

**Report on
West Asia Mathematical Schools
WAMS-Erbil-2018**

**“Control and Optimization with
Industrial Applications”**

From 19 to 29 December 2018

Place of the school

Erbil-Kurdistan region-Iraq

Sponsors

CIMPA, French Embassy, IMU, University of Diyalah and University of Salahaddin.



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Lecturers

- **Abdeljalil Nachaoui**, Laboratoire de Mathématiques Jean Leray, Université de Nantes, France (Abdeljalil.Nachaoui@univ-nantes.fr).
- **Jarosław Woźniak**, University of Szczecin, Szczecin, Poland, (wozniak@univ.szczecin.pl).
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Scientific committee

- **Abdeljalil Nachaoui**, Laboratoire de Mathématiques Jean Leray, Université de Nantes, France (Abdeljalil.Nachaoui@univ-nantes.fr).
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Local Organizing committee

- **Director**: Dr Herish Omer, College of Sciences, department of Mathematics, University of Salahaddin (herish_omer69@yahoo.com)
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Description of Schools

Control and Optimization with Industrial Applications

Abstract: Optimal control is concerned with control laws that maximize a specified measure of a dynamical system's performance. This course is a rigorous introduction to the classical theory of optimal control. The topics covered in this course include optimization, the calculus of variations, Pontryagin's principle, dynamic programming, linear quadratic optimal control, delay differential equation, shape optimisation

Optimal control problems are generally nonlinear and therefore, generally do not have analytic solutions (e.g., like the linear-quadratic optimal control problem). As a result, it is necessary to employ numerical methods to solve optimal control problems. We describe techniques used to approach these classes of problems

Description of Course

; **Introduction.**

- Motivation : examples from industry
- Optimisation : state of the art

< **A review of analysis**

- Basic function spaces
- Definitions Properties of Hilbert space of Hilbert spaces
- Integration by parts in dimension d and applications
- Distributions

= **Review of Mathematical Programming**

- Convex Analysis,
- Constrained and Unconstrained Problems,
- Line search methods, Lagrange multipliers
- Dynamic programming: principle of optimality, dynamic programming, discrete LQR

> **Hamilton-Jacobi-Bellman equation:**

- differential pressure in continuous time, HJB equation, Continuous LQR

[**Calculus of Variations and Optimal Control**

- Basic CoV Problem,
- Euler-Lagrange Equations,
- CoV and Optimal Control,
- Numerical Methods

] **Maximum Principle**

- Statement of MP,
- Proof of MP,
- Bang-bang Control

{ **Classical control theory:**

- Controllability,
- Observability
- Stability

} Semigroups of operators

Controllability of infinite dimensional systems:

- Moment problem method

~ **Stability of infinite dimensional systems:**

- Transfer function method

; : Delay Differential Equation and its Comparison with ODE

- Numerical methods

; ; Mathematical models and Delay optimal control

- Development of the optimal control theory for functional differential equations
- Model of the flying apparatus
- Model of the economical growth

; < Delay optimal control problems with non-fixed initial moment

- Problem with discontinuous initial condition and its effect.
- Linear time-optimal control problem
- Inverse problems
- Problems with the continuous initial condition and its effect
- Problems with the mixed initial condition (general case) and its effect

; = Shape optimisation as part of the optimal control theory

- Definition
- Examples
- Techniques: Iterative methods using shape gradients,
- Genetic Algorithms

Courses, and Communications

The school was inaugurated by a short opening session in which the University of Salaheddin was represented by Professor Herish, Dean of the College of Science.

This session was followed by a conference of professor Nachaoui introducing many examples of industrial applications of optimal control and optimization. This motivated the introduction of various analysis tools for the study of these problems.

The school's science program consisted of several one-and-a-half-hour sessions and several two-hour practical sessions. Half-hour slots were also scheduled to allow participants who wished to present their work. Two talks were presented.

All courses started with detailed reminders and motivations. The level, rhythm and content of the presentations seem to have been well adapted to the public. The many questions that followed each session reflect the great interest that the participants found at this school.

During the practical part of the lectures, the participants used FreeFem++ (a software created by French mathematicians to solve boundary value problems using finite element method) which they have discovered during the school. In fact one of the aims of the school was to give some ideas about the programming by using FreeFem++ to solve boundary value problems numerically. The fact that participants solved themselves problems by FreeFem++ made them feel the importance of each condition and each mathematical term appeared in the theoretical part

and prepared them to solve similar problems independently. Others theoretical results was uillustrated using Matlab tools.

Participation

The number of lecturers is 5 and the number of participants is 43. The participants came from different regions and different Universities of Iraq. The number of participants is 48, the percentage of the female participants is 50%.

In the end, the school brought together some 48 mathematicians, beginners and advanced (see annex for the list of participants), including 31 from Kurdistan region Universities and 13 Iraqis from outside Kurdistan and 2 from Poland, 1 from France and 1 from Morroco.

Material conditions

All the activities of the school took place at Salaheddin University. Almost all participants were accommodated at the guest house of this university. Most of the midday meals were taken collectively on site.

For the courses, we have a very comfortable amphitheater equipped with an excellent video projector and a large white board. The department of mathematics has reserved for the school a computer room equipped with all software required for our practical parts of courses.

Acknowledgement (Erbil 2018)

This school could not take place without the financial support of the sponsors, so many thanks to each of the French embassy-Bagdad, CIMPA, IMU, University of Salahaddin and University of Diyala.

Financial support(Erbil 2018)

The total budget of the school is 15378 Euros. The percentage of the participation of the sponsors in the total budget of the school is as the following :

French Embassy	16.2%
CIMPA	19.9%
IMU	10.2%
Salahaddin University	34.7%
Diyala University	14.8%
Participation of the participants and lecturers of the School	4.2%

List of participant

	Lecturers	University	Country
1	Aboud Fatima	University of Diyala	Iraq
2	Nachaoui Abdeljalil	Universite de Nantes	France
3	Nachaoui Mourad	University of Sultan Moulay Sliman	Morocco
4	Wozniak Jaroslaw	University of Szczecin	Poland
5	Zaboon Radhi	AlMostansriya University	Iraq

	Participants	University	Country
1	Abdul-Jabbar Mr Abdullah M.	University of Salahaddin	Iraq
2	Abdulgaphur Mrs Bushra N.	University of Salahaddin	Iraq
3	Abdullah Mr Herish O	University of Salahaddin	Iraq
4	Ahmed Mrs Nehmat K.	University of Salahaddin	Iraq
5	Al-Mashadani Mrs Huda K Mohammed	University of Ninevah	Iraq
6	Aladool Azzam S Younus	University of Mosul	Iraq
7	Ali Miss Kurdistan M	University of Salahaddin	Iraq
8	Ali Miss Ivan Dler	University of Salahaddin	Iraq
9	Ali Mr Ghazwan Mohammed	Diyala University	Iraq
10	Ali Miss Bahar Obed	University of Salahaddin	Iraq
11	Almamoori Mr Mohammed Kadhim M	Kufa University	Iraq
12	Anwar Miss Dalya A	University of Salahaddin	Iraq
13	Aziz Mr Waleed Hussain	University of Salahaddin	Iraq
14	Berdawood Mr Karzan Ahmad	University of Salahaddin	Iraq
15	Essam Mr Ammar	Dohok University	Iraq
16	Faraidoon Mr Dilan	Sulaimani University	Iraq
17	Hamoodat Mr Alaa Abdurraheem Ahmed	University of Mosul	Iraq
18	Hasan Mrs Hataw Muhammad	Sulaimani University	Iraq
19	Hussain Miss Hazha Zirar	University of Salahaddin	Iraq
20	Ismail Miss Zozan Omer	University of Salahaddin	Iraq
21	Kasim Mr Sameer	Mostansriya University	Iraq
22	Latif Mrs Ivan Subhi	University of Salahaddin	Iraq
23	Mahmood Miss Awreng Biaz	University of Salahaddin	Iraq
24	Mahmoud Mr Namam Jalal	University of Salahaddin	Iraq
25	Majeed Mr Mariwan Marif	Sulaimani University	Iraq

	Participants		University	Country
26	Mohammad	Mr Ibrahim K	University of Salahaddin	Iraq
27	Mohammad	Miss Awaz Shahab	University of Salahaddin	Iraq
28	Mohammed	Mr Amir Abdulillah	University of Mosul	Iraq
29	Mohammedf-Saleh	Mrs Gashaw Aziz	University of Salahaddin	Iraq
30	Qadir	Miss Chimam Muhammad	University of Salahaddin	Iraq
31	Rashed	Mrs Payman Abbas	University of Salahaddin	Iraq
32	Rasheed	Mr Mohammad	Kirkuk University	Iraq
33	Rashid	Mr Rashad	University of Salahaddin	Iraq
34	Sadraddin	Miss Evar Lutfalla	University of Salahaddin	Iraq
35	Saeed	Mr Rostam K	University of Salahaddin	Iraq
36	Saeed	Miss Runak	Kirkuk University	Iraq
37	Salih	Miss Hero Waisi	University of Salahaddin	Iraq
38	Sami	Mrs Sawsan	University of Mosul	Iraq
39	Sedeeq	Miss Bekhal Samad	University of Salahaddin	Iraq
40	Shareef	Mr Nihad	Tikrit University	Iraq
41	Sulaiman	Miss Neshtiman N.	University of Salahaddin	Iraq
42	Wozniak	Mrs Monika Ewa	University of Szczecin	Poland
43	Xoshnaw	Mr Wuria	University of Salahaddin	Iraq

Some photos













Some Important Links

- CIMPA: <http://www.cimpa-icpam.org/>
- University of Diyala: <http://www.uodiyala.edu.iq/>
<http://www.en.sciences.uodiyala.edu.iq/>
<http://www.en.sciences.uodiyala.edu.iq/pageviewer.aspx?id=101>
- <http://www.rnta.eu/WAMS/>
- <https://www.cimpa.info/en/node/43>
- <http://www.nesinkoyleri.org/eng/events.php>