditii Dirichlet, Neumann, Robin (mixt). Existenta si regularitatea solutiilor.	Expunere, problematizare, demonstratia	4 [1,2,3]
Elemente finite Lagrange. Elemente finite simpliciale (elementele P1, P2), estimarea erorii la interpolare cu elemente finite.	Expunere, problematizare, demonstratia	4 [1,2,3]
Analiza numerica a problemelor eliptice la limita. Estimarea erorii.	Expunere, problematizare, demonstratia	2 [1,2,3]
Probleme spectrale asociate operatorilor eliptici pe domenii marginite	Expunere, problematizare, demonstratia	2 [1,2,3]
Analiza numerica a problemelor spectrale prin metoda elementului finit	Expunere, problematizare, demonstratia	2 [1,2,3]
Problema mixta pentru ecuatii parabolice. Existenta si regularitatea solutiei	Expunere, problematizare, demonstratia	2 [1,2,3]
Analiza numerica a ecuatiilor diferentiale de ordinul I. Metode explicite si implicite cu un pas. Analiza consistentei, stabilitatii, convergentei. (recapitulare).	Expunere, problematizare, demonstratia	2 [1,2,3]
Transformata Laplace, Transformata Fourier. Aplicatii in rezolvarea ecuatiilor diferentiale	Expunere, problematizare, demonstratia	2 [1]

Bibliography

1. Gheorghe Aniculaesei, Constantin Ilioi, Ecuatii cu derivate partiale si aproximare numerica, Editura Universitatii „Al.I.Cuza”
2. Raviart, P.-A.; Thomas, J.-M. Introduction à l'analyse numérique des équations aux dérivées partielles. Masson, Paris, 1983
3. F.Hecht, O.Pironneau, A.Le Hyaric, K.Ohtsuka, Freefem++, Laboratoire Jacques-Louis Lions, Univ. Pierre et Marie Curie, Paris. www.freefem.org " "

8.2 Seminary / Laboratory	Teaching methods	Remarks (number of hours, references)
Ecuatii cu derivate partiale. Recapitulare. Metoda separarii variabilelor pentru probleme eliptice. Introducere in FreeFem	exercitiu	2 ore [1,2]
Ecuatii cu derivare partiale. Recapitulare. Metoda separarii variabilelor pentru probleme parabolice si hiperbolice. Introducere in FreeFem	exercitiu	2 ore [1,2]
Distributii si spatii Sobolev	exercitiu	2 ore [1]
Probleme eliptice la limita cu conditii Dirichlet, Neumann, Robin (mixt). Formularea variationala.	exercitiu	2 ore [1]
Elemente finite Lagrange. Elemente finite simpliciale (elementele P1, P2). Interpolare, integrare numerica, etc. Exemple de probleme eliptice tratate numeric in FreeFem(1).	exercitiu	2 ore [1,2]
Analiza numerica a problemelor eliptice la limita. Estimarea erorii.	exercitiu	2 ore [1]
Probleme spectrale asociate operatorilor eliptici pe domenii marginite	exercitiu	2 ore [1]
Analiza numerica a problemelor spectrale prin metoda elementului finit	exercitiu	2 ore [1]
Problema mixta pentru ecuatii parabolice. Existenta si regularitatea solutiei	exercitiu	2 ore [1]
Analiza numerica a ecuatiilor diferentiale de ordinul I. Metode explicite si implicite cu un pas. Analiza consistentei, stabilitatii, convergentei. (recapitulare).	exercitiu	2 ore [1]
Scheme numerice implicite cu un pas pentru aproximarea problemelor parabolice.	exercitiu	4 ore [1]
Problema mixta pentru ecuatii hiperbolice. Existenta si regularitatea solutiei.	exercitiu	4 ore [1]

Bibliography

1. Gheorghe Aniculaesei si Constantin Ilioi, Ecuatii cu derivate partiale si aporoximare numerica, Editura Metode Univ. Al. de I. Cuza " "
2. F.Hecht, O.Pironneau, A.Le Hyaric, K.Ohtsuka, Freefem++, Laboratoire Jacques-Louis Lions, Univ. Pierre et Marie Curie, Paris. www.freefem.org " "

9. Coordination of the contents with the expectations of the community representatives, professional associations and relevant employers in the corresponding domain

Continutul disciplinei este ales pentru a oferi studentilor o viziune asupra unei varietati de modele matematice exprimate prin ecuatii cu derivate partiale si dobandirea de catre acestia a unor instrumente teoretice si practice de aproximare numerica.

10. Assessment and examination

10.1 Continuous assessment		Percentage (min. 30%)		30	
Course	Assessment type			Practical assessment	
	Percentage			50	
	Failure to pass the continuous assessment results in failure to pass the final assessment			No	
	Assessment methods	Details	Percentage	with reexamination	
		Continuous practical assessment	50%	Yes	
		Project	50%	Yes	
Seminary / Laboratory	Assessment type			Practical assessment	
	Percentage			50	
	Failure to pass the continuous assessment results in failure to pass the final assessment			No	
	Assessment methods	Details	Percentage	with reexamination	
		Continuous practical assessment	50%	Yes	
		Project	50%	Yes	

10.2 Final assessment	Percentage (max. 70%)	70
	Assessment type	Final practical assessment

10.3 Special notes (special situations is assessment)	

10.4 Minimum performance standard	
Nota finala minim 5.□	

Date,
Course coordinator,
Assoc. Prof. PhD. IONUT MUNTEANU

Seminary coordinator,
Assoc. Prof. PhD. IONUT MUNTEANU

Aproval date in the department,

Head of the departament,
Prof. PhD. IONEL DUMITREL GHIBA