2013-14 Course Selection for BScI

4 Year Program

Major or Minor in Mathematics

Minor in Computational and Financial Mathematics

Dr. Tuen Wai NG

Department of Mathematics, HKU

Major in Mathematics

- **What is Mathematics?**
- **What could I learn from Mathematics?**
- **How should I plan my career with a Mathematics degree in mind?**

What is mathematics ?

- Wikipedia: "Mathematics" comes from the Latin word "mathematica" which means "science, knowledge, or learning"
- Oxford dictionary: Science of numbers, quantity and space.

- Mathematics is nothing but clear thinking

----Richard Hamming (1915-1998)

Characteristics of mathematics:

abstract

precise

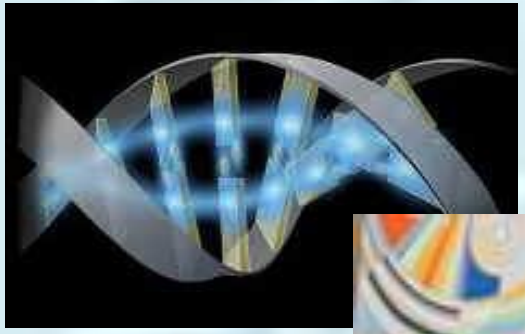
logical reasoning

Why take mathematics as career ?

- "Absolute truth" of mathematics
- Fascinated by the beauty of mathematics
- Many mathematicians think mathematics is like poetry, painting, …
- Appreciate the usefulness of mathematics

Mathematics is useful

- Science and Technology
  - physical science
  - biological and medical science
  - engineering
  - architecture
  - telecommunication
  - ……
- Social Science and Business
  - economics
  - finance
  - logistics
  - ……



What could I learn from Matheamtics?

- **Knowledge that underneath a lot of subjects such as science, economics, finance, engineering … etc. in addition to mathematics itself.**
- **How should I plan my career with a Mathematics degree in mind?**
- **Stay tune!**

Major in Mathematics (requirement)

1. **Introductory level courses (48 credits)**
   a) **Science Foundation Courses (12 credits)**
      SCNC1111 Scientific Method and Reasoning (6)
      SCNC1112 Fundamentals of Modern Science (6)
   b) **Disciplinary Courses (36 credits)**
      MATH1013 University Mathematics II (6)
      MATH2012 Fundamental Concepts of Mathematics (6)
      MATH2101 Linear Algebra I (6)
      MATH2102 Linear Algebra II (6)
      MATH2211 Multivariable Calculus (6)
      MATH2241 Introduction to Mathematical Analysis (6)

2. **Advanced level courses (42 credits)**
   MATH3301 Algebra I (6)
   MATH3401 Analysis I (6)
   MATH3403 Functions of a Complex Variable (6)

Plus at least 24 credits of advanced level Mathematics courses (MATH3XXX or MATH4XXX or MATH6XXX level), at least 12 credits of which should be from MATH4XXX or MATH6XXX level, excluding MATH4988 Mathematics Internship, subject to pre – requisite requirements.

Major in Mathematics (requirement)

Notes

1. Students must have level 2 or above in HKDSE Extended Module 1 or 2 or equivalent to take this major.

   Students who do not fulfill this requirement are advised to take MATH1011 University Mathematics I.

2. The two courses MATH1851 *Calculus and ordinary differential equations* and MATH1853 *Linear Algebra, probability and statistics* together are deemed equivalent to MATH1013 *University Mathematics II*. However, students have to take an extra MATH2xxx course to replace MATH1013 to fulfill the credit requirement.

Major in Mathematics (requirement)

Notes

3. Double counting of courses up to a maximum of 24 credits is permissible when a student with a science major opts to undertake a second major in science. The double – counted courses must include SCNC1111 Scientific method and reasoning (6 credits) and SCNC1112 Fundamentals of modern science (6 credits). Additional credits to be double – counted must be for courses required by both majors. For cases with 24 or less double – counted credits, the student must make up an equivalent number of credits by taking other course offered by any faculty.

4. If more than 24 credits (including SCNC1111 or SCNC1112) are listed as required courses in both the first and second majors undertaken by a student, the student must make up the number of credits is not permissible for major – minor or double – minors combinations. For details, please refer to the BSc Syllabus.

SCNC1111 Scientific Method and Reasoning

- To give students a holistic view of the science discipline in terms of its nature, its history, its fundamental concepts, its methodology, and its impact on civilization and the society.
- To equip students with basic skills of logical and quantitative reasoning.
- To introduce to students mathematical and statistical methods that are used in science studies and research.

SCNC1111 Scientific Method and Reasoning

Part I ***(The Nature and Methodology of Science)***

In this part students will investigate the nature and methodology of science through a historical and philosophical study of the scientific revolution.

They will be introduced to two key aspects of scientific methodology: empiricism, through its historical development in the work of Bacon and Galileo, and falsification, through its modern articulation by Karl Popper.

These aspects are then used to provide perspectives on the nature of scientific progress in the context of the acceptance of the Copernican worldview, and on the difference between science and pseudo-science.

The course emphasizes the fundamental interconnectedness of the sciences through Descartes' development of an explanatory framework based on mechanism and its role in the discovery of the circulation of the blood by William Harvey.

This historical episode, and the background to the scientific revolution more generally, provides an opportunity to explore the social, economic, and ethical connections of science to wider society.

SCNC1111 Scientific Method and Reasoning

Part II (Mathematical and Statistical Reasoning)

In this part students will learn how to apply mathematical and statistical reasoning and choose suitable mathematical and statistical methods and tools to analyse and solve scientific problems.

Students will first be introduced to some key elements of the foundation of mathematics, statistics, and probability. Some historical and recent examples of how mathematics has helped scientific discoveries will be shown.

A lecture will be devoted to Fermi problems, in which students will learn how to make reasonable assumptions and integrate simple mathematics and logical deductions to make educated guesses.

Then students will learn some topics in mathematics and statistics and their applications on science. Each of these topics is motivated by a well-defined scientific problem(e.g., investigating the spread of an epidemic).

The required mathematics will be studied based on the need of those problems, and the connection between the mathematics/statistics part and the scientific problem under consideration is more pronounced.

Under some of the topics, students will be shown how to use the computer to do simulation and to solve the problems.

SCNC1112Fundamentals of Modern Science

- This course introduces the fundamental physical and biological principles that govern the structures and processes of matter and living systems, from subatomic particles, to living organisms, Earth and planetary environment, and to the large scale structure of the Universe.
- The goal is to enable students to understand the connectivity of the different matter and living systems, the interrelationships among the various scientific disciplines, and the current state of the development in modern science.

SCNC1112Fundamentals of Modern Science

Outline:

Part 0: Universal principles and unifying concepts of science

- **Universal principles of science: *Unifying concepts of science***

Part I: The Physical World

Part II: Earth and Beyond

- **Motion and Newtonian Gravity**
- **Theory of General Relativity, Gravity and Cosmology**
- **Earth and Other Planets**
- **Earth's Atmosphere and hydrosphere**

Part III: Chemical Reactions

- ***Unifying concept:* Atoms in Combination / Entropy**
- ***Unifying concept:* water**

Part IV: Life Systems

Introductory level courses

Science Foundation Courses

SCNC1111	Scientific Method and Reasoning
SCNS1112	Fundamentals of Modern Science

Disciplinary Courses#

MATH1013	University Mathematics II
MATH2012	Fundamental Concept of Mathematics
MATH2101	Linear Algebra I
MATH2102	Linear Algebra II
MATH2211	Multivariable Calculus
MATH2241	Introduction to Mathematical Analysis

Available in Both Semesters.

MATH1013 University Mathematics II

- This course aims at students with
  - Core Mathematics plus Module 1 or
  - Core Mathematics plus Module 2 background.
- Provides them with basic knowledge of calculus and some linear algebra that can be applied in various disciplines.
- It is expected to be followed by courses such as MATH2012 (Fundamental concepts of mathematics), MATH2101 (Linear Algebra I), MATH2102 (Linear Algebra II), MATH2211 (Multivariable calculus), and MATH2241 (Introduction to mathematical analysis).

MATH1013 University Mathematics II

Contents:

- Functions; graphs; inverse functions
- Limits, continuity and differentiability
- Mean value theorem; implicit differentiation; L'Hopital's rule
- Higher order derivatives, maxima and minima, graph sketching
- Radian, calculus of trigonometric functions
- Improper integrals, partial fractions, integration by parts
- Complex numbers, polar form, de Moivre's formula
- Basic matrix and vector (of order 2 and 3) operations, determinants
- First order ordinary differential equations

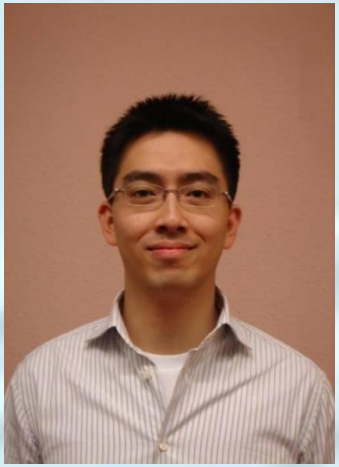
MATH1013 University Mathematics II

- Prerequisites:
  - Level 2 or above in Module 1, or Module 2 of HKDSE Mathematics or equivalent.
  - Students who do not fulfill this requirement are advised to take MATH1011 University mathematics I.
- Teaching:
  - Lectures (36 Hours).
  - Tutorials (12 Hours).
  - Reading/Self study (100 Hours)
- Assessment:
  - One 2.5-hour written examination (50% weighting).
  - Continuous coursework assessment (50% weighting)

MATH1013 University Mathematics II

Teacher (1st Semester):

Dr. Y.M. Chan



Textbook/Reference:

Lecture Notes

MATH1013 University Mathematics II

Teacher (2nd Semester):

Dr. Benjamin Kane

Textbook/Reference:

Lecture Notes

MATH2012 Fundamental Concepts of Mathematics

- To provide students with solid background on fundamental concepts of mathematics and methods of mathematical proofs.
- Such concepts and methods are important for subsequent studies in all higher level courses in mathematics.
- This course can be taken concurrently with other level 2 or above courses.

MATH2012 Fundamental Concepts of Mathematics

- Logic and Set Theory :
  - Statement calculus
  - finite and infinite sets
  - relations and mappings
  - completeness of real numbers,….
- Axiomatic systems in mathematics:
  - models of the natural numbers
  - the real numbers
  - non-Euclidean geometries
  - Examples of groups

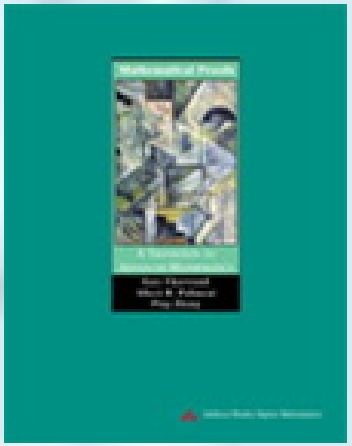
MATH2012 Fundamental Concepts of Mathematics

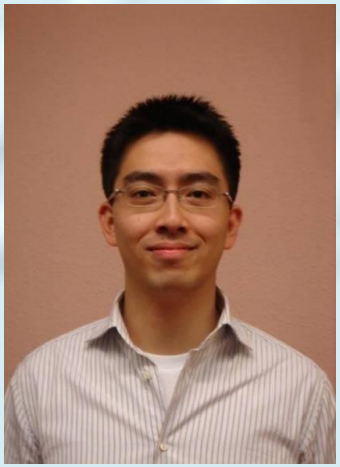
- Prerequisites:
  - Pass in MATH1013 University mathematics II or (MATH1851 Calculus and ordinary differential equations and MATH1853 Linear algebra, probability and statistics).
- Teaching:
  - Lectures (36 Hours).
  - Tutorials (12 Hours).
  - Reading/Self study (100 Hours)
- Assessment:
  - One 2.5-hour written examination (50% weighting).
  - Continuous coursework assessment (50% weighting)

MATH2012 Fundamental Concepts of Mathematics

Teacher (both semesters):

Dr. Y.M. Chan.





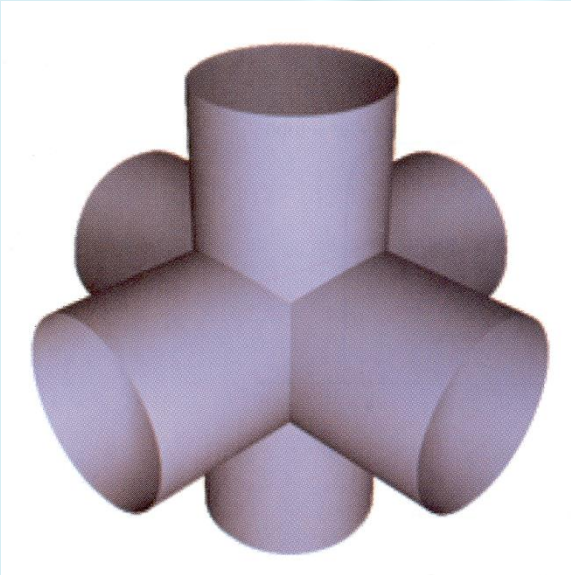
Required/Recommended Reading :

Mathematical Proofs: A Transition to Advanced Mathematics by Gary Chartrand, Albert D. Polimeni, Ping Zhang.

MATH2211 Multi variable Calculus

- Students of this course will learn the theory of multivariable calculus in a rather rigorous manner, and learn how to apply the theory to solve practical problems.
- This is a required course for students taking major in Mathematics or Mathematics/Physics, and is suitable for all students who will use multivariable calculus in their area of study.
- Students taking minor in Mathematics may take this course as one of the required courses.
- This course is a pre-requisite of many mathematics courses of more advanced level.
- Pre – requisite: Pass in MATH1013 University Mathematics II or (MATH1851 Calculus and ordinary equations and MATH1853 Linear algebra, probability and statistics).
- Lectures (36 Hours) plus Tutorials (12 Hours) plus Reading/Self study (100 Hours)

MATH2211 Multi variable Calculus



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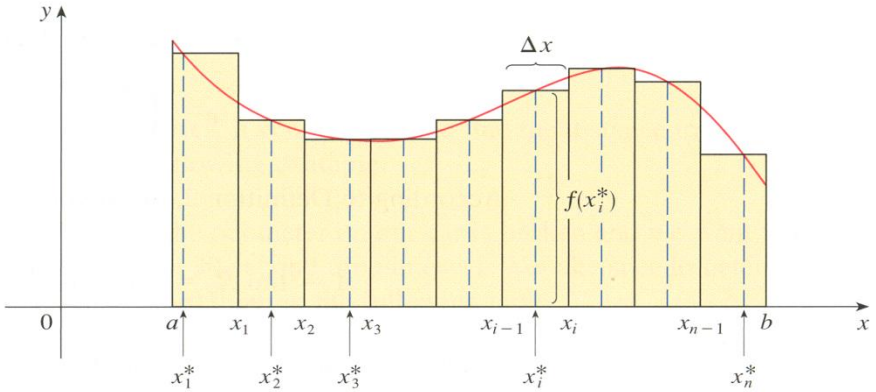
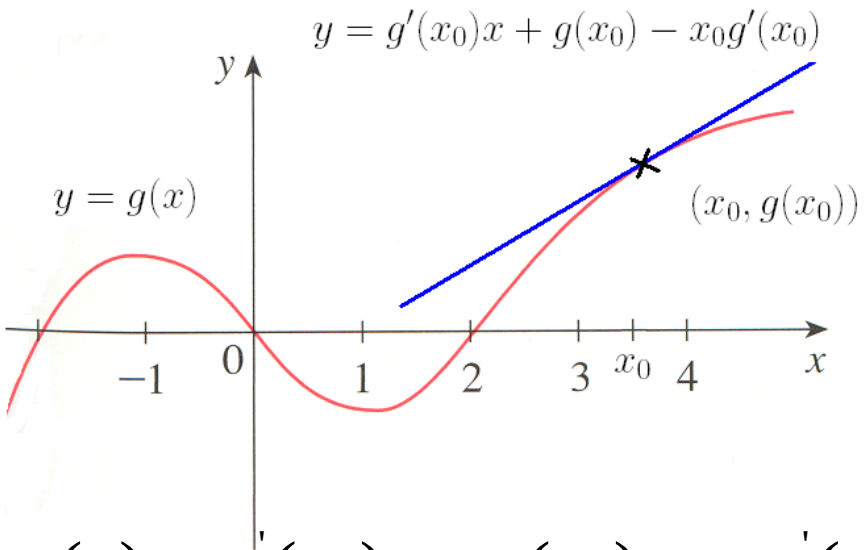
$$A = \lim_{n\to\infty} [f(x_1^*)\,\Delta x + f(x_2^*)\,\Delta x + \cdots + f(x_n^*)\,\Delta x]$$



Integration

Originated from evaluation of area and volume by the ancient Greeks around 200 B.C.

MATH2211 Multi variable Calculus

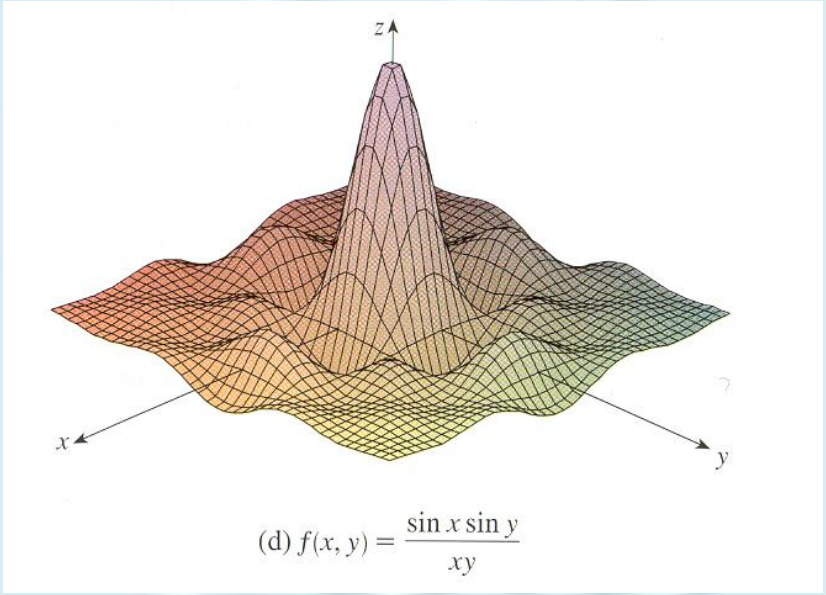


$$g(x) \approx g'(x_0)x + g(x_0) - x_0g'(x_0)$$

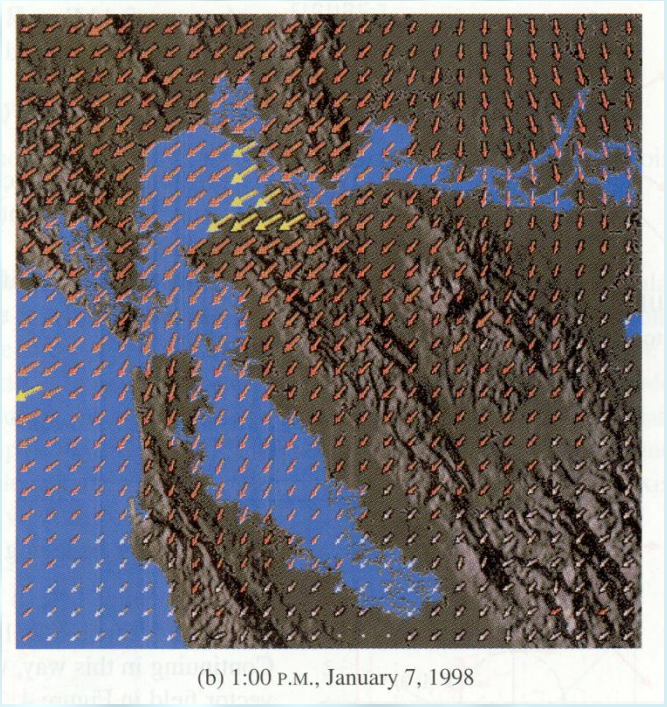
Differentiation

Originated from the study of rigid body motion by Newton in the 17th century.

MATH2211 Multi variable Calculus



(d) $f(x, y) = \dfrac{\sin x \sin y}{xy}$



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Study differentiation and integration of functions of several variables.

MATH2211 Multi variable Calculus

The one – variable fundamental theorem of calculus:

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

and its multi – variable counterparts:

- Stokes' theorem

$$\oint_{\partial S} \mathbf{F} \cdot \mathbf{T}\, ds = \iint_S (\nabla \times \mathbf{F}) \cdot \mathbf{n}\, dS$$

- Divergence theorem

$$\iint_{\partial V} \mathbf{F} \cdot \mathbf{n}\, dS = \iiint_V \nabla \cdot \mathbf{F}\, dV$$

MATH2211 Multi variable Calculus

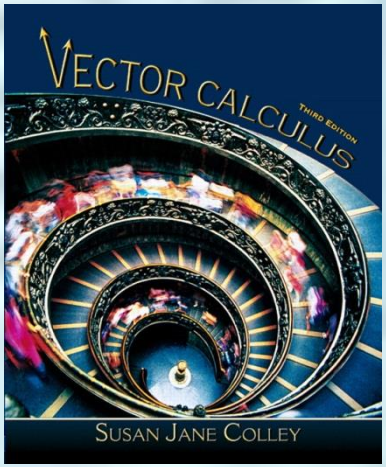
Optimization Problem

- Critical Points, local maxima and minima.
- First and Second derivative tests.
- Method of Lagrange Multipliers for *constraint optimization problem.*

MATH2211 Multi variable Calculus

Teacher (1st semester):

Dr. Zheng HUA



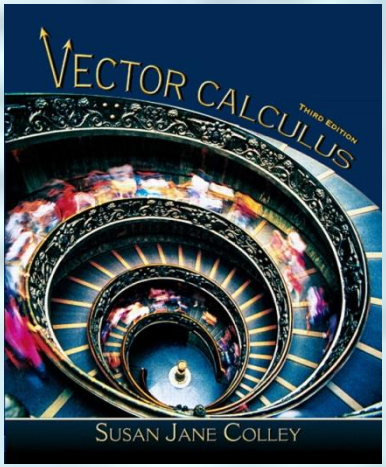
Required/Recommended Reading :

Vector Calculus by Susan J. Colley.

MATH2211 Multi variable Calculus

Teacher (2nd semester):

Dr. James Fullwood



Required/Recommended Reading :

Vector Calculus by Susan J. Colley.

MATH2241

Introduction to Mathematical Analysis

To introduce students to the basic ideas and techniques of mathematical analysis.

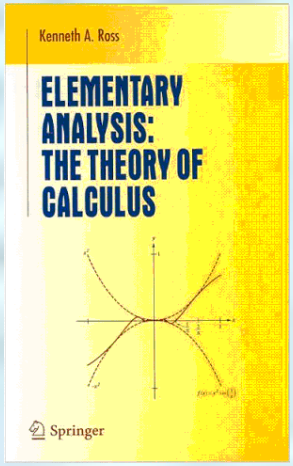
- Prerequisites:
  - Pass in MATH1013 University Mathematics II or (MATH1851 Calculus and ordinary differential equations and MATH1853 Linear algebra, probability and statistics) or MATH2822 Mathematical methods for actuarial science II.
- Teaching:
  - Lectures (36 Hours).
  - Tutorials (12 Hours).
  - Reading/Self study (100 Hours)
- Assessment:
  - One 2.5-hour written examination (50% weighting).
  - Continuous coursework assessment (50% weighting)

MATH2241

Introduction to Mathematical Analysis

Teacher (1st Semester):

Dr. J.T. Chan



Required/Recommended Reading:

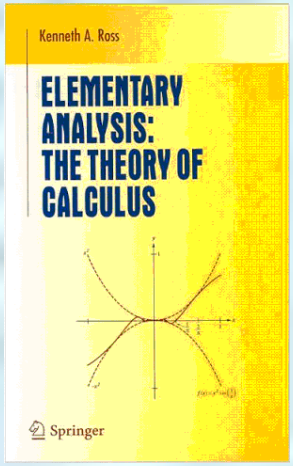
Elementary Analysis: The Theory of Calculus by Kenneth A. Ross.

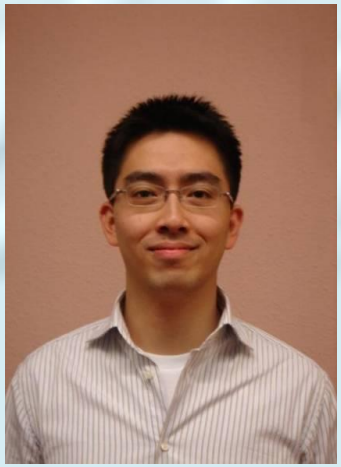
MATH2241

Introduction to Mathematical Analysis

Teacher (2nd Semester):

Dr. Y.M. Chan





Required/Recommended Reading:

Elementary Analysis: The Theory of Calculus by Kenneth A. Ross.

For those who like to learn more mathematics (with an emphasis on proofs) in the first year, you can read the following book.

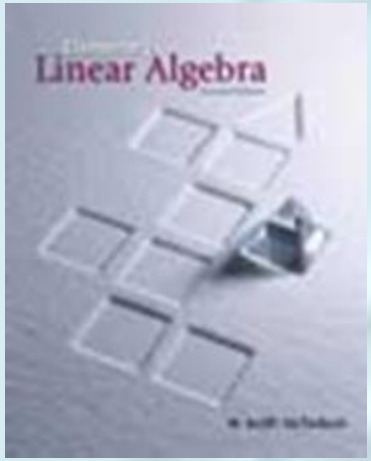
David S. G. Stirling,
Mathematical Analysis
And Proof
(Chichester : Albion Pub., 1997)

MATH2101 Linear Algebra I

- This is a first university level course on linear algebra, which aims at introducing to students the basic concept of linear structure through many concrete examples in the Euclidean spaces.
- The course also enriches students' exposure to mathematical rigor and prepares them for studying more advanced mathematical courses.
- Pre – requisite: Pass in MATH1013 University Mathematics II or (MATH1851 Calculus and ordinary differential equations and MATH1853 Linear algebra, probability and statistics)
- Lectures (36 Hours) plus Tutorials (12 Hours) plus Reading/Self study (100 Hours)

MATH2101 Linear Algebra I

Textbook: *Elementary Linear algebra* by Nicholson.



Teacher (both semesters):
Dr. K.H. Law who is an expert in Discrete Mathematics.

Mr. K. H. Law

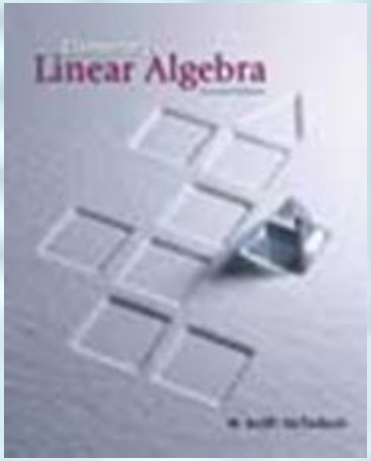
MATH2102 Linear Algebra II

- This is a follow up of the course Linear Algebra I.
- It aims at introducing the general concept of vector spaces, subspaces, dimensions, inner product spaces, etc.
- The course prepares the foundation on linear algebra for students' future study in mathematics and other disciplines.
- Many examples of applications will be drawn on different subject areas.
- Pre – requisite: Pass in MATH2101 Linear Algebra I or MATH2822 Mathematical methods for actuarial science II.
- Lectures (36 Hours) plus Tutorials (12 Hours) plus Reading/Self study (100 Hours)

MATH2102 Linear Algebra II

Teacher (1st semester):

Dr. Matt Young



Textbook/Reference:

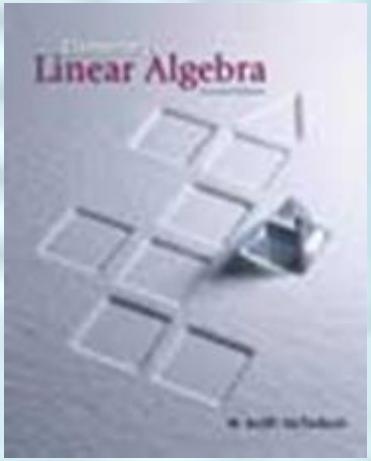
Elementary Linear algebra by Nicholson.

MATH2102 Linear Algebra II

Teacher (2nd semester):

Dr. Y.K. Lau is an expert in number theory, modular forms and L – functions.

Dr. Y. K. Lau



Textbook/Reference:

Elementary Linear algebra by Nicholson.

Linear Algebra

Google™

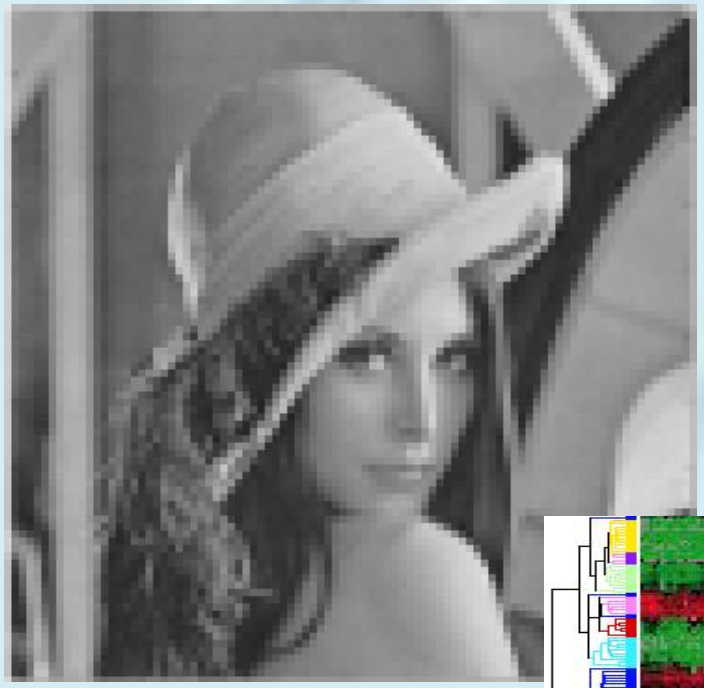
Larry Page

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."

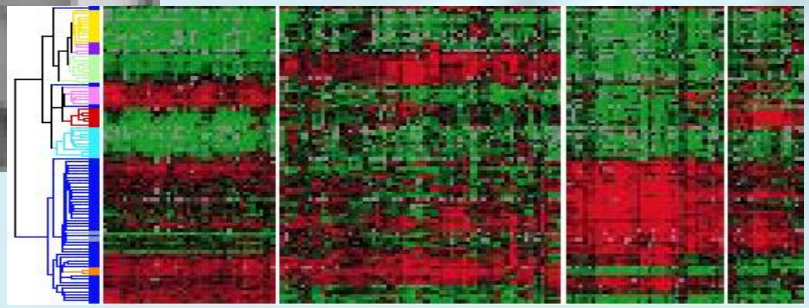
Linear Algebra

How to study and classify Matrices?



$$\begin{pmatrix} 2 & 0 & 4 & 6 \\ 6 & 6 & 1 & 4 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}, \begin{pmatrix} -1 & -2 \\ 1 & 2 \end{pmatrix}$$



Linear Algebra

System of linear equations

$$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 = b_1$$
$$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 = b_2$$
$$a_{31}x_1 + a_{32}x_2 + a_{33}x_3 = b_3$$

$$AX = B$$
$$(ax = b)$$

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix}$$

Linear Algebra

Linear algebra will study in details the properties of vector spaces and the linear transformation between them.

$T : R^n \rightarrow R^m$ is a linear transformation if it satisfies

(L1) $T(X+Y) = T(X) + T(Y)$, and
(L2) $T(kX) = k\,T(X)$

for any scalar k and for any vector X, Y in R^n.

Single Major in Mathematics (without any minor)

- Recommended to take MATH1013 University Mathematics II in the 1st semester.
- Recommended to take also at least one of
  - **MATH2012** *Fundamental Concepts of Mathematics*
  - **MATH2101** *Linear Algebra I*
  - **MATH2211** *Multivariable Calculus*
  - **MATH2241** *Introduction to Mathematical Analysis*

  in year 1.
- Recommended to take also at least one of the following common core courses.
  - **CCST9017 Hidden Order in Daily Life: A Mathematical Perspective (Sem 1)**
  - **CCST9037 Mathematics: Cultural Heritage (Sem 2)**

CCST9017 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.

CCST9017 Hidden Order in Daily Life: A Mathematical Perspective (6 credits)

Some selected topics are:

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

CCST9037 Mathematics: A Cultural Heritage (6 credits)

Through examples gathered from the long history of humankind, around our daily lives, and in diverse areas of human activities, this course aims to help students to comprehend how mathematics was, and is being, developed as a work of human endeavor with cultural, intellectual, and social contexts.

We will also investigate the role of mathematics in the development of other areas of our civilization. In particular we shall examine the interplay between mathematics and other cultural pursuits such as philosophy, the arts, and science and technology, and to study how they have affected each others' development.

CCST9037 Mathematics: A Cultural Heritage

Rather than transmitting a body of technical knowledge in mathematics, our emphasis is placed on appreciating, contemplating, and examining the beauty, the utility, and the "Way" of mathematics, as well as the intricate relationship between mathematics and other human cultural pursuits.

The demand on technical preparation in mathematics is minimal, say up to the level of the general mathematics curriculum in secondary school, but the student is expected to possess intellectual curiosity and willingness to participate in the reasoning process.

Major in Mathematics (requirement)

3. **Capstone Requirement** (6 credits)*

   At least 6 credits selected from the following courses:

   MATH4988 Mathematics internship (6 credits)
   MATH4999 Mathematics project (12 credits)

Students are not required to take Capstone if this Science major is taken as a second major on the condition that the capstone experience in the first major requires the integration or application of knowledge from both major disciplines.

If this is approved, a 6 – credit advanced level course in the second major must be taken to fulfill the credit requirement of the capstone experience.

MATH4988 Mathematics Internship

This course aims to offer students the opportunities to gain work experience in the industry related to their major of study. The workplace learning experience would be of great benefits to the students to apply their knowledge gained in the study to the real work environments.

Students have to take on at least 160 hours of internship work either within the University or outside the University arranged by the department.

Details of internship will be recorded on the student's transcript.

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

Pre-requisites: Students are expected to have satisfactorily completed their Year 3 study.

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

MATH4988 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.

MATH4999 Mathematics Projects

The aim of the course is to provide students with opportunity to formulate and investigate, in depth, problems 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.

Pre-requisites: MATH3301 (Algebra I) and MATH3401 (Analysis I)

MATH4999 Mathematics Projects

Topics:

- Arithmetical Functions and Dirichlet Series
- Calculus of Variations
- Dirichlet's Divisor Problem
- Higher Rank Numerical Ranges
- Introduction to Algebraic Geometry
- Isoclinic n – planes in Euclidean $2n$ – space
- Mathematical Problems in Network Coding
- Numerical Simulation in Fluid Dynamics
- On Construction and Control of Probabilistic Boolean Networks
- Open problems in affine algebraic geometry and commutative/noncommutative algebra
- Perron – Frobenious Theory of Nonnegative Matrices
- Project Scheduling via Network Models: independent study & computer implementation
- Solving Non-Linear Differential Equations
- Statistical Arbitrage Strategies in Equity Market
- Supersymmetric Quantum Mechanics and the Witten Index

Minor in Computational and Financial Mathematics

Minor in Computational & Financial Mathematics (requirement)

1. Introductory level courses (18 credits)
   - MATH1013 University Mathematics II
   - MATH2101 Linear Algebra I
   - MATH2211 Multivariable Calculus
2. Advanced level courses (24 credits)
   - MATH3601 Numerical Analysis
   - MATH3906 Financial Calculus

Plus at least 12 credits selected from the following courses:

- MATH3408 Computational Methods and Differential Equations with Applications
- MATH3603 Probability Theory
- MATH3904 Introduction to Optimization
- MATH3911 Game Theory and Strategy
- MATH4602 Scientific Computing
- MATH4907 Numerical Methods for Financial Calculus

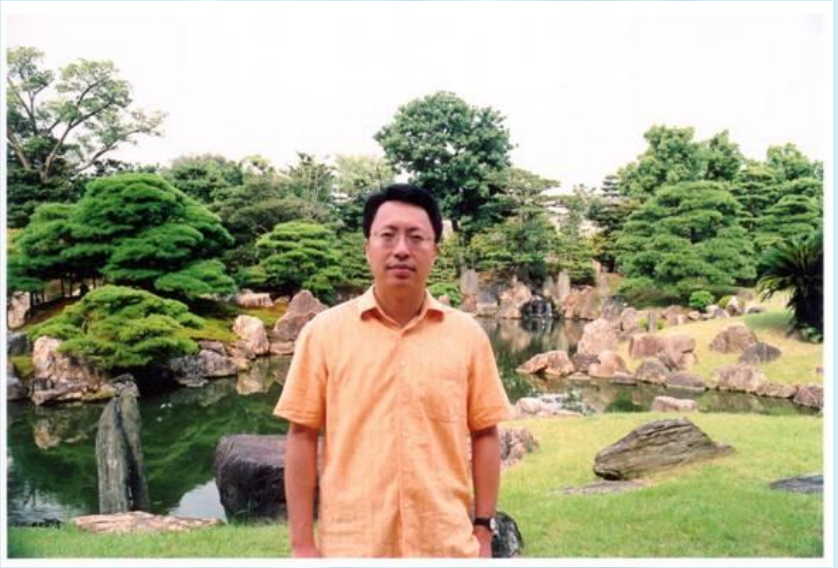
Minor in Computational & Financial Mathematics (requirement)

Notes:

- Students must have level 2 or above in HKDSE Extended Module 1 or 2 of Mathematics or equivalent to take this minor. Students who do not fulfill this requirement are advised to take MATH1011 *University Mathematics I*.
- Students having completed the two courses MATH1821 *Mathematical Methods for Actuarial Science I* and MATH1822 *Mathematical Methods for Actuarial Science II* are deemed to have satisfied the 18 credits introductory level courses requirement of the minor. Such students should, however, take at least 30 credits of advanced courses in order to fulfill the credit requirement of the minor.
- The two courses MATH1851 *Calculus and ordinary differential equations* and MATH1853 *Linear Algebra, probability and statistics* together are deemed equivalent to MATH1013 *University Mathematics II*. However, students have to take an extra MATH2xxx course to replace MATH1013 to fulfill the credit requirement.
- Double counting of credits is not permissible for major – minor or double – minors combinations. For a course appears as a core course in the major – minor or double – minors, students have to make up the credits by taking replacement course in the minor. Please check BSc syllabus for details.
- Courses at the advanced level are subject to change.

Computational Finance

Many investment banks employ mathematicians for 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.

MATH3906 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.
- Good knowledge of partial differential equations and probability theory is needed for further studies.

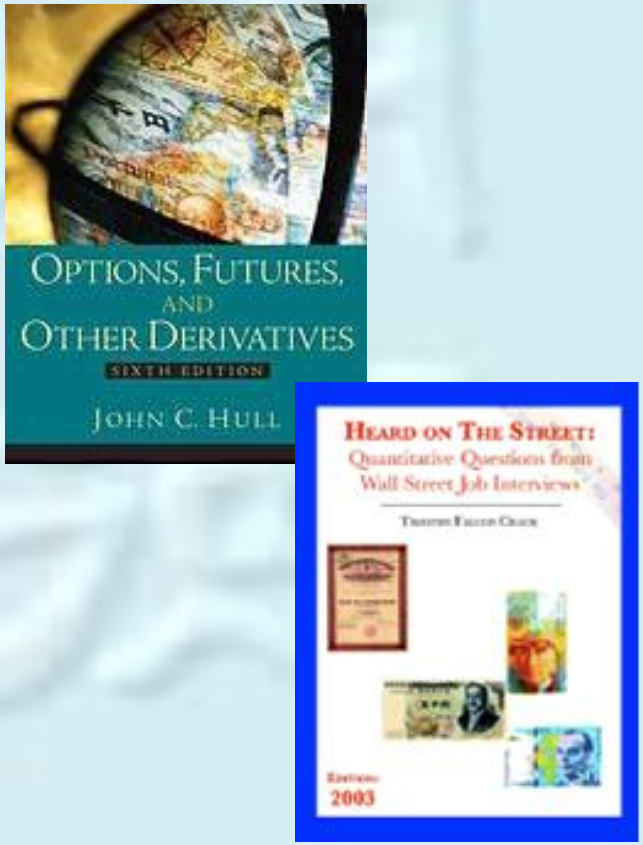
MATH3906 Financial Calculus

- Prerequisites:
  - MATH2101 (Linear Algebra I) and MATH2211 (Multivariable Calculus), or
  - MATH1821 (Mathematical Methods for Actuarial Science I) and MATH1822 (Mathematical Methods for Actuarial Science II).
- Teaching:
  - Lectures (36 Hours).
  - Tutorials (12 Hours).
  - Reading/Self study (100 Hours)
- Assessment:
  - One 2.5-hour written examination (50% weighting).
  - Continuous coursework assessment (50% weighting)

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.



Minor in Mathematics

Minor in Mathematics (requirement)

1. Introductory level courses (18 credits)

   MATH1013 University Mathematics II

   MATH2101 Linear Algebra I

   MATH2211 Multivariable Calculus

   Students are strongly advised to take also MATH2012.

2. Advanced level courses (18 credits)

   At least 18 credits of advanced level Mathematics courses (MATH3XXX or MATH4XXX or MATH6XXX level), subject to prerequisite requirements.

Minor in Mathematics (requirement)

Notes:

- Students must have level 2 or above in HKDSE Extended Module 1 or 2 of Mathematics or equivalent to take this minor. Students who do not fulfill this requirement are advised to take MATH1011 *University Mathematics I*.
- Students having completed the two courses MATH1821 *Mathematical Methods for Actuarial Science I* and MATH1822 *Mathematical Methods for Actuarial Science II* are deemed to have satisfied the 18 credits introductory level courses requirement of Mathematics minor. Such students should, however, take at least 24 credits of advanced courses in order to fulfill the credit requirement of the minor.
- The two courses MATH1851 *Calculus and ordinary differential equations* and MATH1853 *Linear Algebra, probability and statistics* together are deemed equivalent to MATH1013 *University Mathematics II*. However, students have to take an extra MATH2xxx course to replace MATH1013 to fulfill the credit requirement.
- If students would like to take more courses in analysis, they are advised to take the introductory level course MATH2241 *Introduction to Mathematical Analysis* first.

Minor in Mathematics (requirement)

Notes (cont'd):

- Double counting of credits is not permissible for major – minor or double – minors combinations. For a course appears as a core course in the major – minor or double – minors, students have to make up the credits by taking replacement course in the minor. Please check BSc syllabus for details.
- Courses at the advanced level are subject to change.

Minor in Mathematics

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

MATH3001 - Development of Mathematical Ideas
MATH2241 - Introduction to Mathematical Analysis
MATH3301 - Algebra I
MATH3405 - Differential Equations
MATH3600 - Discrete Mathematics
MATH3601 - Numerical Analysis
MATH3603 - Probability Theory
MATH3901 - 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

MATH3401 Analysis I

MATH3901/3902 Operations Research I/II

MATH3904 Introduction to Optimization

MATH3906 Financial Calculus

MATH4907 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

MATH3906 Financial Calculus

MATH4907 Numerical Methods for Financial Calculus

MATH3603 Probability Theory

MATH3601 Numerical Analysis

MATH3408 Computational Methods and Differential Equations with Applications

MATH4602 Scientific Computing

MATH4406 Introduction to PDE

STAT3301 Time-series Analysis

STAT3316 Advanced Probability

More on Mathematics Major

MATH3002 Mathematics Seminar

- This is a seminar style course intended for those 2nd Year BSc 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.

MATH3002 Mathematics Seminar

- Prerequisites:
  - MATH2012 (Fundamental concepts of mathematics),
  - MATH2101 (Linear algebra I),
  - MATH2211 (Multivariable calculus) and
  - MATH2241 (Introduction to mathematical analysis).
- Enrollment needs instructors' approval. This course is for second year BSc students only.
- Quota:12.

MATH3002 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 (30%).

MATH3002 Mathematics Seminar

Selected topics in the past years:

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

MATH3888 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 independently a small mathematics project close to research in nature.

Selected topics in the past years:

- Fibonacci sequence, the golden ratio, and patterns in plants: Phyllotaxis
- How Long is a piece of string? Hidden Mathematics of Everyday Life
- How to Mathematically Turn a Solid Ball into Two Identical Copies of the Original Ball
- Investment Strategies in Stock Markets via Technical Analysis
- Microarray data and diagnosis of cancer
- Various Traveling Salesman Problems

- An Introduction to Design Theory
- Elementary Methods in Prime Number Theory
- Geometry and Function Theory on the Unit Disk
- Linear Algebra and its Applications
- Linear geometry in Euclidean 4-space
- Matrix Groups
- The Plateau Problem

MATH3888 Directed Studies in Mathematics

- Prerequisites:
  - MATH2101 (Linear algebra I),
  - MATH2102 (Linear algebra II),
  - MATH2211 (Multivariable calculus) and
  - MATH2241 (Introduction to mathematical analysis).
- The subject matter of the project will be determined by consultation between the student and his supervisor. He must achieve good standing and get the approval from both the prospective supervisor and the course coordinator to take this course.

Major in Mathematics – CMOR

Recommended courses:

MATH3303 Matrix Theory and Its Applications
MATH3600 Discrete Mathematics
MATH3601 Numerical Analysis
MATH3603 Probability Theory
MATH3901 Operations Research I
MATH3904 Introduction to Optimization
MATH3905 Queuing Theory and Simulation
MATH4602 Scientific Computing
MATH3902 Operations Research II
MATH3943 Network Models in Operations Research

MATH6502 Topics in Applied Discrete Mathematics
MATH6503 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. 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)

HSBC

Major in Mathematics – CMOR

Constraint Optimization Problem:

- Max/Min $f(x_1,\ldots,x_n)$ under the constraints $g_i(x_1,\ldots,x_n)=0$, $i=1,..,m$.
- **MATH3901** *Operational Research I* and **MATH3902** *Operational Research II* study this optimization problem when all these functions are linear.
- **MATH3904** *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

Constraint 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

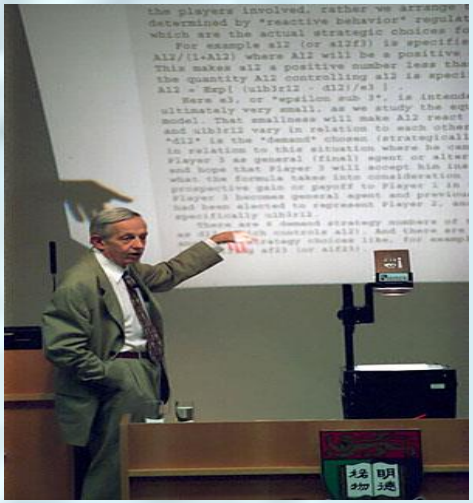
Job Opportunities:

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

Major in Mathematics – Economics/Finance

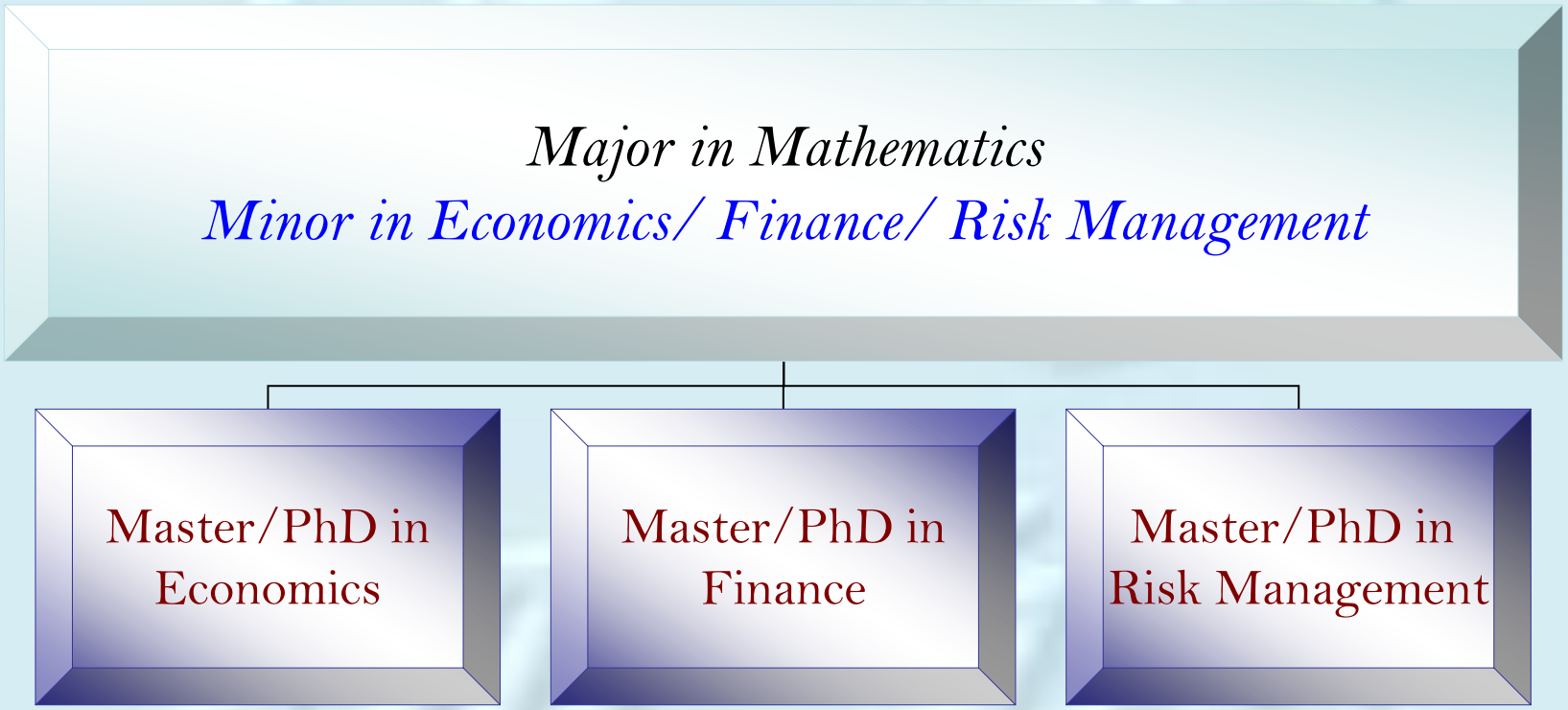
Nobel Prize in Economics: Out of the 41 Laureates of the past 21 years, 18 have degrees in mathematics:

- **2007 Eric S. Maskin (BS in 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)**



2012 Lloyd Shapley (BA, PhD in math)
2012 Alvin E. Roth (BS,MS,PhD in OR)
2011 Christopher A. Sims (BA in math)
2010 Peter A. Diamond (BA in math)

Major in Mathematics – Economics/Finance

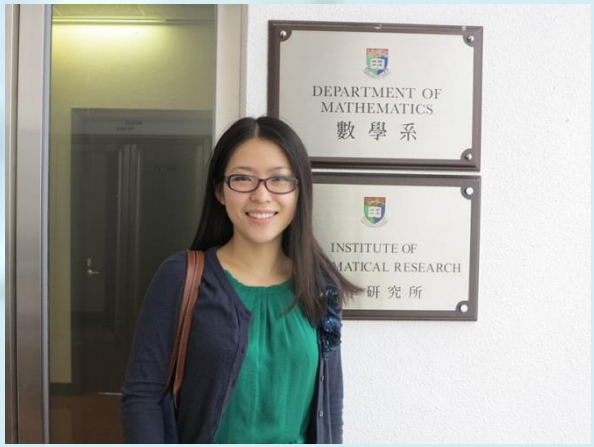


Mathematics is the common language in these areas and it is easier to learn math when you are young.

Major in Mathematics – Economics/Finance

Luo Guannan and Jian Bo (both math major) are now doing a PhD in Economics at Northwestern University and University of Chicago respectively.

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



MATH3401 Analysis I

MATH3901/3902 OR I and II

MATH3904 Introduction to Optimization

MATH3911 Game Theory and Strategy

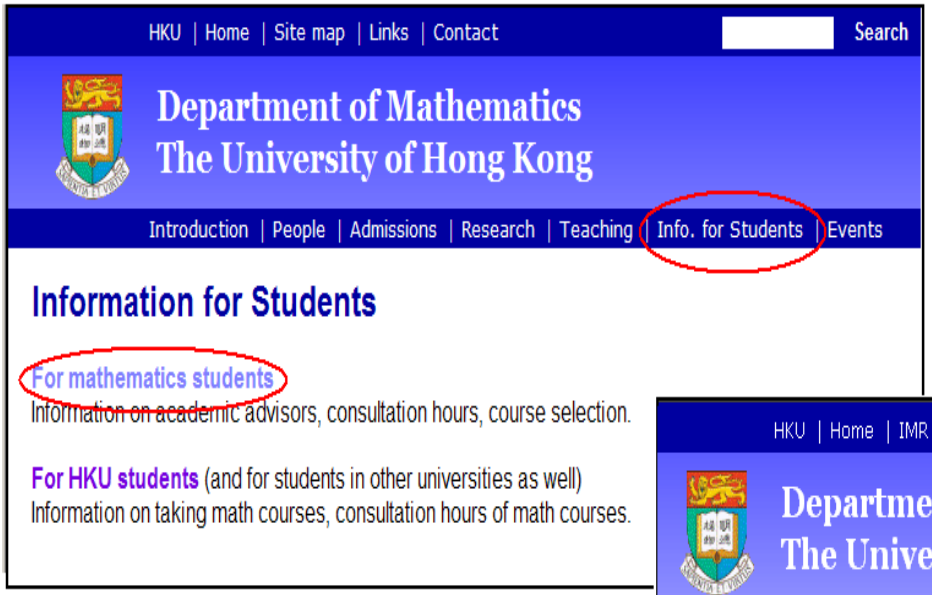
MATH3906 Financial Calculus

MATH4907 Numerical Methods for Financial Calculus

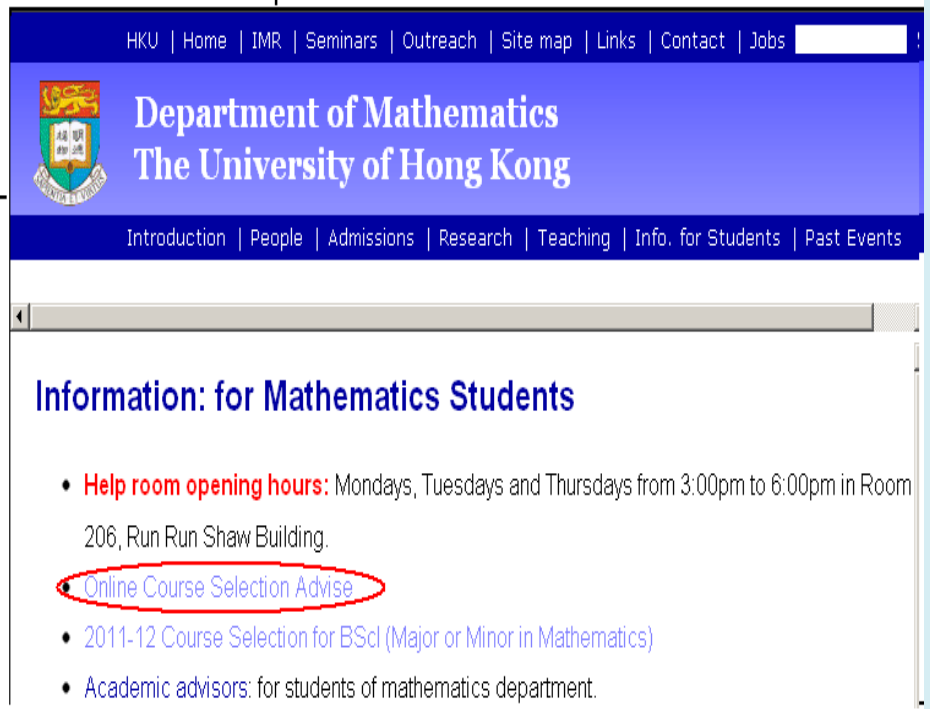
STAT3301 Time-series Analysis

STAT3316 Advanced Probability

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 homepage of our department:

www.hku.hk/math

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

Dr. P.W. Wong (ppwwong@maths.hku.hk)

Dr. G. Han (ghan@maths.hku.hk)

Dr. C.W. Wong (cwwongab@hku.hk)

Dr. S. Wu (swu@maths.hku.hk)

http://hkumath.hku.hk/web/info/math_student.html

For 3 year math majors:

http://hkumath.hku.hk/web/teaching/BSc_I_2012-13_3-Yr_Curriculum.pdf

End