STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Numerical methods		**1010805111010831581**
Field of study	Profile of study (general academic, practical)	Year /Semester
Electronics and Telecommunications	**general academic**	**1 / 1**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
-	**English**	**obligatory**
Cycle of study:	Form of study (full-time,part-time)	
Second-cycle studies	**part-time**	
No. of hours		No. of credits
Lecture: **15** Classes: **15** Laboratory: **-** Project/seminars: **-**		**5**
Status of the course in the study program (Basic, major, other)	(university-wide, from another field)	
basic	**from field**	
Education areas and fields of science and art		ECTS distribution (number and %)
technical sciences **Technical sciences**		**5 100%** **5 100%**

Responsible for subject / lecturer:

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Electronics and Telecommunications
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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	K1_W01 Has a systematic knowledge of mathematical analysis, algebra and theory of probability. K1_W09 Knows the principles of construction of computer programs ; has knowledge from the area of computing science; knows the syntax of C, C++, C#, MatLab.
2	**Skills**	K1_U01 Is able to extract information from Polish or English language literature, databases and other sources. Is able to synthesize gathered information, draw conclusions, and justify opinions. K1_U13 Is able to write software for basic computational algorithms, using popular programming languages (e.g. Matlab, C). Uses high level programming languages: C, C++, C#, Matlab. Is able to write and run programs to solve selected problems in electronics and telecommunication. Is able to conduct simulation experiments to evaluate parameters of circuits, systems and networks.
3	**Social competencies**	K1_K01 Is aware of the limitations of his/her current knowledge and skills; is committed to further self-study. K1_K02 Demonstrates responsibility and professionalism in solving technical problems. Is able to participate in collaborative projects.

Assumptions and objectives of the course:

After taking this course, students should be able to:

1. Apply standard techniques to analyze key properties of numerical algorithms such as stabilityand convergence,
2. Understand and analyze common pitfalls in numerical computing such as ill-conditioning andInstability,
3. Perform data analysis efficiently and accura

tely using data fitting methods,

4. Derive and analyze numerical methods for ODEs and PDEs,
5. Perform optimization using well-established algorithms,
6. Implement a range of numerical algorithms efficiently in Matlab.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Has extended, in-depth knowledge of those branches of mathematics which are used in formulating and solving problems in electronic and telecommunications. - [K2_W00]

2. Has a systematic knowledge, with the necessary theoretical background, of optimization methods used in solving engineering problems. - [K2_W03]

3. Is conversant with numerical methods used in electronics and telecommunication. - [K2_W07]

4. Has a systematic, detailed knowledge, together with necessary mathematical background, of advanced methods of digital signal processing. - [K2_W09]

Skills:

1. Is able to communicate freely in English. Is able to discuss professional matters in English; is able to use knowledgeably English language sources (books, technical and scientific journals, application notes, catalogues, instructions, standards, etc.). - [K2_U01]

2. Is able to prepare a scientific paper or technical report and give a presentation (in English or in Polish) on solving a problem in the area of electronics and/or telecommunication; is able to participate in a discussion related to the presented problem. - [K2_U02]

3. Is able to select adequate numerical methods and simulation methods to solve typical tasks related to analysis, design and optimization of systems and computational tasks in telecommunication. - [K2_U09]

4. Is able to design and implement algorithms for solving numerical problems. - [K2_U11]

Social competencies:

1. Is able to act as a formal head of a small group of co-workers; is able to lead a small team. - [K2_K01]

2. Is aware of the limitations of his/her current knowledge and skills; is committed to lifelong learning. - [K2_K04]

3. Is aware of the necessity to approach solving technical problems with responsibility and professionalism. - [K2_K05]

Assessment methods of study outcomes

Final project. Students will be required to form teams and to propose a problem drawn from an application area of their choice. The project should make use of concepts covered in the course. Each group will develop Matlab-based software to solve their problem, and also to submit a report that includes a mathematical analysis of their methodology based on the theoretical tools learned in the course.

Course description

This course will emphasize the development of numerical algorithms to provide solutions to common problems formulated in science and engineering. The primary objective of the course is to develop the basic understanding of the construction of numerical algorithms, and perhaps more importantly, the applicability and limits of their appropriate use. The emphasis of the course will be the thorough study of numerical algorithms to understand (i) the guaranteed accuracy that various methods provide, (2) the efficiency and scalabili

ty for large scale systems. and (3) issues of stability. Topics include the standard algorithms for numerical computation: root finding for nonlinear equations, interpolation and approximation of functions by simpler computational building blocks (for example-polynomials and splines), numerical differentiation and divided differences, numerical quadrature and integration, numerical solutions of ordinary differential equations and boundary value problems, numerical optimization and regularization algorithms, neural networks, genetic and evolutionary algorithms, gradient based optimization methods. An important component of numerical analysis is computational implementation of algorithms which are developed in the course in order to observe first hand the issues of accuracy, computational work effort, and stability. Exercises will include computational experiments in a programming language of the student's choice. One class lecture will be devoted to a high level pseudo-code type programming language (Matlab) which will suffice in case students have not had prior programming experience. Attendence is required and the exams will be over the lectures and homework.

Basic bibliography:

1. Numerical Methods for Scientists and Engineers by Richard Hamming

2. A.Quarteroni, R.Sacco, F.Saleri, Numerical mathematics, Springer, 2002.

3. A.Quarteroni, F.Saleri, Scientific Computing with Matlab and Octave, Springer, 2006

4. http://kstio.com/nm

Additional bibliography:

1. G. R. Fulford, P. Forrester, A. Jones, Modelling with Differential and Difference Equations, Cambridge University Press, 1997

Result of average student's workload

Activity	Time (working hours)

1. Participation in lectures	15
2. participation in laboratory exercises	15
3. literature studies	25
4. preparation for the exam	15
5. numerical methods implementation	30

Student's workload		
Source of workload	**hours**	**ECTS**
Total workload	125	5
Contact hours	35	2
Practical activities	45	3