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	Scientific computing
2.2 Course taught by	Prof. PhD. IONEL DUMITREL GHIBA/ Specialist ADINA GIORGIANA CIOMAGA
2.3 Seminary / laboratory taught by	Prof. PhD. IONEL DUMITREL GHIBA

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.	30
Supplimentary study (library, on-line platforms, etc.)	30
Individual study for seminary/laboratory, homeworks, projects, etc.	32
Tutoring	0
Examination	2
Other activities	0
3.7 Total hours of individual activity*	94
3.8 Total hours per semester	150
3.9 Credit points	6

4. Pre-requisites - Curriculum (if necessary)

Mathematical Analysis, Linear Algebra, Computer Programming

5. Conditions (if necessary)

5.1 Course	Laboratory room
5.2 Seminary / Laboratory	Laboratory room

6. Objectives

The students -wil be able to use knowledges gained from previous courses taken (linear algebra, mathematical analysis, numerical analysis, optimization) in order to find and/or approximate the solutions of certain real problems, to obtain numerical algorithms, and to implement them. -will be able to generalize the results, when practice will demand. -wil be able to understand the fundamental ideas behind fitting data and apply them in practical situations.

7. Specific competencies/Learning outcomes

• conducts quantitative research • promotes knowledge transfer • carries out interdisciplinary research activities • performs data analysis • uses IT tools

8. Contents

8.1 Course	**Teaching methods**	**Remarks** (number oh hours, references)
INTRODUCTION Classical signal processing operations such as signal transmission, stationary noise removal orpredictive coding are implemented with linear time-invariant operators. (a) Signal/Image Representation and Linear Time-Invariant Filtering (lecture 1)	Questioning, dialogue, lecture, proof	2h
Chapter I. FOURIER TRANSFORM The Fourier transform diagonalizes all linear time-invariant operators, which are the buildingblocks of signal processing. It is therefore not only the starting point of our exploration but thebasis of all further developments. (a) Fourier Transform in L1(R) and L2(R). Examples (lecture 2)(b) Properties: regularity, uncertainty principle and Gibbs phenomena. (lecture 3) (c) Two-dimensional Fourier Transform. (lecture 4)	Questioning, dialogue, lecture, proof	2h 2h 2h
Chapter II. DISCRETE FOURIER TRANSFORM The Fourier transform is discretized for signals of finite size and implemented with a Fast FourierTransform algorithm. (a) Sampling analog signals: Shannon-Whitaker theorem and Aliasing. (lecture 5) (b) Single resolution approximation. Fourier series and their properties. (lecture 6) (c) Discrete Fourier Transform and Fast Fourier Transform (FFT) algorithm (lecture 7)	Questioning, dialogue, lecture, proof	2h 2h 2h
Chapter III. WAVELET TRANSFORM analyze signal structures of very different sizes, it is necessary to use time-frequency atoms.The wavelet transform decomposes signals over dilated and translated wavelet. (a) Wavelet Transform. Examples (lecture 8) (b) Dyadic Wavelet Transform (lecture 9) (c) Regularity properties and reconstruction from singularities (lecture 10)	Questioning, dialogue, lecture, proof	2h 2h 2h
Chapter IV. DISCRETE WAVELET TRANSFORMTwo-dimensional wavelet bases are discretized to define orthonormal bases of images includingN pixels. Wavelet coefficients are calculated with the fast O(N) algorithm. (a) Multiresolution approximations with wavelet bases: Mallat-Meyer theorem (lecture 11) (b) Discrete Wavelet Transforms (lecture 12) (c) Fast Wavelet Transform algorithm (lecture 13)	Questioning, dialogue, lecture, proof	2h 2h 2h

8.1 Course	**Teaching methods**	**Remarks** (number oh hours, references)
Conclusion (a) Final overview, Real Life applications and New Research Directions. (lecture 14)	Questioning, dialogue, lecture, proof	2h

Bibliography
1. E. Stein and R. Shakarchi - Fourier Analysis. An introduction, Princeton University Press, 2003. 2. S. Mallat - A Wavelet Tour of Signal Processing. Academic Press, 1999.

8.2 Seminary / Laboratory	**Teaching methods**	**Remarks** (number oh hours, references)
INTRODUCTION Classical signal processing operations such as signal transmission, stationary noise removal orpredictive coding are implemented with linear time-invariant operators. (a) Signal/Image Representation and Linear Time-Invariant Filtering (lecture 1)	Questioning, dialogue, exercises	2h
Chapter I. FOURIER TRANSFORM The Fourier transform diagonalizes all linear time-invariant operators, which are the buildingblocks of signal processing. It is therefore not only the starting point of our exploration but the basis of all further developments. (a) Fourier Transform in L1(R) and L2(R). Examples (lecture 2)(b) Properties: regularity, uncertainty principle and Gibbs phenomena. (lecture 3) (c) Two-dimensional Fourier Transform. (lecture 4)	Questioning, dialogue, exercises	2h 2h 2h
Chapter II. DISCRETE FOURIER TRANSFORM The Fourier transform is discretized for signals of finite size and implemented with a Fast FourierTransform algorithm. (a) Sampling analog signals: Shannon-Whitaker theorem and Aliasing. (lecture 5) (b) Single resolution approximation. Fourier series and their properties. (lecture 6) (c) Discrete Fourier Transform and Fast Fourier Transform (FFT) algorithm (lecture 7)	Questioning, dialogue, exercises	2h 2h 2h
Chapter III. WAVELET TRANSFORMo analyze signal structures of very different sizes, it is necessary to use time-frequency atoms.The wavelet transform decomposes signals over dilated and translated wavelet. (a) Wavelet Transform. Examples (lecture 8) (b) Dyadic Wavelet Transform (lecture 9) (c) Regularity properties and reconstruction from singularities (lecture 10)	Questioning, dialogue, exercises	2h 2h 2h
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Conclusion (a) Final overview, Real Life applications and New Research Directions. (lecture 14)	Questioning, dialogue, exercises	2h

Bibliography

1. E. Stein and R. Shakarchi - Fourier Analysis. An introduction, Princeton University Press, 2003.
2. S. Mallat - A Wavelet Tour of Signal Processing. Academic Press, 1999.

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

This course will be introducing students to Fourier and Wavelet Transform, with applications in signal and image processing. Fourier and wavelet bases decompose signals over oscillatory waveforms that reveal many signal properties, and provide a path to sparse representations. Discretized signals often have a very large size N ≥ 106, and thus can only be processed by fast algorithms, typically implemented with O(NlogN) operations and memories. Fourier and wavelet transforms illustrate the deep connection between well structured mathematical tools and fast algorithms.

10. Assessment and examination

<table>
<tr><td colspan="2">10.1 Continuous assessment</td><td colspan="3">Percentage (min. 30%)</td><td>50</td></tr>
<tr><td rowspan="5">Course</td><td colspan="4">Assessment type</td><td></td></tr>
<tr><td colspan="4">Percentage</td><td>0</td></tr>
<tr><td colspan="4">Failure to pass the continuous assessment results in failure to pass the final assessment</td><td></td></tr>
<tr><td rowspan="2">Assessment methods</td><td>Details</td><td colspan="2">Percentage</td><td>with reexamination</td></tr>
<tr><td></td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="6">Seminary / Laboratory</td><td colspan="4">Assessment type</td><td>Mixed assessment</td></tr>
<tr><td colspan="4">Percentage</td><td>100</td></tr>
<tr><td colspan="4">Failure to pass the continuous assessment results in failure to pass the final assessment</td><td>No</td></tr>
<tr><td rowspan="3">Assessment methods</td><td>Details</td><td colspan="2">Percentage</td><td>with reexamination</td></tr>
<tr><td>Current assessment</td><td colspan="2">50</td><td>No</td></tr>
<tr><td>Homework</td><td colspan="2">50</td><td>No</td></tr>
</table>

10.2 Final assessment	Percentage (max. 70%)	50
	Assessment type	Final mixed assessment

10.3 Special notes (special situations is assessment)

Homework & Labs
There will be TWO set problems to be written and submitted for grading, and TWO labs that will be evaluated in class.

It is essential for students to complete all of the homework assignments and labs. The purpose of homework is for you to practice the concepts covered in class. The purpose of labs is to practice concepts as they would be used in the 'real-world', using Python. If you need or desire an extension on any homework or lab for any reason, contact your instructor in a timely fashion, as permitted by the need. There is no guarantee that you will receive an extension on any assignment, so plan your schedule carefully.

Finally, you are encouraged to work with others on homeworks. Mathematics is a social activity! However, do not simply use others to do your work but rather use others to help work through and engage in the concepts. If you work with others on written homeworks or labs, indicate on your assignment with whom you worked. Plagiarism is unacceptable and will result in a zero grade for all persons involved, and will result in serious academic repercussions.

Exams
There will be ONE final exam, composed of two parts.
i) The theoretical part will be given during a two-hour block, and you are expected to solve some problems, employing concepts covered in class. For this part, you are not permitted to use any outside materials, resources, or electronic devices (including but not limited to mobile phones, smartwatches, etc., but not including a calculator) on the exam.
(ii) The practical part will be given during a one-hour block where you will solve a problem with random data, implement an algorithm and then discuss the solution with an evaluator. For this part, you are permited access (and restricted) to course labs and lecture notes.
The exact time and location will be announced later in the semester. You are expected to be present, seated, and ready to take the exam before the exam begins. There will be one make-up exam. If a student has a conflict with another final exam, the student must contact their instructor in advance in order to have it resolved.

Phone and Device Policies
Following the Mathematics Department guidelines, all electronic devices should be turned off and put away during class. Use of such devices can result in dismissal from class. If there is an issue which requires you to need a phone in class, discuss this with your instructor.

10.4 Minimum performance standard
Grading The course grade (N) is given by the following formula N = (Hw1 + Hw2)/4 + (Lab1 + Lab2)/4 + F/2 where Hw is a homework grade, Lab is a lab grade and F is the final exam grade.

Date,

Course coordinator,
Prof. PhD. IONEL DUMITREL GHIBA/ Specialist ADINA GIORGIANA CIOMAGA

Seminary coordinator,
Prof. PhD. IONEL DUMITREL GHIBA

Aproval date in the department,

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