Master of Science in Mathematics

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GENERAL INFORMATION

Introduction

The Master of Science in Mathematics program at the Royal University of Phnom Penh provides high-level mathematical training to postgraduate students. The degree takes a broad approach to mathematical training, with students taking courses in both pure and applied mathematics.

The first year of the M.Sc. (Mathematics) provides students with training in subjects including linear algebra, differential geometry, discrete mathematics, probability, real, complex analysis, introduction to mathematical statistics and topology. The second year of the degree is being developed to allow students to specialize in those subjects which will be greatest benefit to the Cambodian context. It is envisioned that this course will focus on training Cambodian human resources for specialized fields such as financial and economic mathematics, cryptography and mathematics for science, among others.

Whilst the Masters in Mathematics program aims to train students for future careers in mathematics-related fields, it also seeks to build capacity within the Royal University of Phnom Penh; it is also provide the skilled people in this area to work at new established universities in some provinces in Cambodia. To this end, the M.Sc. (Mathematics) has implemented a unique counterpart system within its teaching program. Under this system, each course is taught by a recognized international mathematician, with the assistance of a Cambodian counterpart from the Department of Mathematics at the Royal University of Phnom Penh. This close association between foreign experts and Cambodian staff benefits both parties, building RUPP's resources and experience in postgraduate teaching, and allowing international professors to build a closer association with RUPP and Cambodia.

International professors teaching at RUPP come from institutions including the Université Paris VI, Université d'Aix Marseille and Université de Nice Sophia-Antipolis (France), the University of Marrakech (Morocco), Colorado State University (USA) and other American and Japanese universities. The International Mathematical Union and the United States National Committee on Mathematics will also support several mathematicians in teaching at RUPP.

In addition to the support of these institutions, the Master of Science in Mathematics at the Royal University of Phnom Penh has been developed thanks to the assistance of several international organizations. Its primary sponsors are the Centre International de Mathématiques Pures et Appliquées (CIMPA), the International Mathematical Union (IMU), the US National Committee on Mathematics, the Agence Universitaire pour la Francophonie (AUF), the French Embassy, Phnom Penh and the Toyota Foundation.

Course Structure

The M.Sc. (Mathematics) is taught through a series of intensive, subject-specific modules of 45 hours, each taken over a period of roughly three weeks. Students take eight of these modules in their first year, seven of which are compulsory, and one of which is an elective. The second year of the M.Sc. requires students to take seven courses.

All courses are taught by recognized professors from overseas universities, in association with a member of staff from the Department of Mathematics at the Royal University of Phnom Penh.

At the same time as the students attending the final year require to do project report or research writing to enable them to experience in research activities which is the foundation for further studies. Research topics will be given to students so as they can select and work under co-supervision of foreign professors or lecturers who have come to teach in the courses in

first and final year of the master program and their counterparts at the local department. The students communicate with the foreign supervisors through email or any other electronic communications.

Enrollment
The applicants must sit an examination set by the organizing committee of the M.Sc. (Mathematics) at RUPP. The outstanding students from the Mathematics summer program at the Institute of Technology, Cambodia, can be selected for automatic entry into the degree program, if there is any recommendation.

Application
All potential applicants must be in possession of a Bachelor's degree in a related field from a recognized university.

Method of Instruction
All courses are taught in English. However, due to the strong support of French institutions and universities, outstanding students in the M.Sc. (Mathematics) program are encouraged to pursue further study of the French language, which they will find beneficial in future applications for a Ph.D. or further training in France.

CURRICULUM

Year I			
Subject	**Course Code**	**24 Credits**	**Teaching Hours**
Linear Algebra	MMA101	3	45
Probability	MMA102	3	45
Geometry (Differential Calculus)	MMA103	3	45
Introduction to Real Analysis	MMA104	3	45
Discrete Mathematics	MMA105	3	45
Introduction to Statistics	MMA106	3	45
Complex Analysis	MMA107	3	45
Topology	MMA108	3	45
Year II			
Subject	**Course Code**	**27 Credits**	**Teaching Hours**
Complement I for Teachers	MMA109	3	45
Combinatorial Geometry	MMA110	3	45
Partial Differential Equations	MMA111	3	45
Algebraic Equations of Higher Degree and the Galois Theory	MMA112	3	45
Complement II for Teachers	MMA113	3	45
Numerical Analysis	MMA114	3	45
Compact Riemann Surfaces	MMA115	3	45
Project Report/ Research Writing ?	MMA116	6?	

COURSE DESCRIPTIONS

MMA101 Linear Algebra
Yasuo Morita,Tohoku University, Japan
(Email: morita@math.tohoku.ac.jp)

Students learn Group, rings and fields; Matrices and vectors, Determinants, Linear spaces and linear maps, Systems of linear equations, Eigenvalues and eigenvectors, Bilinear forms and metrics on linear spaces , Dual spaces and tensor spaces.

MMA102 Probability
Sonia Fourati, INSA, university of Rouen, France
(Email: sonia.fourati@upmc.fr)

Elements of Combinatorial Analysis, Finite probability spaces, Conditioning and Independence:

Conditioning by an event, Denumerability and summability, Generalization to denumerable spaces of finite probability spaces and conditioning and independence, Random variables having a density, Covariance, Line of Regression, The Gaussian Case, Distribution function and characteristic function of a random variable, Different techniques of simulation

Text books:
William Feller: Introduction to Probability Theory (Volume I and II)

MMA103 Geometry (Differential Calculus)
Kiminao Ishitoya, Aichi University of Education, Japan
(Email: kishito@auecc.aichi-edu.ac.jp)

The course includes Curves, Surfaces, Conformal Mappings, Geodesics, The Gauss-Bonnet Theorem, Introduction to Algebraic Topology

MMA 104 Introduction to real analysis
Eduardo Cattani, University of Massachusset, Amherst, USA

Basic Notion: (Properties of the real numbers. Countable and uncountable set), Sequences and Series: Basic definitions, Cauchy sequences, Bolzano-Weierstrass Theorem. Continuity: Definition, Continuous functions on closed intervals, Intermediate value Theorem, Uniform continuity.. Riemann Integral: Upper and lower sums, Existence of integral for continuity functions. Differentiation: Definition of derivative, Fundamental Theorem of calculus, Taylor's Theorem. Sequences of Functions: Pointwise and uniform convergence, matric spaces and contraction mapping theorem. Series of functions: Power series-radius of convergence, behavior of series under differentiation and integration, Taylor series and the remainder theorem.

Text books:
- Bernard Gelbaum and John Olmested, Counterexamples in analysis. Dover, 2003
- Michael Reed, Fundamental Ideas of Analysis, Wiley, 1998
- Walter Rudin, Principles of mathematical Analysis. Third edition. International Series in Pure and Applied Mathematics. McGraw-Hill Book Co., 1976

MMA105 Discrete Mathematics
Michel Waldschmidt,University of Paris 6,Frace
(Email: miw@math.jussiru.fr)

1.Counting: Integers,sets,subsets.
2.Combinatorial probability
3.Arithmetics: divisibility,primality,factorization
4.Graphs, trees
5.Cryptography

MMA 106 Introduction to statistics
Jan Hannig, University of North Carolina, US
(Email: hannig@email.unc.edu)

This is a course in statistics. The covered topic will include basics of mathematical statistics such as distribution theory, asymptotic theory, point estimate, interval estimate, hypothesis testing. We also cover some basics of linear regression.

Text Books:
- Casella and Berger: Statistical Inference, Duxbury 2/e (Chapter 5-10) ISBN: 0 534 24312 6
- Bickel and Doksum: Mathematical Statistics, Vol 1, 2/e, Prentice Hall, ISBN: 0-138-50363-X
- Mood, Graybill, Boas, Introduction to the theory of Statistics
-Ross, A First Course in Probability
-Grimmet and Stirzaker, Probability and Random Processes

MMA107 Complex Analysis
To be determined

MMA 108 Topology
Michel Jambu, University of Nice, France
(E-mail: jambu@unice.fr)

This course is an introduction to topology. Before defining topologies, we recall the topologies defined by metrics. Then we focus on the main properties of Hausdorff spaces, connectedness and compactness. Finally, we introduce the fundamental groups and we give some examples of applications.
Major Topics by Chapter in text:
1. Introduction and mathematical preliminaries
2. Metric spaces
3. Topological spaces
4. Convergence and Hausdorff spaces
5. Connectedness
6. Compactness
7. Fundamental groups; Applications

Textbooks:
M A Armstrong. Basic Topology, Springer, 1983.

MMA 109 Complement 1 for teachers (Projective Geometry)

Michel Jambu, University of Nice Sophia Antipolis, France
(E-mail: jambu@unice.fr)

This course is an introduction to projective geometry. The students are supposed to master affine geometry. This is a classical course on projective geometry with a last chapter on some applications to algebraic curve where elliptic curve will be introduced.

Major Topic by Chapter in text:

1. Projective spaces
2. Projective frames
3. Projective transformations, homography
4. Affine vs projective
5. Affine coordinates vs projective coordinates
6. Topology of projective spaces (real and complex)
7. The complex projective line, the cross-ratio, homography, the circular group
8. Complexifications
9. Cyclic points
10. Projective duality
11. Application to algebraic curves

Textbook:

Geometry, by Michèle Audin, Universitext, Springer-Verlag 2003

MMA 110 Combinatorial Geometry

Paul Vaderlind Rikard Bogvad, Stockholm University, Sweden
(Email: paul@math.su.se)

Part 1:

1. Convexity in R^n. Caratheodory and Radons Theorems.
2. Helly type theorems for finite family of countable families and for overcountable families.
3. Generalizations of Helly's Theorem. Basic applications to geometry.

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6. Hausdorff metric for compact sets, Blashke Selection Theorem, The existence of Maximal sets, the Area and Volume.

4. Sets of constant width and Universal covers, the Joung's Theorem
5. Illumination Problem and the Hadwiger Conjecture
6. Hausdorff metric for compact sets, Blashke Selection Theorem, The existence of Maximal sets,the Area and Volume

Part 2:

1. V and H-description of polytopes
2. Faces and combinatorial type of polytopes
3. Higher-dimensional polytopes (cyclic and simplicial polytopes)
4. Number of faces: Eulers theorem and Dehn-Somerville equations, Upper bound theorem
5. Diameter of a polytope and Hirsch conjecture

MMA 111 PDE (Partial Differential Equation)

Will Murray, California State University, Long Beach, USA
(Email: wmurray@csulb.edu)

Prerequisites: Students should have strong calculus skills and at least basic linear algebra. Especially important topics include integration, Taylor Series, partial differentiation, matrix manipulation, and eigenvalue theory.

We will study the theory and applications of ordinary and partial differential equations. Topics include first-order equations, second and higher order equations, series solutions of second order linear equations, systems of first order linear equations, numerical methods, partial differential equations, and Fourier Series.

Text Books:

- Boyce, Elementary Differential Equation and Boundary Value Problems, Ninth Edition. Selected topics from chapters 1-5, 7, 8, and 10.

MMA 112 Algebraic Equations of Higher Degree and the Galois Theory

Shun-ichi Kimura, hiroshima University, Japan
(Email: kimura@math.sci.hirosima-u.ac.jp)

In this course, we learn the development of the algebraic equations, from historical view point. We treat the formula for cubic and quartic equations, and the relation between algebraic equations and geometric constructions. By proving that geometric construction corresponds to solving a series of quadratic equations, we can formulate the impossibility of trisection an angle and doubling the cube. Using the noting of the field extension, we will rigorously prove the impossibility. At the same time, it implies that we can construct regular 17gons. We also discuss geometric construction using paper folding, mark ruler, or other interesting tools. They

are equivalent to using the formula for cubic and quartic equations. Finally, by introducing the Galois group, we can give more subtle research of field extension. We mainly concentrate the subfield of the rational function field over C, to prove the impossibility of the formula for quintic equations, only using radicals and addition, subtraction, multiplication and division.

Major Topic by Chapter in Text : (subject to change)

1 Cardano formula, Ferrai's formula
2 Geometric construction and quadratic equation
3 Euclidean Algorithm and Rationalization of denominator
4 Notion of fields
5 Three problems from Ancient Greece
6 Formula for extension degree
7 Symmetric functions and invariant subfield
8 Galois group and the Fundamental Theorem
9 Construction of regular 17gons
10 Radical extension and normal subgroups
11 Impossibility for quintic equations

Textbooks:
(1) Emit Artin: Galois Theory (Dover) Concise but well written textbook:Shortest path to Galois theory.
(2) Postnikov: Foundations of Galois Theory (Dover) Richer account for the background material.
(3) Jean-pierre Tignol:Galois'Theory of Algebraic Equations (World Scientific Pub). Very rich historical background for the development of Galois theory.

MMA 113 Complement 2 for teachers
Pierre Arnoux, University of Marseille, France

To be developed

MMA 114 Numerical Analysis
Angel Pineda, California State University, Fullerton, USA. (Email: apineda@fullerton.edu)
Homepage: http://math.fullerton.edu/apineda/

This course is an introduction to numerical analysis using MALAB as the scientific computing platform. The objective of this course is to understand how to use computers to solve mathematical problems and to implement the algorithms. The course will cover both theory and applications. The following topics will be covered: solutions of nonlinear equations in one variable, solutions to linear systems of equations in several variables, polynomial interpolation, approximate solutions to problems using linear least squares and numerical differentiation and integration.
Major Topics by Chapter in Text:
Chapter 0: Finite Precision Arithmetic and Computer Implementation of Algorithms
Chapter 1: Solving Linear and Non-linear Equations with one Unknown
Chapter 2: Solving Linear and Non-linear Systems of Equations
Chapter 3: Interpolation
Chapter 4: Least squares
Chapter 5: Numerical Differentiation and Integration

Textbook:
Timothy Sauer, Numerical Analysis, Pearson, 2006.
Software: MALAB, The Math Works, Inc.

MMA 115 Compact Riemann Surfaces
Takayasu Kuwata, Tokyo Denki University, Japan
(E-mail: kuwata@im.dendai.ac.jp)

The theory of compact Riemann surfaces is attractive, because we need knowledge in various fields like algebra, geometry, complex analysis etc. After the review of manifolds and complex analysis, I want to treat an introduction to compact manifolds, especially, compact Riemann surfaces, as applications.
Major Topics by Chapter in Text:

1 Algebraic curves in the projective plane
2 Review of complex analysis
3 Riemann surfaces (one dimension complex manifolds)
4 Holomorphic functions and meromorphic functions
5 Differential forms
6 Divisors on compact Riemann surfaces
7 Riemann-Roch's Theorem of compact Riemann surfaces
8 Some applications

Textbooks:
- Phillip A. Griffiths, Introduction to Algebraic Curves, American Mathematical Society
- M. Namba, Geometry of Projective Curves, Marcel Dekker, 1984