
# TEMPUS Project
# SEE Doctoral Studies in Mathematical Sciences


**Tuzla Summer University, July 7-8, 2010**

From Bologna to EHEA – ERA

# SEE DOCTORAL STUDIES IN MATHEMATICAL SCIENCES

*Harmonized, high quality, internationally oriented and networked doctoral programmes in mathematical sciences in South-Eastern Europe*

**Pure Mathematics/Applied Mathematics/Theoretical Computer Science**

University of Sarajevo, University of Graz, Sofia University
Institute of Mathematics and Informatics/Bulgarian Academy of Sciences
Mathematical Society of South-Eastern Europe, University of Belgrade
University of Skopje, University of Montenegro, University of Tuzla
University of Banjaluka, University of Shkodra

**Project Years 2009-2010**

Workshop on PhD Structure
IT in Mathematical Modelling
SEE Young Researchers Workshop
Scientific & Labour Market Oriented Goals
Workshop on Core Subjects and QA
Course & Lab in Mathematical Modelling
Course in Financial Mathematics
Marie Curie BioMedMath Network Synergy

**SEE Doctoral Year in Mathematical Sciences 2011**

Number Theory
Dynamical Systems
Probability and Statistics
Optimization
Data Structures and High Performance Computing
Computability and Complexity

**Contact: www.see-dsmath.eu or e-mail the grant holder, Prof. Dr. dr.h.c Muharem Avdispahić, mavdispa@pmf.unsa.ba**

# Project outcomes

**I. Development of a model of structured doctoral studies in Math. Sciences involving the network of WB universities**

**II. Doctoral curricula design in the areas of Pure and Applied Mathematics and Theoretical Computer Science**

**III. Strategy to train the next generation of mathematics professors at WB universities for the research-based education and student-centered learning**

**IV. Strengthening master programs: learning outcomes and labor market/link to the third cycle dichotomy, pilot cases in Math Modeling and Financial Mathematics**

**V. Improvement of IT and library facilities**

**VI. Effective and efficient management, dissemination, sustainability of objectives, QA procedures**

**Year One:**
**DOCTORAL PROGRAM STRUCTURE AND CORE KNOWLEDGES**

**Year Two:**
**CURRICULA DESIGN AND CAPACITY BUILDING**

**Year Three:**
**SEE DOCTORAL YEAR IN MATHEMATICAL SCIENCES 2011**

# Project objectives

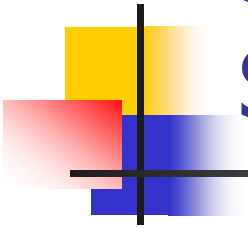
- Doctoral studies in mathematical sciences in South-East Europe up to the EHEA-ERA standards
- Harmonized, high quality, internationally oriented and networked programme/s
- Critical mass achieved both on PhD candidates' and advisors' side
- Doctoral candidates given the opportunity to work in research teams and different research environments

# EHEA & ERA

Berlin 2003

- European Higher Education Area and European Research Area – two pillars of the knowledge based society
- Structured doctoral programmes as the third cycle in the Bologna Process

# SEE Doctoral Year in Mathematical Sciences 2011



- Number Theory (Sarajevo, February)
- Probability and Statistics (Podgorica, April)
- Dynamical Systems (Tuzla, May)
- Optimization (Belgrade, September)
- Algebraic Combinatorics, Computability and Complexity (Sofia, October)
- Data Structures and High Performance Computing (Skopje, November)

# Goals

- Establishing transparency of expectations and setting quality and assessment standards  to be followed
- In principle, every PhD student at WB partner institutions who starts his/her studies that year, will be expected to take one of these courses
- In ECTS terminology, in case of institutions which use ECTS also at doctoral level, each of the courses will bear 30 points

# Study visits

a) Assessment of existing practice in obtaining PhD degree in mathematical sciences at partner universities

b) Comparison with Bologna doctoral programmes at EU universities

c) Identifying the areas of expertise in mathematical sciences at partner universities from EHEA-ERA perspective

d) Capacity building

# Workshop on PhD structure
# Graz, June 22 – 26, 2009

- Duration of doctoral programme
- Proportion between taught courses and research
- Supervision modalities
- Embedding in institutional strategies and policies
- Dissemination and sustainability perspective

# Academic Board Members

- Franz Kappel (Graz), Chair
- Muharem Avdispahić (Sarajevo)
- Dončo Dimovski (Skopje)
- Stefan Dodunekov (IMI-BAS)
- Gundolf Haase (Graz)
- Emil Horozov (Sofia)
- Petar Kenderov (IMI-BAS)
- Dragan Marušić (Tuzla/Koper)
- Miodrag Mateljević (Belgrade)
- Dušan Tošić (Belgrade)



MASSEE
International Congress on Mathematics
MICOM 2009

# SEE Young Researchers Workshop

## TEMPUS JP SEE DOCTORAL STUDIES IN MATHEMATICAL SCIENCES

September 16-20, 2009
Ohrid, FYR Macedonia

# Academic Board Activities

- AB Meeting on Core Knowledges and Evaluation of SEE Young Researchers Workshop, Sofia,  September 21-24, 2009

- AB Meeting on Monitoring and Core Subjects Syllabi, Sarajevo, March 11-14, 2010

# Workshop on PhD Core Subjects and QA, Tuzla, November 4–8, 2009

- Wide discussion of AB Recommendations
- Consortium member departments asked to prepare PhD curricula proposals that incorporate these courses and the other parts of the core knowledges

# Number Theory

## Syllabus for the TEMPUS-SEE PhD Course

Muharem Avdispahić[i]
Department of Mathematics, University of Sarajevo

Stefan Dodunekov[ii]
Institute of Mathematics and Informatics
Bulgarian Academy of Sciences

## Algebraic Number Theory

Number fields and algebraic integers
Unique factorization of ideals
Ideal class group
Dirichlet theorem on units
p-adic fields and local to global principle
Dedekind zeta and Hecke L-function
Elliptic curves over number fields
Zeta function of an elliptic curve
Birch and Swinnerton-Dyer conjecture
Shimura-Taniyama and Fermat's last theorem

## Analytic Number Theory

Euler's proof of infinitude of primes
Dirichlet theorem on primes in arithmetic progressions
Functional equation for the Riemann zeta function
Prime number theorem
Prime number theorem in the Selberg class
Li's criterion for the Riemann hypothesis
Poisson summation formula as a trace formula
Hyperbolic geometry
Selberg's zeta and prime geodesic theorems
Explicit formulas in the fundamental class

## Computational Number Theory

Complexity of number-theoretic algorithms
Arithmetic of elliptic curves
Primality testing
Integer Factorization
Discrete logarithm
LLL algorithm
Quantum algorithms
Elliptic curves in criptography

# Optimization

## Syllabus for the TEMPUS–SEE PhD Course

Franz Kappel[1]
Institute for Mathematics and Scientific Computing
University of Graz

Petar Kenderov[2]
Institute of Mathematics and Informatics
Bulgarian Academy of Sciences

| Module | No. of units | Contents |
|---|---|---|
| I: Unconstrained optimization | 15 | Fundamentals<br>Line search methods<br>Trust region methods<br>Conjugate gradient methods<br>Quasi-Newton methods<br>BFGS-methods<br>Sampling methods (Hooke-Jeeves, implicit filtering, MDS, Nelder-Mead) |
| II: Constraint optimization | 20 | Optimality conditions<br>Linear programming, interior point methods<br>Quadratic programming<br>SQP methods<br>Multi-objective optimization<br>The Hamilton-Jacobi-Bellman equation<br>Linear-quadratic control problems |
| III: Optimization of noisy functions | 5 | Implicit filtering<br>Direct search algorithms |
| IV: Global optimization | 20 | Branch and bound methods<br>Cutting plane methods<br>Interval methods<br>Simulated annealing<br>Clustering methods<br>Genetic algorithms |

# TEMPUS-SEE
# PhD Course on
# Data Structures and High Performance Computing

Gundolf Haase[1], Uni Graz
Dušan Tošić[2], Uni Belgrad

I) **Algorithms and Data Structures** [2].
See also [3, 4].

1) vector, list, stack, queue, tree
2) accessing, sorting and complexity wrt. data structur
3) hashing
4) realization of 1)–3) in C/C++ (here, use of STL), C/Java Java [10]
5) object oriented programming (C++, Java)
6) data structures and performance:
complexity,
memory hierarchies [8, §6] and cache [6, §5] aware data structures
7) Code examples on PCs taking into account cache, SSE units of recent CPUs

This block contains exercises to each item above such that the students develop practical skill of the the above topics in the chosen programming language.

II) **HPC related Concepts and Architectures**

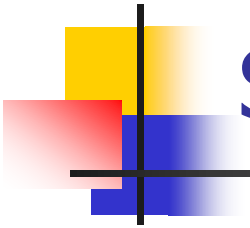
1) Computer concepts:
The von-Neumann Computer concept,
Flynn's Taxiometry (SISD, SIMD, MISD, MIMD),
Topologies of computer/processor networks [6, §8]
2) Concurrency and Correctness [7, §3.1] (data races, atomic operations, deadlock, live lock) in various parallel environments:
shared memory; semaphores/mutex; Message Passing; distributed memory [6, §6]; hybrid environments
3) Designing and developing parallel programs:
Partitioning; Communications; Synchronization; Data Dependencies; Granularity
4) Limits and Coast of Parallel Programming:
(weak) speedup, efficiency; Amdahl's law; Gustavson's law
5) Review of recent Multi-core processors, see LLNL[3], by the students

The contents of this block are presented partially by the students by studying the given literature and web material, e.g., for item 4) and 5), Exercises to data partitioning and simple tasks as reduce operations are presented to the students.

III) Compiler and Software support for parallel computer architectures

1) Concurrent and distributed programming based on C/C++/Java [5]
2) Parallel processing based on OpenMP for shared memory systems
3) Parallel processing based on MPI [9] for distributed memory systems.
4) Grid and Cloud computing.
5) Parallel processing base on some Open source tools.
6) Recent parallel programming standards as OpenCl (CUDA).

This block will be mainly organized in seminars and exercises.



# Syllabi

- Course goals
- Prerequisites
- Course modules (20 units each)
- Literature
- Grading (homework, project, final exam)
- 20 WB + 4 EU PhD students per course
- 3 lecturers (EU & WB) per course

# Spring 2010

- The networked activities at WB universities on producing syllabi for courses covering other parts of core knowledge, elective and special courses and research seminars
- Dissemination through a series of one day round tables at WB universities on PhD structure and curricula in mathematical sciences in April 2010

# Workshop on harmonized PhD programme/s, Belgrade, June 13–17

- To discuss achievements and start the process of institutional approval of the agreed model of SEE Doctoral Studies in Mathematical Sciences and the PhD curricula at partner institutions
- The first generation of networked doctoral studies in mathematical sciences enrolled by the end of 2010

# Strengthening master programmes

- Workshop on scientific and labor market oriented goals, Mathematical modelling and financial mathematics, Budva, October 21-24, 2009
- Intensive course and lab in mathematical modelling, Shkodra, July 3 – 31, 2010
- Intensive course in Financial mathematics, Banja Luka, Aug. 7- Sept. 4, 2010
- ECTS apply to both intensive courses

# Link to FP7

- Dundee 2010 "Mathematical Modelling of Cancer Growth and Treatment"
- Event 4 in FP7 Marie Curie Training Series BioMedMath
- 14 day summer school aimed at PhD and postdocs
- 3  young researchers from WB universities
- 2 WB professors at a 3 day scientific workshop

INSTITUT FÜR MATHEMATIK UND WISSENSCHAFTLICHES RECHNEN

KARL-FRANZENS-UNIVERSITÄT GRAZ

# Training in Use of IT in Mathematical Modeling

Activity V.1 of the TEMPUS Programme "SEE Doctoral Studies in Mathematical Sciences", Projekt No.: 144703-TEMPUS-2008-BA-JPCR (2008-4712)

**September 7 –11, 2009**
**Institute for Mathematics and Scientific Computing**

# Management

- Consortium Committee Initial Meeting, Sarajevo, January 28-31, 2009
- Consortium Committee First Review and Planning Meeting, Belgrade, 12th month, 1st year
- Consortium Committee Second Review and Plannning Meeting, Skopje, Month 12, Year 2
- Consortium Committee Final Review Meeting, Sarajevo, 12th month, 3rd year
  - Analysis of overall results
  - course of  post TEMPUS funding actions recommended by the Sustainability plan

# Synergy and perspectives

- DAAD Centers of Excellence for Applications of Mathematics
- Erasmus Mundus (incl. Basileus)
- Nationally supported projects
- European Mathematical Society and MASSEE partnership within the European Science Foundation project

Thank you!