Department of Mathematics

Coursework Details (2024-25)

Requirements:

MPhil students: 2 compulsory courses & 3 elective courses; and

PhD students: 2 compulsory courses & 4 elective courses

[Students should register for the course once when they start attending the course]

Course Code	Course Title	Duration	Remarks
SSAF6001*	Basic Laboratory Safety Course for RPg Candidate in the Faculty of Science	The safety course will be conducted by the Safety Office twice a year (i.e. normally in Sept and Jan).	Faculty Compulsory
MATH6001	Guided study in mathematics	Full year course (enrolment in either Sem allowed)	Compulsory
MATH6002	Selected topics in mathematics	Full year course (enrolment in either Sem allowed)	
MATH6014	Topics in Advanced Numerical Analysis	First Semester	
MATH6015	Topics in Artificial Intelligence and Machine Learning	Second Semester	
MATH6101	Intermediate complex analysis	First Semester	JCAS [HKU]
MATH6102	Algebraic topology		JCAS
MATH6103	Real analysis I		JCAS [CUHK]
MATH6104	Abstract algebra		JCAS
MATH6105	Numerical analysis		JCAS
MATH6201	Topics in geometry		JCAS [CUHK]
MATH6202	Complex manifolds		JCAS [HKU]
MATH6203	Several complex variables		JCAS
MATH6204	Topics in partial differential equations	First Semester	JCAS [CUHK]
MATH6205	Advanced algebra II		JCAS
MATH6206	Topics in advanced algebra		JCAS [CUHK]
MATH6207	Topics in applied mathematics		JCAS
MATH6208	Topics in numerical analysis	First Semester	JCAS [CUHK]
MATH6209	Algebraic D-modules		JCAS
MATH6210	Differential topology		JCAS
MATH6211	Algebraic geometry		JCAS
MATH6212	Topics in algebraic geometry		JCAS
MATH6213	Topics in differential topology		JCAS
MATH6214	Topics in analysis	Second Semester	JCAS [CUHK]
MATH6215	Applied differential equations	Second Semester	JCAS [CUHK]
MATH6216	Stochastic processes		JCAS
MATH6217	Topics in financial mathematics		JCAS
MATH6218	Riemannian geometry I		JCAS [CUHK]
MATH6219	Topics in applied functional analysis		JCAS
MATH6220	Real analysis II		JCAS
MATH6221	Riemannian geometry II		JCAS
MATH6222	Harmonic analysis on p-adic groups and lie algebra		JCAS
MATH6223	Algebraic surfaces		JCAS
MATH6224	Topics in advanced probability theory	First Semester	
MATH6501	Topics in algebra	First Semester	
MATH6502	Topics in applied discrete mathematics	Second Semester	
MATH6503	Topics in advanced optimization	Second Semester	
MATH6504	Geometric topology		
MATH6505	Real analysis	Second Semester	
MATH6901	Graduate seminar in pure mathematics		
MATH6902	Graduate seminar in applied mathematics		
MATH6903	Independent studies	Full year course (enrolment in either Sem allowed)	

JCAS = Course under Centre for Advanced Study

Last Updated: Jul 24, 2024

MATH6001 Guided study in mathematics (COMPULSORY)

This course introduces students to their respective proposed fields of research, enabling them to acquire the basic knowledge, learn the research techniques and study the relevant literature. Details of the course will be organized by the supervisors for their students. The course will consist of study group, advanced reading, literature study and presentations. Details of the course will be organized by the supervisor for his/her students, subject to approval by the Head of Department.

Assessment: 100% continuous assessment

Contact Person: Professor N Mok

MATH6002 Selected topics in mathematics

This course enables students to broaden their mathematical knowledge in an area they have not studied before but may not be covered in any of the other postgraduate courses being offered in that year. The selection of topic is made with advice from the supervisor(s). This course can only be taken with the approval of the supervisor(s) and the Chairperson of the Departmental Research Postgraduate Committee.

Assessment: Continuous assessment and written examinations

Contact Person: Professor N Mok

MATH6014 Topics in advanced numerical analysis

This course delves into advanced topics in numerical analysis, providing students with a comprehensive understanding of key concepts and methods.

Assessment: Coursework (50%); Examination (50%)

MATH6015 Topics in artificial intelligence and machine learning

Selected topics in artificial intelligence that are of current interest will be discussed in this course.

Assessment: Coursework (50%); Examination (50%)

MATH6101 Intermediate complex analysis

The objective is to familiarize students with concepts and techniques in Complex Analysis beyond an introductory course in Functions of a Complex Variable. This course covers a choice of topics in Complex Analysis in one complex variable such as complex potential theory, meromorphic functions, open Riemann surfaces, compact Riemann surfaces, normal families, geometric theory of holomorphic mappings and complex dynamics.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6102 Algebraic topology

This introductory postgraduate course aims to provide a foundation in the more elementary parts of algebraic topology.

The course will begin with a review on the fundamental groups, followed by a review on the simplicial homology theory. The course will then enter into the main part, which is Homology Theory, with the emphasis on the singular theory, although a glimpse on the cellular theory is not ruled out. The last part of the course will be less structured, with topics to be chosen from among cohomology rings, higher homotopy groups, spectral sequences, etc.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6103 Real analysis I

This course provides a solid foundation in the Lebesque integration theory and basic techniques in analysis. Topics included σ -algebra of sets, measure theory, Lebesgue integration theory, convergence theorems, Lp-spaces, differentiation. Students taking this course are expected to have knowledge in advanced calculus and elementary analysis.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6104 Abstract algebra

Advanced theory of groups, linear algebra, rings, modules, and fields, including Galois theory.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6105 Numerical analysis

Direct and iterative methods. Programming techniques and software libraries. Sparse solvers. Fast algorithms, multi-grid and domain decomposition techniques.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6201 Topics in geometry

This course aims to introduce students to different research areas in geometry and their applications.

This course covers a choice of topics in different areas of geometry such as Riemannian geometry, symplectic geometry, gauge theory and calculus of variations.

Assessment: Written or oral examinations

Contact Person: Professor J H Lu

MATH6202 Complex manifolds

This course aims to introduce students to research on complex manifolds. This course contains an introductory part on basic notions such as holomorphic vector bundles, sheaves and sheaf cohomology, cohomology theories in terms of differential forms, and Hermitian and Kaehler manifolds, together with a choice of topics on analytic and geometric aspects of the theory of complex manifolds.

Assessment: Written or oral examinations; pass/fail

Contact Person: Professor N Mok

MATH6203 Several complex variables

The objective is to familiarize the students with basic analytic and algebraic techniques in Several Complex Variables. Topics include: Hartogs extension, domains of holomorphy, holomorphic convexity, plurisubharmonic functions, Weierstrass preparation and division theorems, analytic subvarieties, coherent analytics sheaves, closed positive currents, solving the Cauchy-Reigmann equation with L^2-estimates.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6204 Topics in partial differential equations

This is a basic course on Laplace operator on manifolds. This would introduce from scratch the notion of a manifold, then define the Laplacian first as a differential operator and then as an operator in L^2.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6205 Advanced algebra II

Advanced topics in algebra: group representations, associative algebras, commutative algebra, homological algebra, algebraic number theory, Lie algebras.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6206 Topics in advanced algebra

This course provides background in central advanced algebra topics needed to begin research. Topics covered include multilinear algebra, commutative algebra, homological algebra, and aspects of classical and algebraic group as an introduction to representation theory and algebraic geometry.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6207 Topics in applied mathematics

Topics selected from advanced applied mathematics.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6208 Topics in numerical analysis

The mathematical models of most scientific and engineering problems take the form of partial differential equations. With the rapid development of high performance computers over the past decades, the possibilities of efficiently utilizing these models have dramatically increased. The focus of this course is on scalable numerical methods for solving partial differential equations, with emphasis on the newly developed parallel algorithms, such as domain decomposition and multilevel methods.

Assessment: Class presentations and participation

Contact Person: Professor N Mok

MATH6209 Algebraic D-modules

The course will cover the basic theory of D-modules (modules over the algebras of differential operators with polynomial coefficients). The topics to be covered: (1) algebras of differential operators with polynomial coefficients (2) Bernstein dimension and Bernstein (3) multiplicity of D-modules (4) holonomic D-modules (5) inverse and direct images of D-modules (6) preservation of holonomicity under inverse and direct images (7) duality of D-modules (in particular holonomic duality).

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6210 Differential topology

This course is an introduction to several basic topological invariants for manifolds. Major topics are: differentiable manifolds and maps, Sard's Theorem, degree of maps, fundamental group, covering space, homology group. Students taking this course are expected to have knowledge in elementary analysis.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6211 Algebraic geometry

This is an introductory course of algebraic geometry in the style of Hartshorne's book. We will study the basics of varieties, schemes, sheaves on schemes, divisors, morphisms, differentials. The textbook will be Hartshorne's "Algebraic Geometry". The materials will be the first two chapters of the book. We will go through the first Chapter quickly and spend most of the time on Chapter 2. The knowledge of commutative algebra is crucial.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6212 Topics in algebraic geometry

It is a continuation of MATH6211 Algebraic Geometry as covered by Hartshorne's book "Algebraic Geometry". Topics include projective morphisms, differentials, formal schemes and cohomology theory.

Prerequisite: MATH6211 Algebraic Geometry
Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6213 Topics in differential topology

The course explores topics in Differential Topology including but not excluded to the following: fiber bundles, Morse theory, handle-body decomposition of manifolds, characteristic classes for vector bundles and their applications.

Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6214 Topics in analysis

Advanced topics in Analysis including topics in Real Analysis and Stochastic Analysis.

Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6215 Applied differential equations

Various topics selected from applied ordinary differential equations and applied partial differential equations. The selection of the topics depends on the field of interest of the instructor.

Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6216 Stochastic processes

Theory of Markov processes, second order stationary theory, Poisson and point processes, Brownian motion, Martingales and queueing theory.

Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6217 Topics in financial mathematics

This is a course intended for graduate students or ambitious undergraduate students who are interested in financial mathematics. Minimal knowledge in finance is needed as we shall introduce necessary backgrounds along our way. Starting from the basics, we shall describe fundamental results on optimization theory and its applications to optimal portfolio selection problems.

Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6218 Riemannian geometry I

This course is intended to provide a solid background in Riemannian Geometry. Topics include: affine connection, tensor calculus, Riemannian metric, geodesics, curvature tensor, completeness and some global theory. Students taking this course are expected to have knowledge in differential geometry of curves and surfaces.

Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6219 Topics in applied functional analysis

Topics will be chosen from the following list:
1. Generalized functions (also called distributions), delta function, generalized Fourier Transform. Applications to differential equations, Fundamental solution, Green's function. 2. Sobolev spaces, Sobolev Embedding Theorem, Trace. 3. Hilbert space linear operator theory (bounded operators, compact operators, closed unbounded operators), spectral theory. Applications on differential equations (infinitesimal generator, semigroup of linear operators). 4. Applications on optimization problems.
Wherever needed, we shall also review techniques for Metric spaces (Catergory Theorem), Banach spaces (Hahn-Banach Theorem, Opening Mapping Theorem, Closed Graph Theorem and Uniform Boundedness Principle) and Hilbert spaces (Orthogonality and best approximation, Fourier isometry).

Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6220 Real analysis II

This course provides more advanced topics in real analysis. Topics include signed measures, Hahn decomposition theorem, Lebesgue decomposition theorem, product measures, Fubini theorem, measure and topology, and Riesz representation theorem. Students taking this course are expected to have knowledge in Real Analysis (HKU: MATH6103) or its equivalent.

Assessment: Written or oral examinations
Contact Person: Professor N Mok

MATH6221 Riemannian geometry II

This is a continuation of Riemannian Geometry I (HKU: MATH6218). Advanced topics in Riemannian Geometry will be selected from: comparison theorems, Bochner method, Hodge theory, submanifold theory and variational formulas. Students taking this course are expected to have knowledge in Riemannian Geometry I (HKU: MATH6218) or equivalent.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6222 Harmonic analysis on p-adic groups and lie algebra

This is an introductory course on representation theory and harmonic analysis on p-adic groups and Lie algebras.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6223 Algebraic surfaces

This course will be an introduction to the theory of algebraic surfaces aiming at the Enriques-Kodaira classification. As a motivation for the classification of higher dimensional algebraic varieties, minimal model theory for algebraic surfaces will also be introduced. We will start with basic concepts in algebraic geometry from the classical approach (not dealing with schemes). As the most important tools in algebraic geometry, sheaves and their cohomology will be studied. After a brief discussion on algebraic curves, we will study intersection theory by focusing on algebraic surfaces. Positivity of line bundles plays a very important role in projective geometry. We will study vanishing theorems and numerical criteria for ampleness. Regarding the classification of algebraic surfaces, the Enriques-Kodaira classification theorem will be proved. We will also introduce the minimal model program for algebraic surfaces and study singularities of surfaces. If time permits, some selected topics will be discussed.

Assessment: Written or oral examinations

Contact Person: Professor N Mok

MATH6224 Topics in advanced probability theory

Selected topics from probability theory and related fields with their applications, including, but not limited to, probability theory, statistics, stochastic calculus, stochastic optimization, stochastic approximation, statistical inference, information theory and so on.

Assessment: Project reports and test

Contact Person: Professor G Han

MATH6501 Topics in algebra

This course aims to provide students specializing in mathematics with the opportunity to study some topics in algebra in greater depth. This course covers a selection of topics in algebra, such as group theory, rings and modules, Galois theory, quadratic forms, multilinear algebra, algebraic number theory, group representation, introduction to commutative algebra, Groebner basis theory, introduction to algebraic geometry. The selected topics may vary from year to year.

Assessment: Continuous assessment and written examinations

Contact Person: Head of Department

MATH6502 Topics in applied discrete mathematics

This course aims to provide students with the opportunity to study some further topics in applied discrete mathematics.

A selection of topics in discrete mathematics applied in combinatorics and optimization (such as algebraic coding theory, cryptography, discrete optimization, etc.) The selected topics may vary from year to year.

Assessment: Continuous assessment and written examinations

Contact Person: Head of Department

MATH6503 Topics in advanced optimization

A study in greater depth of some special topics in mathematical programming or optimization. It is mainly intended for students in Operations Research or related subject areas.

This course covers a selection of topics which may include convex, quadratic, geometric, stochastic programming, or discrete combinatorial optimization. The selected topics may vary from year to year.

Assessment: Continuous assessment and written examination

Contact Person: Head of Department

MATH6504 Geometric topology

This course gives a geometric introduction to some of the methods of algebraic topology. The emphasis throughout will be on the geometric motivations and applications of the theory. Continuity, compactness, connectedness, the fundamental group, triangulations and classification of surfaces, theory and applications of simplicial homology, theory of covering spaces.

Assessment: Continuous assessment and written examination

Contact Person: Head of Department

MATH6505 Real analysis

The aim of the course is to introduce the basic ideas and techniques of measure theory and the Lebesgue integral.

Assessment: Continuous assessment and written examination

Contact Person: Head of Department

MATH6901 Graduate seminar in pure mathematics

This course aims to familiarize students with some basic notions in graduate-level pure mathematics and to train students on seminar Presentations.

This seminar will revolve around a subject area in pure mathematics to be determined each time the course is offered. Students enrolled in the course will be involved in the presentation of materials from books or research papers.

Assessment: Presentations

Contact Person: Professor J H Lu

MATH6902 Graduate seminar in applied mathematics

This seminar is intended especially for graduate students in applied mathematics. Students enrolled in the class prepare several presentations based on research papers or books.

Topics include numerical analysis, control theory, stochastic modeling, data mining and advanced computation.

Assessment: Presentations

MATH6903 Independent studies

To allow the student to pursue the study of special topics not available in regular graduate courses. The special topic(s) need to be agreed upon between the student and the supervisor(s), who will make proper arrangement to allow the student to consult an expert/experts on the topic on a regular basis during the course of a semester.

Assessment: Reports made to the supervisor(s)

Contact Person: Professor N Mok

* SSAF6001 Basic Laboratory Safety Course for RPg Candidate in the Faculty of Science

In order to enhance the safety awareness and knowledge of Science RPg students, a 3-hour safety course will be made compulsory to RPg students of the following registration dates:

- MPhil candidates registered on or after January 1, 2009
- 3-year PhD candidates registered on or after January 1, 2008
- 4-year PhD candidates registered on or after January 1, 2007

The Basic Laboratory Safety Training will be conducted by the Safety Office twice a year (i.e. normally in Sept and Jan).

RPG students are required to enroll this course during the online enrolment period. Please note that students, who have successfully completed this course requirement before, need not retake this course again.