Course NUMERICAL ANALYSIS AND OPTIMISATION

Basic Information

This is a course, which contributes to MSc award in Mathematics

Duration	**216 hours (6 ECTS)**
Starting date	February 1st
Study credits	6 ECTS credits
Language of instruction	English level B1(European Framework of Reference of Communicative Skills)
Academic requirements	– BSc degree in Mathematics, Physics, Computer Science, Engineering or equivalent (a copy of your diplomas from previous university studies and transcripts of completes courses and grades) – Skype interview

Course Description

The course "Numerical Analysis and Optimisation" is devoted to the study of numerical and optimisational algorithims as well as their theoretical basis. This course bases on the previous course on numerical linear algebra and provides the base for future courses on mathematical modelling.

We discuss the transition from a real world scientific or technical problem to a numeric or optimisational problem and modern approaches and algorithms to solve them. We also study theoretical methods to analyze the problems and solutions.

Special Features of the Course

The aim of the course is to immediately enable the students to employ numeric algorithms in their investigations. For that sake we try out the algorithms in programming environments, such as Matlab/Octave, Maxima, depending on which is more appropriate for a particular problem.

A lot of technical details of robust implementation of the algorithms are discussed.

The course also includes much information about applications of numeric algorithms in various real-world problems.

Course Aim

The course aims to give students the skills and theoretical basis to learn and investigate the existing approaches and algorithms in numerical analysis and optimization, as well as to develop new numeric algorithms to solve the problems they face in their problems of science and technology.

Course Objectives

- To acquaint the students with the theory behind the classical and modern numerical and optimization algorithms;
- to acquaint the students with modern software environments and libraries to solve numerical and optimization problems;
- to acquaint the students with modern trends in numerical analysis and optimization;
- to develop practical skills in programming numerical and optimization algorithms.

Learning Outcomes of the Course

By the end of the course, students will be able to:

- chose appropriate algorithms for solving a particular numerical or optimization problem;
- solve numerical and optimization problems by means of existing software;
- estimate the expected accuracy of the solution to a problem and estimate the actual accuracy of the solution obtained;
- identify possible problems in numerical or optimization algorithms, propose improvements;
- develop improvements to algorithms to account the peculiarities of a particular problem.

Course (module) Structure

Learning Activities	Hours
Lectures	18
Practice sessions / Seminars,	36
Self-study Assignments	126
Final Exam (including preparation)	36
Total study hours	**216**

Course Outline

Week	Lectures	Practice session / Assignments	Hours[1]
1-4	Interpolation and approximation	– Various forms of interpolating polynomials – Polynomial approximation – Orthogonal polynomials – Special methods of approximation: spherical harmonics, continued fractions, multiple variables interpolation – Home assignment No 1 – Home assignment No 2 – Home assignment No 3	40
5-13	Solving differential equations	– Classical methods for ordinary differential equations	90

[1] Hours designed for Classroom sessions, Web-sessions, Home Assignments etc.

		− Implicit methods for ordinary differential equations − Boundary and inverse problems for ordinary differential equations − Classical methods for partial differential equations − Variational methods for partial differential equations: Bubnov-Galerkin, spectral methods, finite element methods − Inverse problems for partial differential equations − Home assignment No 4 − Home assignment No 5 − Home assignment No 6	
14-18	Optimisation techniques	− Classical optimisation techniques − Newtonian and quasi-newtonian optimisation techniques − Multi-objective optimisation − Home assignment No 7 − Home assignment No 8 − Home assignment No 9	50
19-20	Final exam		36

Assessment

Grade policy for both practical home assignments and the final exam is:

- A (excellent work) 91–100 points
- B (above average work) 81–90 points
- C (average work) 71–80 points
- D (below average work) 50–70 points
- F (failed work) < 50 points

The exam is taken orally. Each exam ticket consists of 2 theoretical questions from the list of exam questions.

The final grade includes grade for homework and exam in a ratio of 50:50.

Attendance Policy

Students are expected to attend classes regularly. However, occasional skipping classes is permissible if a student does all necessary in-class work at home.

Lecturer(s) and Tutors, Contact Information

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Core Reading

All the books are available on-line in Elsevier at SFU library.

1. **Stephen Satchell,** Optimizing Optimization, 1st Edition, The Next Generation of Optimization Applications and Theory, Hardcover ISBN: 9780123749529, eBook ISBN: 9780080959207, Imprint: Academic Press, Published Date: 8th October 2009, Page Count: 328

2. **Manfred Gilli, Dietmar Maringer, Enrico Schumann**, Numerical Methods and Optimization in Finance, 2nd Edition, Paperback ISBN: 9780128150658, eBook ISBN: 9780128150665, Imprint: Academic Press, Published Date: 16th August 2019, Page Count: 638