

Report on my visit to Phnom Penh, April 20 - May 8, 2015

RUPP - Royal University of Phnom Penh

Master of Science in Mathematics

Course: Algebra and Geometry

From April 20 to May 8, 2015, I taught a 45 hours course *Algebra and Geometry* to the students of year 1 of the Master of Science in Mathematics of the Royal University of Phnom Penh (RUPP)

<http://www.rupp.edu.kh/master/mathematics/>

supported by CIMPA (Centre International de Mathématiques Pures et Appliquées)

<http://www.cimpa-icpam.org/activites-par-region/master-cambodia/>

and by the *Voluntary Lecturer Program* (VLP) of the International Mathematical Union (IMU)

<http://www.mathunion.org/cdc/volunteer-lecturer-program/>

Initially, 13 students were selected to attend this program, only 11 attended my course; 9 of them attended all my lectures, only 2 were not fully assiduous. The final result is that one student received the maximal mark A, two got B+, two B, three C, and three failed.

In the appendix I give the list of topics which have been covered. As a reference I used a lecture notes of Michel Jambu, plus a book *Geometry* by M. Audin (Springer Verlag). The students had a copy of these documents.

A colleague from Cantho University in Vietnam, Nguyen Trung Kien, who is interested to participate to this program later, visited Phnom Penh for three days. He attended one of my courses and told me that this course, which is given here in the 5th year of University (first year after the 4 years of BSc), is included in the program of 2nd year in his University and in other universities in his country. As a matter of fact, the course on linear algebra I taught should have been done two years before, in principle the students attended it and got the exam at that time, but clearly they had very little idea of what it is about. I needed to go slowly and I

could not cover as much material as I initially planed - but I hope that 3 and maybe 5 of them have a better understanding of linear algebra now.

On April 30, 2015. I gave a lecture on *number theory and cryptography*, which is the topic of my course next year for Master 2 — the powerpoint file is available at url

<http://webusers.imj-prg.fr/~michel.waldschmidt/ppt/Cryptography2015.ppt>

The visit of Nguyen Trung Kien may give rise to a cooperation between RUPP and Cantho University: the next step in this process is scheduled early September 2015 when some colleagues from RUPP will attend a SEAMS School

Number Theory and Applications in Cryptography and Coding Theory
August 31 - September 8, 2015, Ho Chi Minh City (Vietnam)

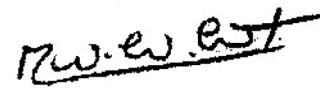
that I am organizing with Francesco Pappalardi in the Department of Computer Science at **HCMC** (Ho Chi Minh City, University of Science). We will go together to Cantho and discuss further actions.

This visit of Nguyen Trung Kien gave us the opportunity of having a nice dinner on May 2nd on the bank of the Mekong River with Hun Kanal, Soklin, Mam Mareth, Lin Mongkolsery and Sopheap Khvay.

We also had a meeting at RUPP on May 4th to discuss the future of mathematics in Cambodia with Hun Kanal, Mam Mareth, Seam Ngonn, Lin Mongkolsery, Chan Sony. One item we discussed was the forthcoming meeting in Phnom Penh with ISP for the South East Asian Mathematical Network (SEAMaN) involving Cambodia, Laos and Myanmar.

I met Alex Brayle (Responsable de l'Antenne de Phnom Penh, Bureau Asie - Pacifique, Agence universitaire de la Francophonie) on Thursday, May 7; I also visited the mathematicians of ITC (Institut de Technologie du Cambodge). The same day I had a meeting with Chan Roath.

My visit was supported by the **VLP** program of IMU. I am very thankful to IMU for this support. I wish to thank the colleagues from RUPP, especially Hun Kanal, Mam Mareth and Sok Lin, for the excellent organisation of my visit.



Michel Waldschmidt.

This report is available on the internet at URL

<http://webusers.imj-prg.fr/~michel.waldschmidt/articles/pdf/RptRUPP2015miw.pdf>

April 20 - May 8, 2015.
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(URPP - Université Royale de Phnom Penh).
Master of Science in Mathematics.

Algebra and Geometry

Michel Waldschmidt

1. Algebra

- Groups, subgroups. Homomorphisms. Direct products. Normal subgroups, quotients. Group acting on a set.
- Rings and Fields. Ideals, homomorphisms. Characteristic. Algebraically closed fields.
- Linear Algebra : Vector spaces, subspaces and spanning sets. Linear independence. Bases.
- Linear Maps: image, kernel. Direct products of vector spaces. Direct sums of vector subspaces. Quotient.
- Finite Dimensional Vector Spaces. Existence of bases. The theorem of the incomplete basis. Dimension, rank. Linear maps. Dual. Bidual. Transpose of a linear map.
- Matrices. Definition, properties. Matrices and linear maps. Matrice of the transpose. Base change. Elimination: Gauss, Jordan. Determinant.
- Linear equations. Definition. Homogeneous systems. Cramer systems.
- Eigentheory. Eigenvalues and eigenvectors. Characteristic polynomial. Triangulable matrices. Diagonalizable matrices. Eigenspaces. Minimal polynomial, Hamilton-Cayley theorem. Jordan form.

2. Affine Geometry: Affine Spaces.

- Definitions. Chasles relation. Dimension. Affine subspace. Vectorization.
- Barycenters
- Affine Maps
- Affine Frames
- Theorems of Thales, Pappus, Desargues, Menelaus and Ceva.

<http://webusers.imj-prg.fr/~michel.waldschmidt/enseignement.html>

4, Place Jussieu Bureau 15-25 417

Tél. : [33] (0)1 44 27 54 41

<http://www.imj-prg.fr/~michel.waldschmidt/>

Secr. : [33] (0)1 44 27 38 08

Fax : [33] (0)1 44 27 63 25

michel.waldschmidt@imj-prg.fr

