

*2009 – 10 Course Selection for  
BScII – III*

*Major or Minor in Mathematics*

*Dr. Yung Siu Pang*

*Department of Mathematics HKU*

# *Major in Mathematics (students admitted in 2006 or before)*

## 1. Introductory Level Courses (30 credits)

<b>MATH1101</b>	<b>Linear Algebra I</b>
<b>MATH1102</b>	<b>Linear Algebra II</b>
<b>MATH1201</b>	<b>Calculus I</b>
<b>MATH1202</b>	<b>Calculus II</b>
<b>MATH1001</b>	<b>Fundamental Concepts of Mathematics</b>

## 2. Advanced Level Courses (48 credits)

<b>MATH2301</b>	<b>Algebra I</b>
<b>MATH2401</b>	<b>Analysis I</b>

**Plus at least 36 credits of advanced level Mathematics course (MATH2XXX or MATH3XXX level)**

# *Major in Mathematics (students admitted in 2007 or after)*

## 1. Introductory level courses (18 credits)

MATH1001 Fundamental Concepts of Mathematics  
MATH1111 Linear Algebra  
MATH1211 Multi-variable Calculus

## 2. Advanced level courses (48 credits)

MATH2201 Introduction to Mathematical Analysis  
MATH2301 Algebra I  
MATH2401 Analysis I

## Plus at least 18 credits from the following courses:

MATH2304 Introduction to Number Theory  
MATH2403 Functions of a Complex Variable  
MATH2405 Differential Equations  
MATH2600 Discrete Mathematics  
MATH2601 Numerical Analysis  
MATH2603 Probability Theory  
MATH2901 Operations Research I  
MATH2904 Introduction to Optimization

Plus at least 12 credits of advanced level Mathematics courses (MATH2XXX or MATH3XXX level), subject to prerequisite requirements.

# *MATH2301 Algebra I*

- Study of groups, rings and fields.
- Useful to MATH3302 Algebra II, MATH3310 Topics in Algebra and MATH3502 Geometric Topology.
- Teacher: Prof. J.H. Lu (*UC Berkeley*)



# *MATH2401 Analysis I*

- Study metric topology and several important results in multi-variable differential calculus.
- Prerequisite of almost all pure mathematics courses.
- Teacher: Prof. W.S. Cheung (*Harvard*)



# *Major in Mathematics*

Most math majors follow one of the following three main themes:

- **(Pure) Mathematics (Math)**
- **Computational Mathematics, Logistics/  
Operations Research (CMOR)**
- **Mathematics, Economics and Finance  
(MAEF)**

# *Major in Mathematics - Math*

## **Recommended Courses:**

**MATH2303 Matrix Theory and its Applications**

**MATH2304 Introduction to Number Theory**

**MATH2402 Analysis II**

**MATH2403 Functions of a Complex Variable**

**MATH3302 Algebra II**

**MATH3404 Functional Analysis**

**MATH3501 Geometry**

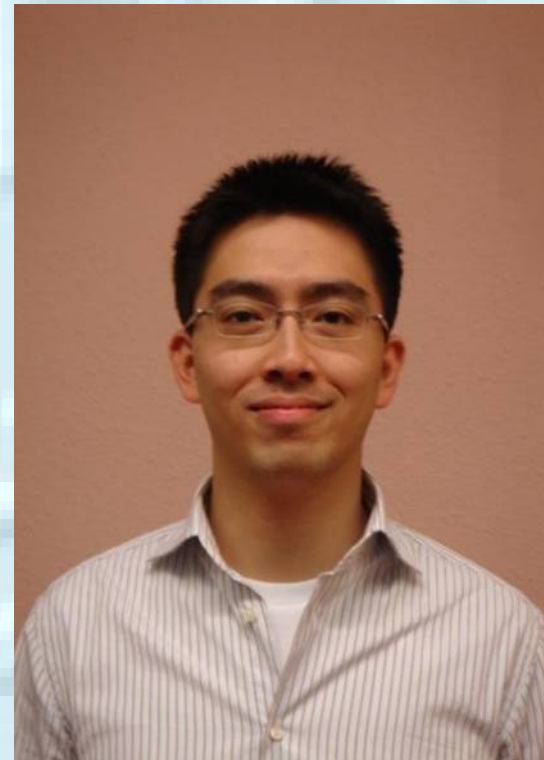
**MATH3502 Geometric Topology**

**MATH2001 Development of Mathematical Ideas**

**MATH3406 Introduction to Partial Differential Equations**

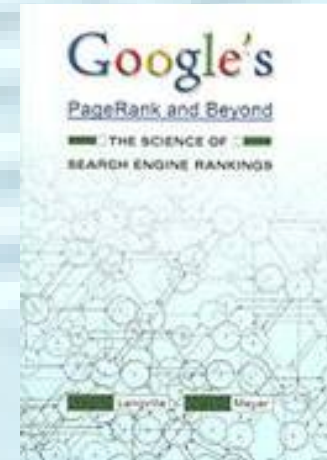
# *MATH2303 Matrix Theory and its Applications*

- Second course in Linear Algebra
- Useful to MATH2601 Numerical Analysis, MATH3602 Scientific Computing and Operation Research courses
- Related to MATH3404 Functional Analysis
- Teacher: Dr. Y.M. Chan (*Oxford*)





# *MATH2303 Matrix Theory and its Applications*



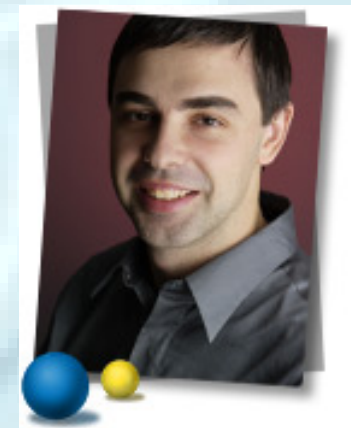
- Matrix theory is extremely useful in the studies of applied and pure mathematics, statistics, economics, finance, engineering, etc.
- For example, it is used in **image processing** and **search engines** like Google.
- See the book, *Google's PageRank and beyond : the science of search engine rankings* by Amy N. Langville and Carl D. Meyer.

# *MATH1111 Linear Algebra*



Larry Page

Google™



Sergey Brin

“The heart of our software is **PageRank™**, a system for ranking web pages developed by our founders **Larry Page** and **Sergey Brin** at Stanford University.”

# *MATH2402 Analysis II*

- Modern treatment of calculus in several variables.
- Introduction to the concept of **differential forms** and **manifolds** (“higher dimensional surface”).
- Useful to the studies of Differential and Algebraic Geometry and General Relativity, etc.
- Teacher: Prof. W.S. Cheung (Harvard)

# *MATH2402 Analysis II*

The one – variable fundamental theorem of calculus:

$$\int_a^b f'(x)dx = f(b) - f(a)$$

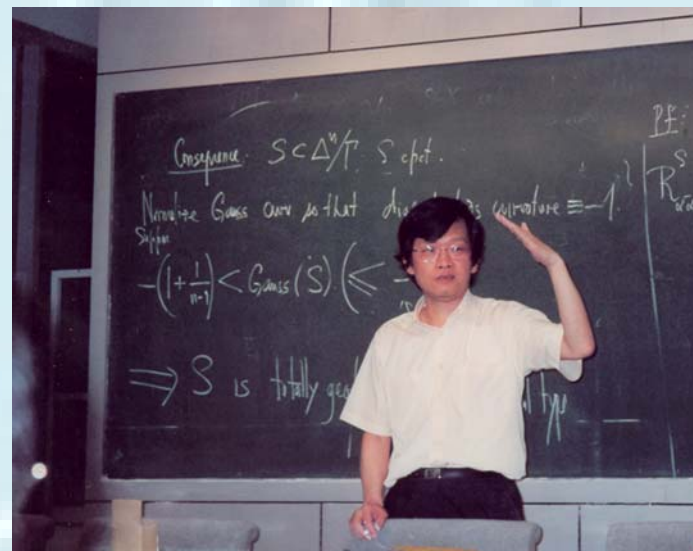
is generalized to manifold:

Stokes' theorem

$$\int_{\partial c} \omega = \int_c d\omega$$

# MATH2403 Functions of a Complex Variable

- Carry out calculus on the complex plane.
- Study of “differentiable” functions of a complex variable which have many nice and interesting properties.
- Useful to the studies of almost all branches of pure mathematics and theoretical physics such as quantum mechanics.
- Teacher: Prof. N. Mok (*Stanford*)



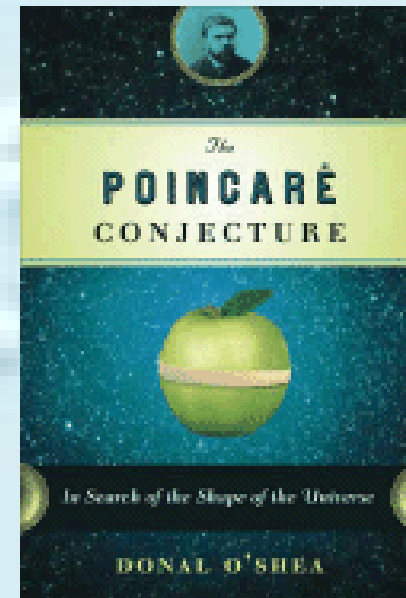
# *MATH3501 Geometry*

- Use multi-variable calculus to study geometry of curves and surfaces in 3-space.
- Useful to the studies of Differential and Algebraic Geometry and General Relativity, etc.
- Teacher: Prof. J.H. Lu (*UC Berkeley*)



# MATH3502 Geometric Topology

- Introduction to Algebraic Topology.
- Useful to the studies of Differential and Algebraic Geometry and General Relativity, etc.
- For recent important breakthrough in topology, see the book *The Poincaré conjecture: in search of the shape of the universe* by Donal O'Shea.
- This course is not offered in the academic year 2009 – 10.



# *Major in Mathematics – CMOR*

## **Recommended courses:**

**MATH2303 Matrix Theory and Its Applications**

**MATH2601 Numerical Analysis**

**MATH2603 Probability Theory**

**MATH2901 Operations Research I**

**MATH2904 Introduction to Optimization**

**MATH2905 Queuing Theory and Simulation**

**MATH3602 Scientific Computing**

**MATH3902 Operations Research II**

**MATH3903 Network Models in Operations Research**

**MATH3610 Topics in Applied Discrete Mathematics**

**MATH3910 Topics in mathematical Programming and optimization**

**BUSI1003 Introduction to Management Information System**

**CSIS1119 Introduction to Data Structures and Algorithms**

**ECON0701 Introductory Econometrics**

**STAT3301 Time-series Analysis**



# *Major in Mathematics – CMOR*

- Courses in Computational Mathematics and Operations Research are taught by experts in these two areas.
- For operations research:  
Prof. S.C.K. Chu (*Columbia*)  
Dr. W.K. Ching (*CUHK*)  
Prof. W. Zang (*Rutgers*)
- For computational mathematics:  
Dr. K.H. Chan (*CUHK*)  
Dr. G.Y. Han (*Notre Dame*)

The operations research courses mainly study different types of the constraint optimization problems.

# *Major in Mathematics – CMOR*

## *Operations Research Group*

Prof. S.C.K. Chu, Prof. W. Zang, Dr. W.K. Ching  
(Prof. K.P. Ng)



# *Major in Mathematics – CMOR*

## *Constrained Optimization Problem:*

- Max/Min  $f(x_1, \dots, x_n)$  under the constraints  $g_i(x_1, \dots, x_n) = 0$ ,  $i = 1, \dots, m$ .
- **MATH2901** *Operational Research I* and **MATH3902** *Operational Research II* study this optimization problem when all these functions are linear.
- **MATH2904** *Introduction to Optimization* studies the same optimization problem when some of these functions are **non-linear** by using multi-variable calculus.
- Numerical methods may be employed.

# Major in Mathematics – CMOR



*Constrained Optimization Problem (an example):*

Customers redistribute themselves based on the perceived service performance (queuing time and traveling time) and customer loyalty.

**Goal: Try to predict the final customer redistribution.**

# *Major in Mathematics – CMOR*

## *Job Opportunities:*

- Logistics companies
- Airport Authority Hong Kong
- Banks (data mining)
- Software companies

# *Major in Mathematics – MAEF*

## **Recommended courses:**

- **MATH2906 Financial Calculus**
- **MATH2907 Numerical Methods for Financial Calculus**
- **BUSI1002 Introduction to Accounting**
- **ECON2101 Microeconomics Theory**
- **ECON2102 Macroeconomics Theory**
- **FINA1001 Introduction to Finance**
- **FINA2802 Investments**



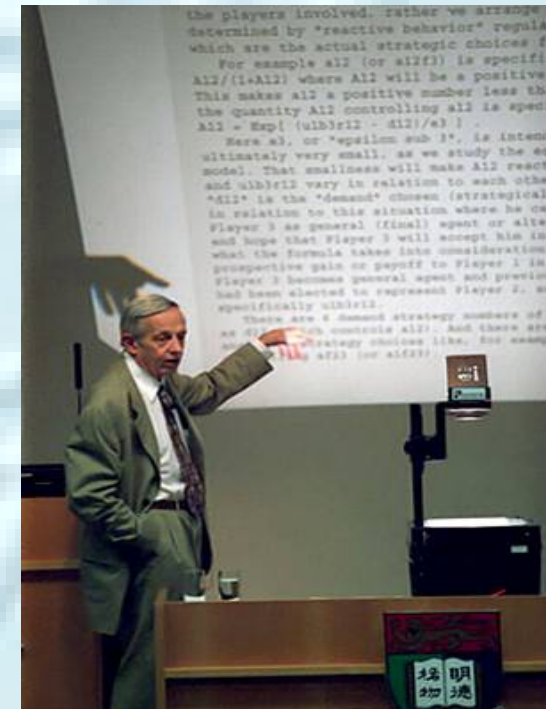
*Major in Mathematics  
Minor in Economics or  
Finance or Risk  
Management!*

Students can prepare the level I examination of *Chartered Financial Analyst* by taking suitable courses in this category.

# Major in Mathematics – MAEF

Nobel Prize (Economics) Laureates since 90's  
of the last century who have a math degree:

- 2007 Eric S. Maskin (PhD in applied math)
- 2007 Roger B. Myerson (PhD in applied math)
- 2005 Robert J. Aumann (BS, MS, PhD in math)
- 2004 Edward C. Prescott (BA in math, MS in operations research)
- 2003 Clive W. J. Granger (BA in math)
- 2002 Daniel Kahneman (BA in math and psychology)
- 2001 Michael Spence (BA, MA in math)
- 2000 James J. Heckman (BA in math)
- 1998 Amartya Sen (BA minor in math)
- 1997 Robert C. Merton (BS, MS in applied math)
- 1996 James A. Mirrlees (MA in math)
- 1996 William Vickrey (BS in math)
- 1994 **John F. Nash Jr.** (PhD in math)
- 1994 Reinhard Selten (PhD in math)
- 1992 Gary S. Becker (BA in math)



*John F. Nash Jr. in HKU*

# *Major in Mathematics – MAEF*

*Major in Mathematics*

*Minor in Economics/ Finance/ Risk Management*

Master/PhD in  
Economics

Master/PhD in  
Finance

Master/PhD in  
Risk Management

*Mathematics is the common language in these areas  
and it is easier to learn math when you are young.*



# *Major in Mathematics – MAEF*

Luo Guannan (a math major) is now doing a PhD in Economics at Northwestern University.

If you plan to do a master or PhD in economics or finance, the following courses are recommended:

MATH2401 Analysis I

MATH2901/3902 OR I and II

MATH2904 Introduction to Optimization

MATH2911 Game Theory and Strategy

MATH2906 Financial Calculus

MATH2907 Numerical Methods for Financial Calculus

STAT3301 Time-series Analysis

STAT3316 Advanced Probability



# *Computational Finance*

Many investment banks employ mathematicians to do risk management or computational finance.



**Dr. Lau Chi Fong (PhD in number theory)**  
**Former Head of Market Risk Management**  
**HSBC Global Markets**

# *Computational Finance*

- Usually need a PhD in Mathematics/Physics/Computer Sciences/Statistics to do quantitative finance in investment banks.
- Develop and analyze new financial products.
- Write programs to evaluate the price of financial derivatives.
- Mathematical modeling skills.
- Computing skills, e.g., Visual Basic.

# *Computational Finance*

## **Recommended courses:**

- **MATH2906 Financial Calculus**
- **MATH2907 Numerical Methods for Financial Calculus**
- MATH2603 Probability Theory
- MATH2601 Numerical Analysis
- MATH3602 Scientific Computing
- MATH3406 Introduction to PDE
- **STAT3301 Time-series Analysis**
- **STAT3316 Advanced Probability**

# *Computational Finance*

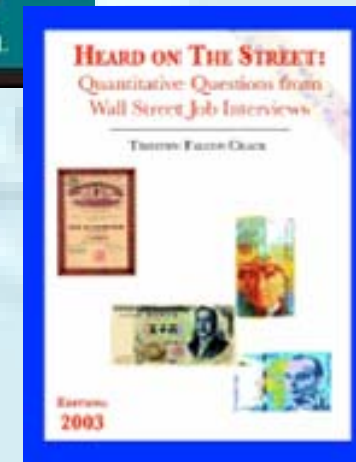
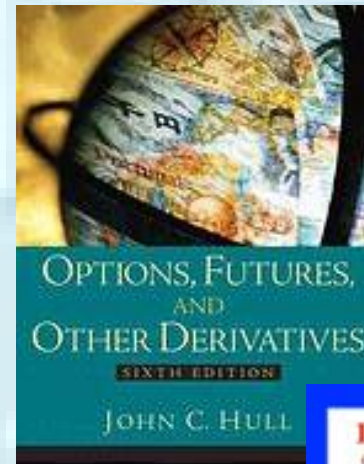
## **MATH2906 Financial Calculus**

- Modeling of financial derivatives, asset pricing and market risks
- Introduction to stochastic calculus
- Provide a solid background for future study in quantitative finance.
- Prerequisite: MATH2603 Probability Theory
- Good knowledge of partial differential equations and probability theory is needed for further studies.

# Computational Finance

## Suggested Readings:

- *Options, futures, and other derivatives* by John C. Hull
- *An elementary introduction to mathematical finance* by Sheldon M
- *Heard on the street : quantitative questions from Wall Street job interviews* by Timothy Falcon Crack.



# *General Mathematics Courses*

- **MATH0011 Numbers and Patterns in Nature and Life**
- **MATH2001 Development of Mathematical Ideas**
- **MATH2304 Introduction to Number Theory**
- **YSCN0002 Mathematics: A Cultural Heritage**
- **YSCN0034 Hidden Order in Daily Life: A Mathematics Perspective**

# *MATH2304 Introduction to Number Theory*

Dr. YK Lau  
(*HKU*)

Expert in  
modular forms  
and L-functions



Prerequisites: MATH1111 and  
MATH1211

Co-requisite: MATH2301.

Enrollment needs instructors' approval.

Prof. KM Tsang  
(*Princeton*)

Expert in  
Riemann's zeta  
function and  
analytic number  
theory.

Student of Prof.  
Atle Selberg (1950  
Fields-Medallist)



# *MATH2304 Introduction to Number Theory*

Strong tradition in number theory in our  
department

Prof. K.M. Tsang



Prof. M.C.Liu

World expert in  
Goldbach's  
conjecture

Fields-Medallist, Prof. Alan Baker

# *YSCN0034 Hidden Order in Daily Life: A Mathematical Perspective*

Through exploring non-technically some mathematically rich daily life topics, this course aims to help students gain essential mathematical literacy for living in the 21st century.

Students will learn the mathematical concepts and principles of things that they encounter in the modern society, and learn how to handle and interpret numerical and other forms of mathematical data that affect their daily life.

# *YSCN0034 Hidden Order in Daily Life: A Mathematical Perspective*

Some selected topics are:

- Game Theory and Auction
- Mathematics of Voting
- Some Mathematical Principles of the Stock Markets
- Mathematics in the Courtroom
- Benford's Law and Detecting Fraud in Accounting Data

# *Major in Mathematics (requirement)*

## **3. Experiential Learning Requirement (6 credits)**

Students (admitted in 2007 or after) must take at least one of the following forms of extraordinary – learning experience to fulfill the capstone requirement:

MATH2002 Mathematics seminar (6 credits)

MATH2999 Directed studies in mathematics (6 credits)

MATH3988 Mathematics Internship (6 credits)

MATH3999 Mathematics project (12 credits)

Exchange programme via HKU World Wide Exchange Programme (1 semester or 1 year) (non – credit bearing)<sup>#</sup>

## **4. Students also need to take two Science Faculty electives: One course from Block B (The Physical World) and one course from Block C (Life & Living)**

# Students must take an additional 6-credit advanced level mathematics course.

# *MATH2002 Mathematics Seminar*

- This course is offered in the 2nd semester.
- This is a seminar style course intended for those **year one students** who have very strong interests and good ability in mathematics.
- Study some book chapters and elementary research articles and make presentations in front of the whole class.
- Active participation in all the discussions is expected. The aim of the course is to let students learn how to initiate self/independent study in mathematics.

## *MATH2002 Mathematics Seminar*

- Prerequisites: MATH1001, MATH1111 and MATH1211 (one of MATH1111 and MATH1211 can be co-requisite).
- Enrollment needs instructors' approval.
- Quota:12.
- It will be run by Prof. K.M. Tsang, Dr. N.K. Tsing and Dr. S.P. Yung this year.

# *MATH2002 Mathematics Seminar*

- Teaching: Meeting of the whole class for two hours each teaching week, plus individual meetings with the instructors.
- Assessment:
  - Coursework assessment (70%), based on class presentations, participation in discussions and a written report.
  - Final written examination of 2 hours (30%).

# *MATH2002 Mathematics Seminar*

The following topics were covered last year.

- Convex geometry (Helly's theorem)
- Euler's characteristics
- Hyperbolic geometry (Basic notions)
- Isoperimetric problem
- Markov chain
- Marriage's lemma
- Mathematics in voting (Arrow's Impossibility Theorem)
- Pagerank algorithm
- Sperner's lemma
- SIR model
- Zorn's Lemma



# *MATH2999 Directed Studies in Mathematics*

This course is designed for a student who would like to take an early experience on independent study. It provides the student with the opportunity to do a small mathematics project close to research in nature independently.

Selected topics in the past years:

- Exploration of the technical analysis of finance data
- Fibonacci sequence, the golden ratio, and patterns in plants: Phyllotaxis
- The Plateau problem
- Microarray data and diagnosis of cancer
- Positive rational solutions to some diophantine equations
- Coxeter Groups
- Riemann surfaces and / or complex manifolds
- Linear geometry in Euclidean 4-space
- Open problems in affine algebraic geometry and commutative/noncommutative algebra

# *MATH3988 Mathematics Internship*

This course aims to offer students the opportunities to gain work experience in the industry related to their major of study. Students have to take on at least 120 hours of internship work either within the University or outside the University arranged by the School/Departments.

Available in 1st, 2nd, and the summer semester.

**Assessment:** Required to submit a written report and to give a presentation on their internship experience. This course will be assessed on **Pass or Fail** basis.

# *MATH3988 Mathematics Internship*

In the past years, our students interned at various organizations: for example

- **AECOM:** A Fortune 500 company, serves clients in more than 100 countries and provides professional technical and management support services to a broad range of markets, including transportation, facilities, environmental and energy.
- **Hong Kong Observatory**
- **Secondary school**

Teachers in the Math Department also offered internship in the summer.

# *MATH3999 Mathematics Projects*

The object is to provide a student with an opportunity to formulate and investigate, in depth, a problem of practical interest and/or have a foretaste of mathematical research. The work, to be done on an individual basis, is considered a highly desirable part of the training of a mathematician.

# *MATH3999 Mathematics Projects*

## Topics:

- Nonnegative matrices and their Perron roots (Dr. J.T. Chan)
- Numerical Simulation in Fluid Dynamics (Dr. K.H. Chan)
- Calculus of Variations (Professor W.S. Cheung)
- Genetic Regulatory Networks and Probabilistic Boolean Networks (Dr. W.K. Ching)
- Project Scheduling via Network Models: independent study & computer implementation (Professor S.C.K. Chu)
- Mathematical Problems in Network Coding (Dr. G.Y. Han)
- Arithmetical Functions and Dirichlet Series (Dr. Y.K. Lau)
- Introduction to Algebraic Geometry (Professor J. Lu)
- Solving Non-Linear Differential Equations (Dr. T. W. Ng)
- Dirichlet's Divisor Problem (Professor K.M. Tsang)
- Higher Rank Numerical Ranges (Dr. N.K. Tsing)
- Supersymmetric Quantum Mechanics and the Witten Index (Dr. S. Wu)

# *Exchange Programme (non – credit bearing)*

**MIT**



**University of California, Berkeley**



**University of Lund**

# *Further Studies*

**Columbia  
University**



**MIT**



**New York University**



*What should I do if I want  
to be a minor in mathematics?*



# *Minor in Mathematics (requirement)*

1. Introductory level courses (12 credits)

MATH1111 Linear Algebra

**Plus** one of the following courses

MATH1211 Multi – variable Calculus

MATH1805 University Mathematics B

MATH1813 Mathematical Methods for Actuarial Science

2. Advanced level courses (24 credits)

Any 24 credits of advanced level Mathematics courses (MATH2XXX or MATH3XXX level), subject to prerequisite requirements.

# *Minor in Mathematics*

If you are interested in mathematics and would like to be a minor in mathematics, the following courses are recommended:

**MATH2001 - Development of Mathematical Ideas**

**MATH2201 - Introduction to Mathematical Analysis**

**MATH2301 - Algebra I**

**MATH2405 - Differential Equations**

**MATH2600 - Discrete Mathematics**

**MATH2601 - Numerical Analysis**

**MATH2603 - Probability Theory**

**MATH2901 - Operations Research I**

# *Minor in Mathematics*

If you would like to be a minor in math and plan to pursue a **master/PhD in economics/finance**, the following courses are recommended:

**MATH2401 Analysis I**

**MATH2901/3902 Operations Research I/II**

**MATH2904 Introduction to Optimization**

**MATH2906 Financial Calculus**

**MATH2907 Numerical Methods for Financial Calculus**

**STAT3301 Time-series Analysis**

**STAT3316 Advanced Probability**

# *Minor in Mathematics*

If you would like to be a minor in math and plan to pursue a **master/PhD in computational/mathematical finance** in the future, the following courses are recommended:

**MATH2906 Financial Calculus**

**MATH2907 Numerical Methods for Financial Calculus**

**MATH2603 Probability Theory**

**MATH2601 Numerical Analysis**

**MATH3602 Scientific Computing**

**MATH3406 Introduction to PDE**

**STAT3301 Time-series Analysis**

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# *Minor in Mathematics*

If you would like to be a minor in math and plan to pursue a **master/PhD in computational/mathematical finance** in the future, the following courses are recommended

**MATH2906 Financial Calculus**

**MATH2907 Numerical Methods for Financial Calculus**

**MATH2603 Probability Theory**

**MATH2601 Numerical Analysis**

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**MATH3406 Introduction to PDE**

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# *Bridging Courses in Mathematics*

Students with different mathematics background can major or minor in mathematics by taking suitable bridging courses and follow different paths.

For more information, please visit the following link

[http://hkumath.hku.hk/~wkc/advisor\\_major.htm](http://hkumath.hku.hk/~wkc/advisor_major.htm)

*Differentiate yourself from the competitions*

Major in math is a good indicator:

**Good in Math = Intelligent**

**Good in Math = Flexible**

# *Further Enquiries: Course Selection Advisors*

## Year One:

Dr. Y.K. Lau ([yklau@maths.hku.hk](mailto:yklau@maths.hku.hk))

Dr. C.W. Wong ([cwwongab@hkusua.hku.hk](mailto:cwwongab@hkusua.hku.hk))

## Year Two and Three:

Dr. G. Han ([ghan@maths.hku.hk](mailto:ghan@maths.hku.hk))

Dr. S.P. Yung ([spyung@hkucc.hku.hk](mailto:spyung@hkucc.hku.hk)) (2nd sem)

Prof. W. Zang ([wzang@maths.hku.hk](mailto:wzang@maths.hku.hk)) (1st sem)

[http://hkumath.hku.hk/web/info/math\\_student.html](http://hkumath.hku.hk/web/info/math_student.html)

*End*