

2007-08 Course Selection for BScII-III

Major or Minor in Mathematics

Dr Ng Tuen Wai

Department of Mathematics, HKU

Major in Mathematics

1. Introductory level courses (30 credits)

MATH1101	Linear Algebra I
MATH1102	Linear Algebra II
MATH1201	Calculus I
MATH1202	Calculus II
MATH1000	Basic concepts of Mathematics

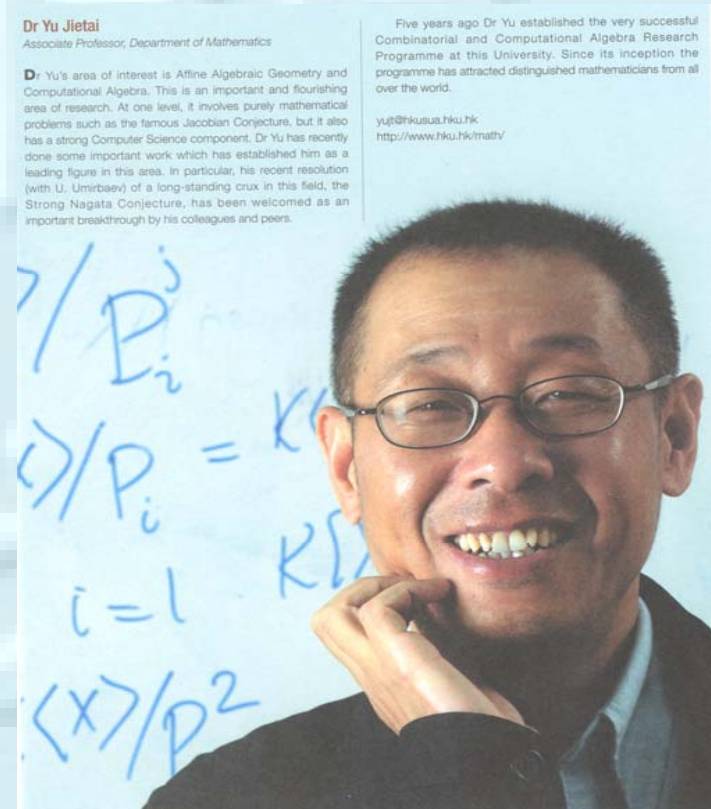
2. Advanced level courses (48 credits)

MATH2301	Algebra I
MATH2401	Analysis I

**Plus at least 36 credits of advanced level Mathematics courses
(MATH2000 or MATH3000 level).**

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.T. Yu (*Notre Dame*)



MATH 2401 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 will concentrate on one of the following three main theme:

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

Pure Mathematics

MATH2303 Matrix Theory and its Applications (1)

MATH2304 Introduction to Number Theory (2)

MATH2402 Analysis II (2)

MATH2403 Functions of a Complex Variable (1)

MATH3302 Algebra II (2)

MATH3404 Functional Analysis (2)

MATH3501 Geometry (1)

MATH3502 Geometric Topology (2)

MATH2001 Development of Mathematical Ideas (2)

MATH3406 Introduction to Partial Differential Eq. (2)

MATH 2303 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. S.Y. Wu (*MIT*)



- 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.





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.”

Page, Brin, Motwani, Winograd, The PageRank Citation Ranking: Bringing Order to the Web. Stanford Digital Library Technologies Project, 1998.

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: Dr. P.W. Wong (*Columbia*)

Fundamental Theorem of Calculus (FTC)

The one-variable fundamental theorem:

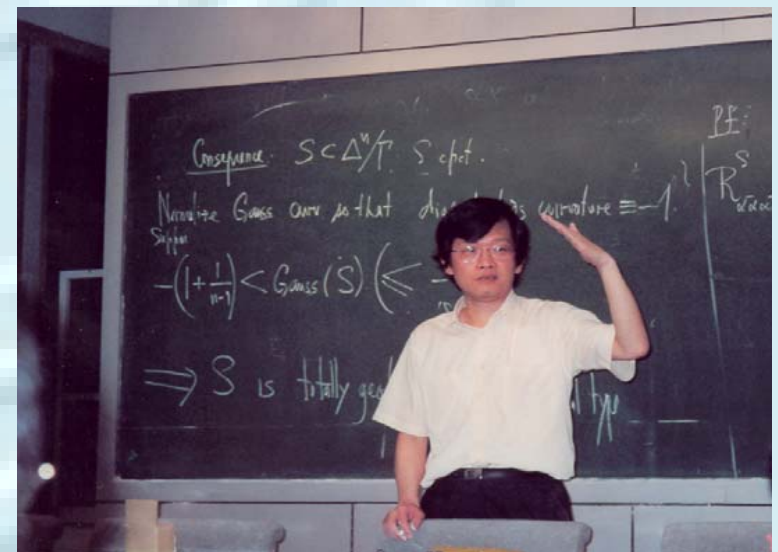
$$\int_a^b f'(x) dx = f(b) - f(a).$$

Main goal: Generalize FTC to Stokes' theorem for manifolds:

$$\iint_M \text{curl } \mathbf{F} \cdot \mathbf{n} d\sigma = \int_{\partial M} \mathbf{F} \cdot d\mathbf{x}$$

MATH2403 Functions of a Complex Variable

- Do 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 like quantum mechanics.
- Teacher: Prof. N. Mok (*Stanford*)



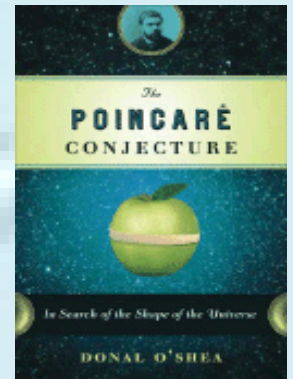
MATH3501 Geometry

- 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: Dr. J.H. Lu
(*UC Berkeley*)



MATH3502 Geometry Topology

- Introduction to Algebraic Topology.
- Useful to the studies of Differential and Algebraic Geometry and General Relativity, etc.
- Teacher: Dr. P.W. Wong (*Columbia*)
- For recent important breakthrough in topology, see the book “The Poincaré conjecture: in search of the shape of the universe” by Donal O'Shea.



Computational Mathematics, Logistics/Operations Research

Recommended courses:

MATH2303 Matrix Theory and Its Applications (1)

MATH2601 Numerical Analysis (1)

MATH2603 Probability Theory (1)

MATH2901 Operations Research I (1)

MATH2904 Introduction to Optimization (1)

MATH2905 Queuing Theory and Simulation

MATH3602 Scientific Computing (2)

MATH3902 Operations Research II (2)

MATH3903 Network Models in Operations Research (2)

MATH3610 Topics in Applied Discrete Mathematics

MATH3910 Topics in Mathematical Programming and Optimization (2)

BUSI1003 Introduction to Management Information System

CSIS1119 Introduction to Data Structures and Algorithms

ECON0701 Introductory Econometrics

STAT3301 Time-series Analysis

Operations Research Group

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



Computational Mathematics, Logistics/Operations Research

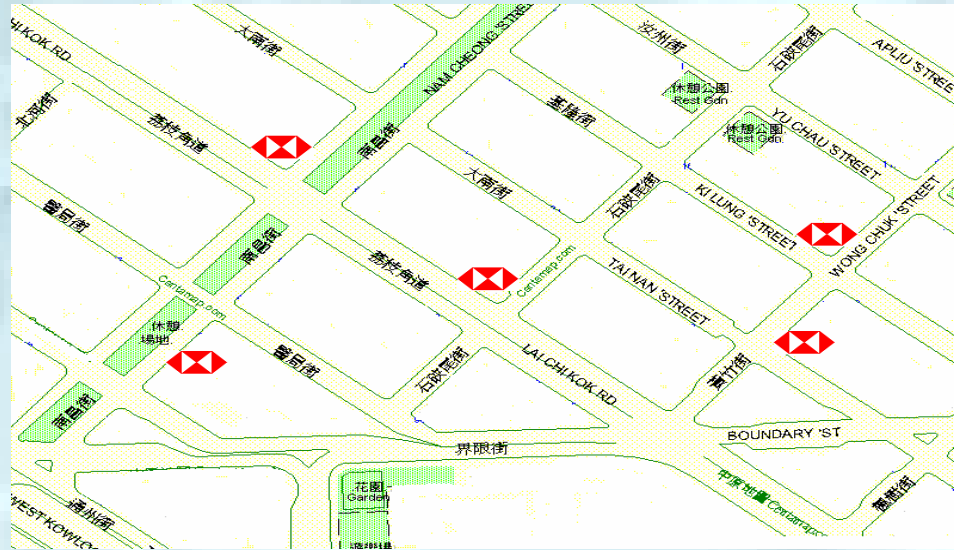
- Courses in Computational Mathematics and Operations Research are taught by experts in these two areas.
- For operations research:
 - Prof. S.C.K. Chu (*Columbia*)
 - Dr. W.K. Ching (*CUHK*)
 - Dr. W. Zang (*Rutgers*)
- For computational mathematics:
 - Dr. K.H. Chan (*CUHK*)
 - Dr. G.Y. Han (*Notre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

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

Main problem: Optimization with constraints

- Max/Min $f(x_1, \dots, x_n)$ under the constraints $g_i(x_1, \dots, x_n) = 0, i = 1, \dots, m$.
- OR I and II study this optimization problem when all functions are linear.
- IO studies the same optimization problem when some of these functions are **non-linear** by using multi-variable calculus.
- Some numerical methods are needed to solve the problems.

Example: Optimization problem for customer redistribution



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.

Mathematics, Economics and Finance

Recommended courses:

MATH2906 Financial Calculus (2)

MATH2907 Numerical Methods for Financial Calculus (offered in 08-09)

BUSI1002 Introduction to Accounting

ECON2101 Microeconomics Theory

ECON2102 Macroeconomics Theory

FINA1001 Introduction to Finance

FINA2802 Investments

Major in Mathematics

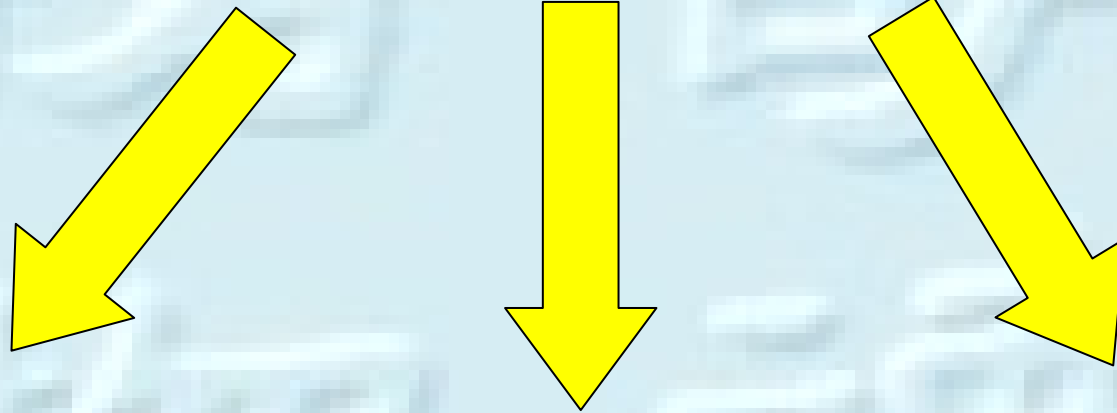
Minor in Economics or

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,
Minor in Economics / Finance / Risk Management*



Master / PhD: Economics

Finance

Risk
Management

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

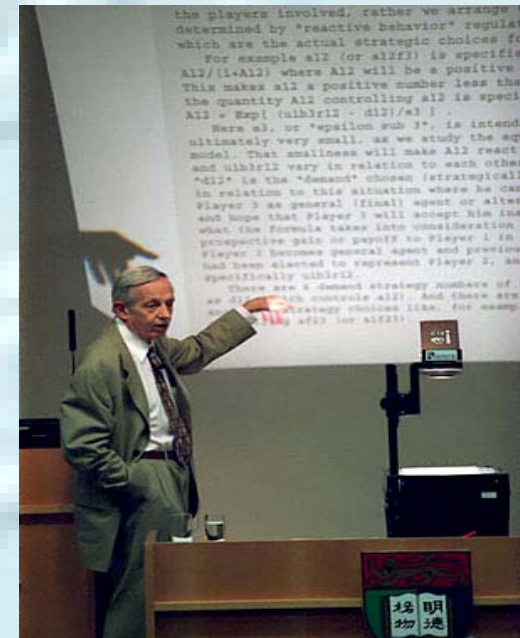


Mathematics, Economics and Finance

Nobel Prize in Economics

Out of the 26 Laureates of the past fourteen years, 13 have degrees in mathematics:

- 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)



**YSCN0016 Games and the
Mathematical Mind**

Master/PhD in Economics/Finance

- Luo Guannan (a math major) is going to Northwestern University to do a PhD in Economics this September.
- 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 IO
 - MATH2906 Financial Calculus
 - STAT3301 Time-series Analysis
 - STAT3316 Advanced Probability



羅冠南
Luo Guannan

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

HSBC 



Dr. Lau Chi Fong (PhD in number theory)

**Head of Market Risk Management, HSBC
Global Markets**

Computational/Quantitative 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 skill.
- Computing skills, e.g., Visual Basic.

Computational Finance

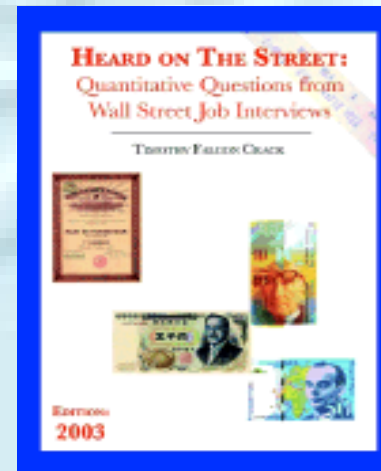
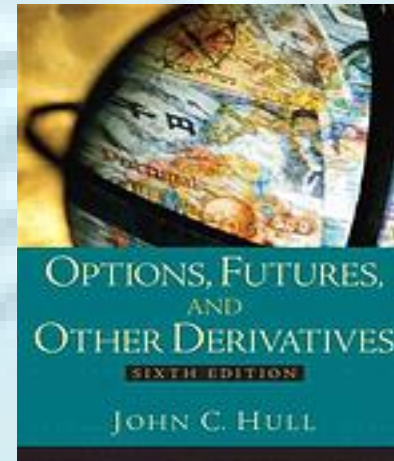
- **MATH2906 Financial Calculus (2)**
- **MATH2907 Numerical Methods for Financial Calculus (offered in 2008-09)**
- MATH2603 Probability Theory
- MATH2601 Numerical Analysis
- MATH3602 Scientific Computing
- MATH3406 Introduction to PDE
- **STAT3301 Time-series Analysis**
- **STAT3316 Advanced Probability**

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.
- Teacher: Dr. S.P. Yung (*Wisconsin*)

To learn more about quantitative finance, can read the following books

- **Options, futures, and other derivatives / John C. Hull**
- **An Elementary Introduction to Mathematical Finance/ Sheldon M**
- **Heard on the street : quantitative questions from Wall Street job interviews / 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**

New direction: Mathematical Biology

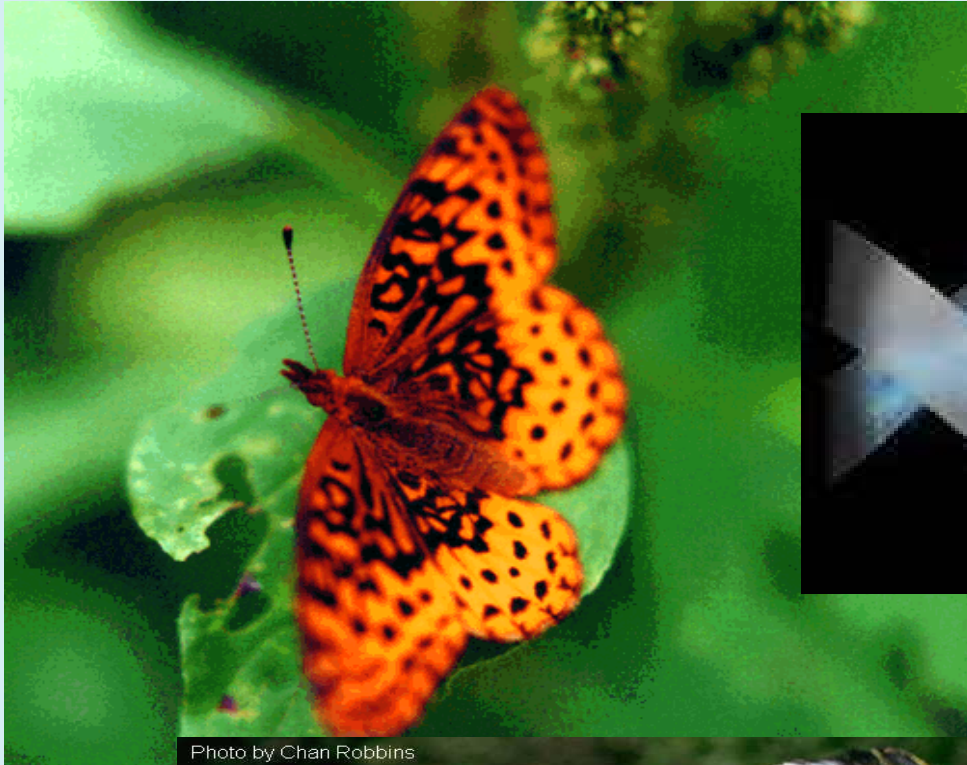
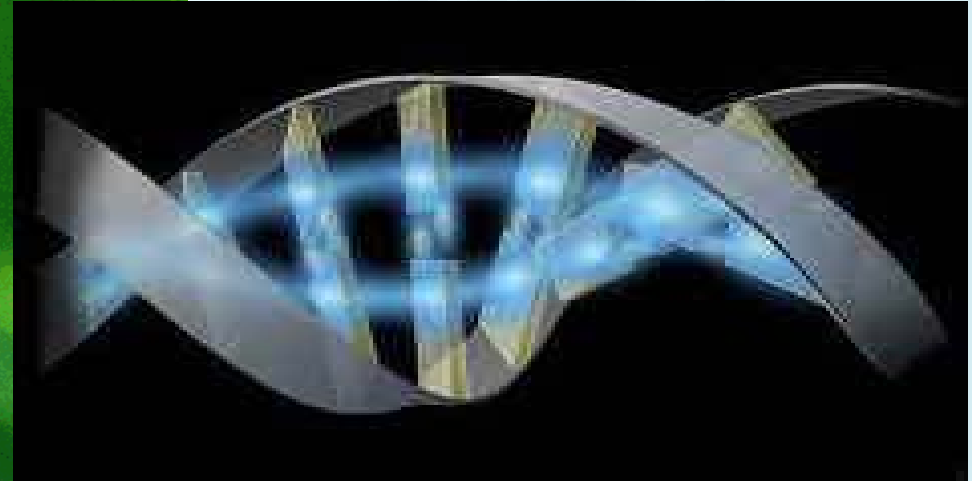
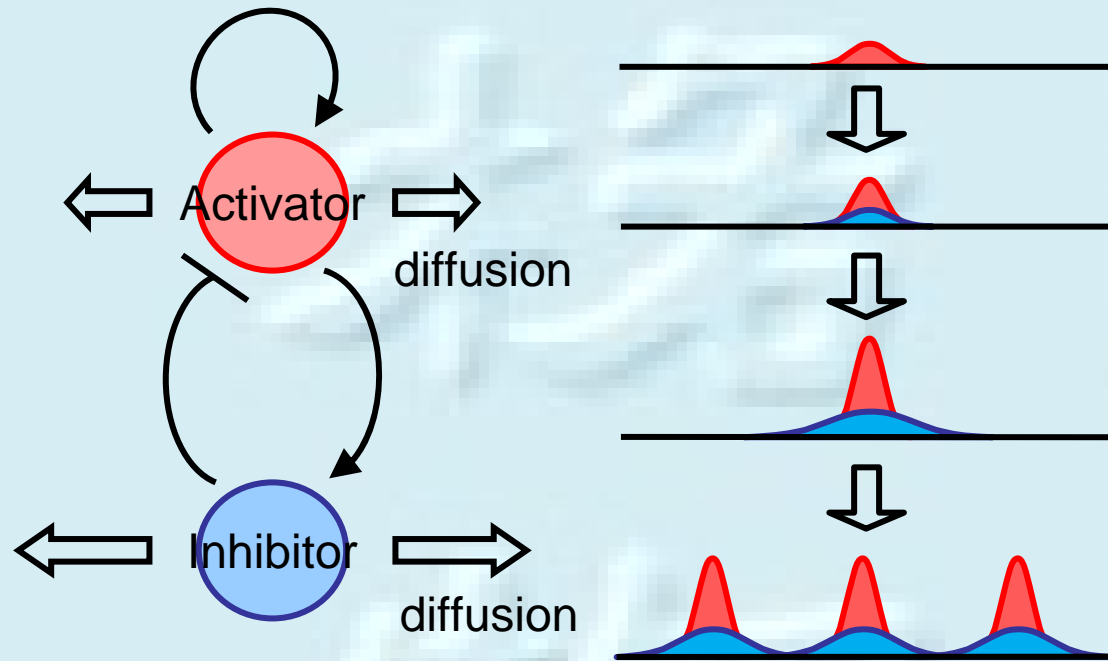


Photo by Chan Robbins

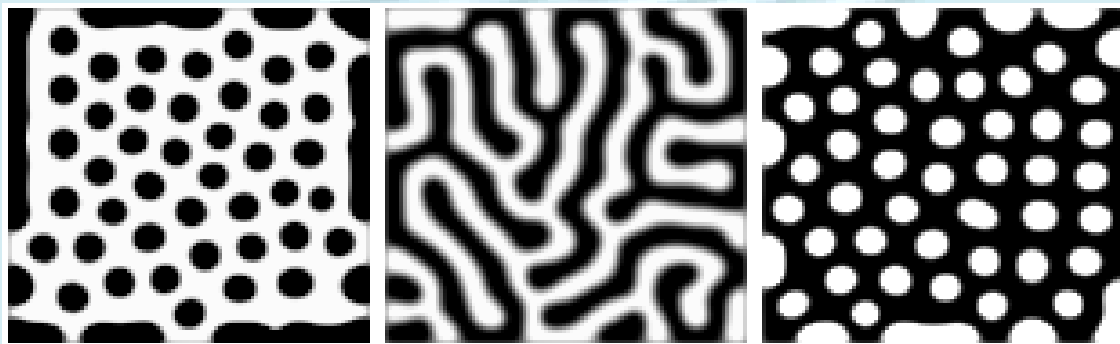
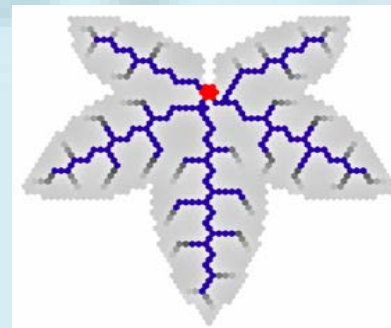
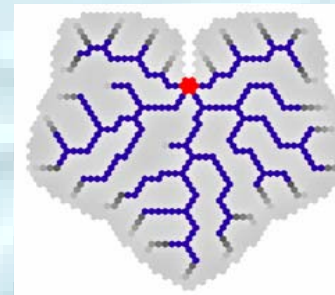
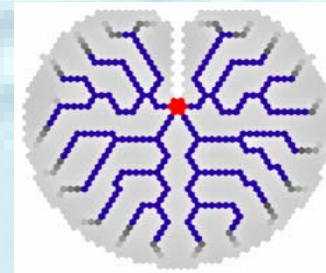
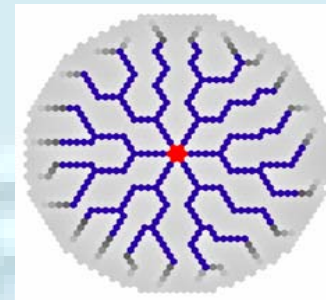


Studies for Biological Pattern Formations

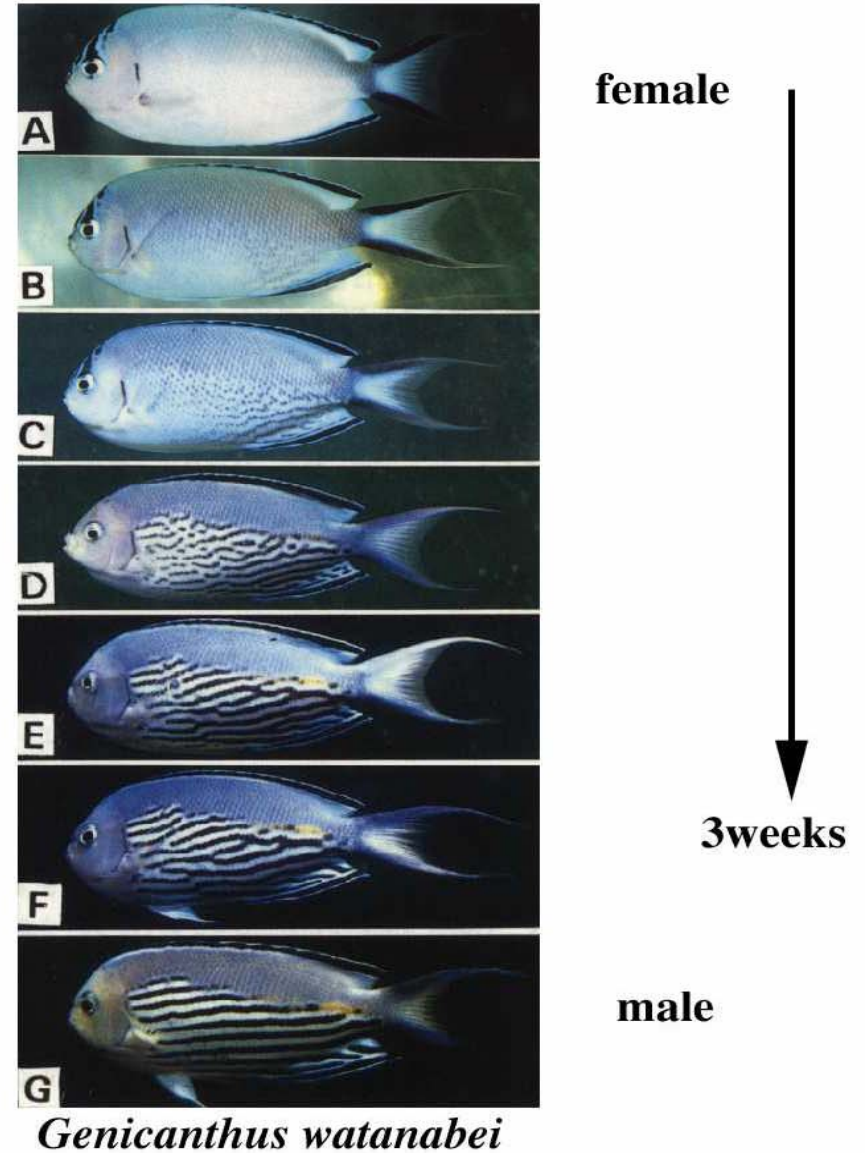
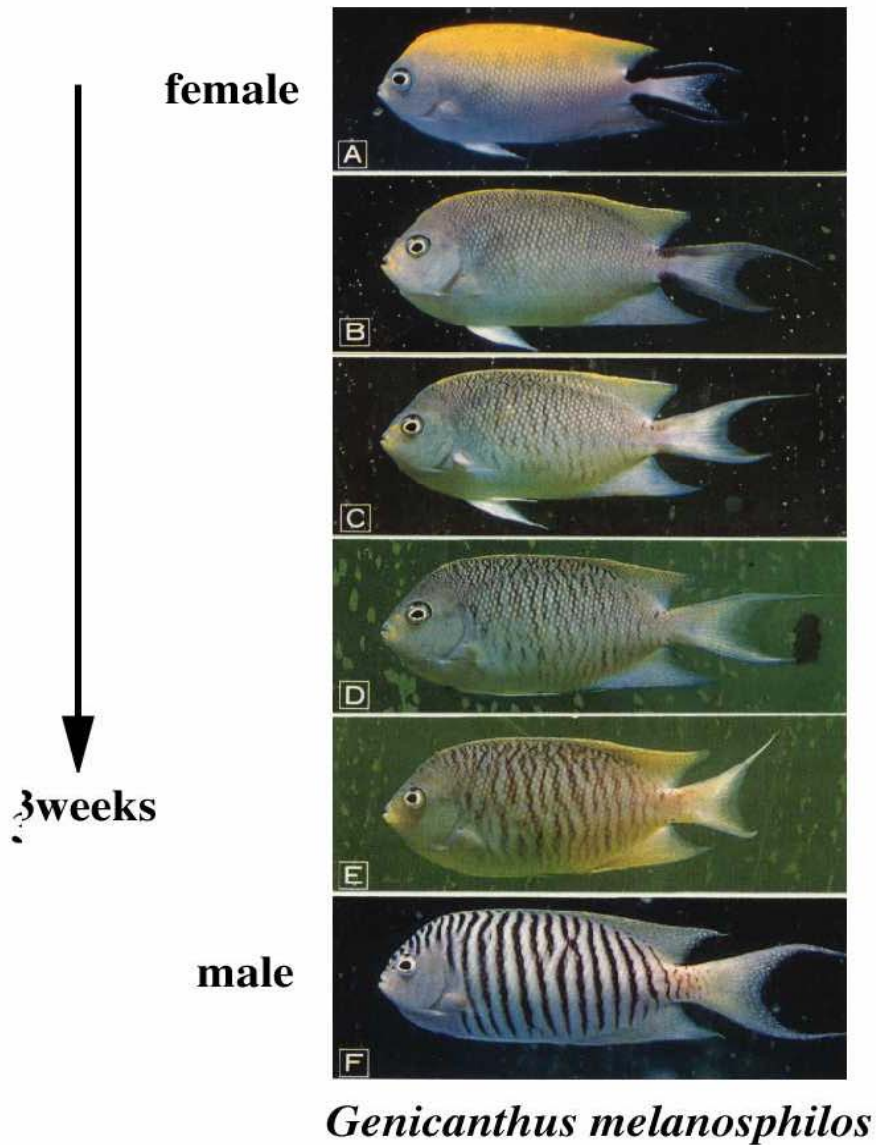
Turing's instability



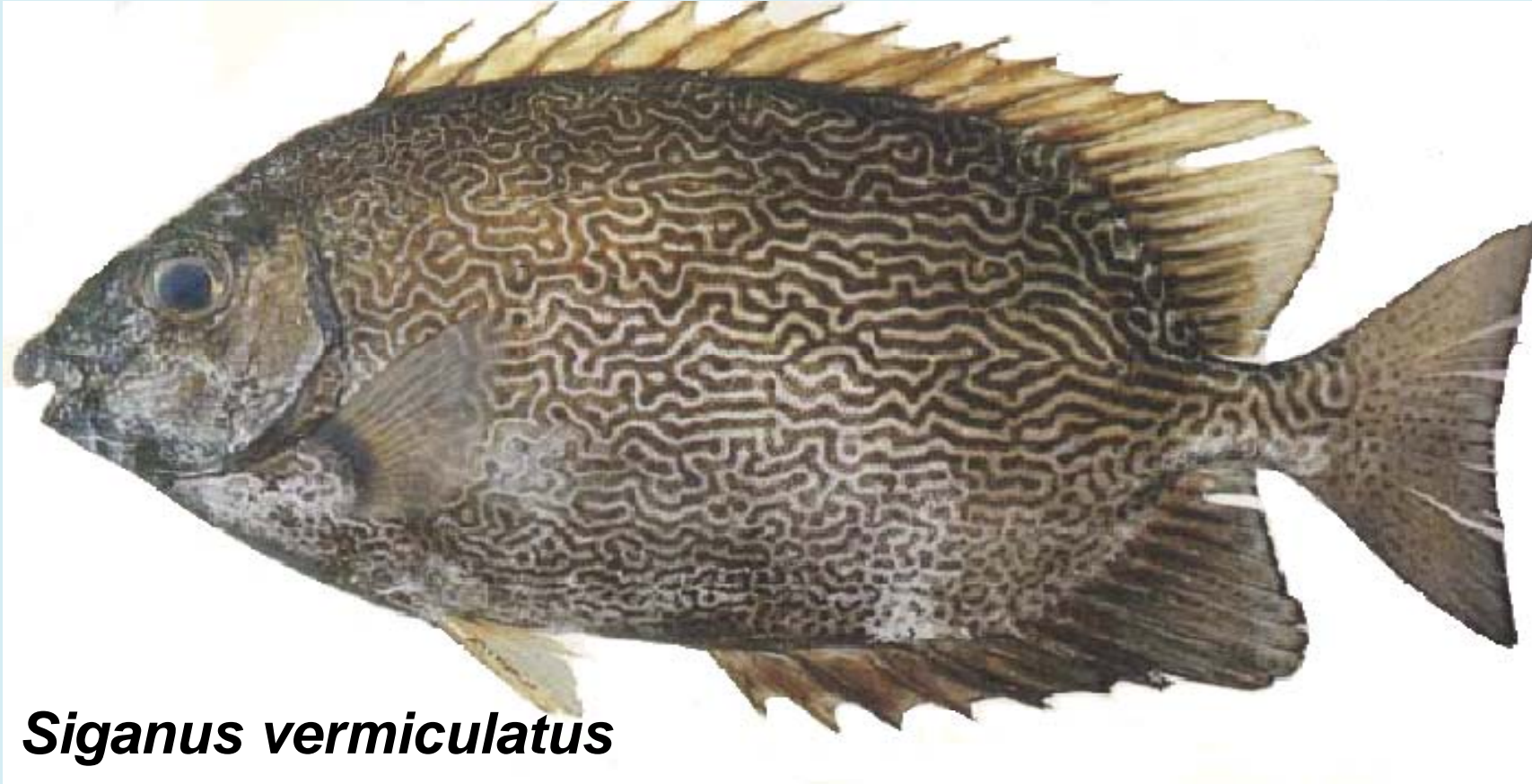
Leaf veins



Pattern Alterations during Sexual Change of *Genicanthus*



Mochizuki Atsushi (望月敦史) National Institute of Basic Biology



Siganus vermiculatus

**MATH0011 Numbers and Patterns in Nature and Life
(Dr. TW Ng and Dr. NK Tsing)**

MATH2001 Development of Mathematical Ideas

- To study the origin and growth of some basic mathematical concepts.
- To gain a deeper insight and broader view of mathematics as a discipline and human endeavour.
- To provide the students with an opportunity to write on and talk about mathematics, and to engage in independent study.

MATH2001 Development of Mathematical Ideas

Selected topics:

Geometry: Euclid's Elements (Prof. M.K. Siu)

Analysis: History of Calculus (Dr. N.K. Tsing)

Algebra: Solving Equations (Dr. T.W. Ng)

Introduction to Number Theory

Dr. Y.K. Lau
(*HKU*)

Expert in
modular forms
and L-functions



Prof. K.M. Tsang
(*Princeton*)

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

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

Long tradition of number theory in our department

Prof. K.M. Tsang

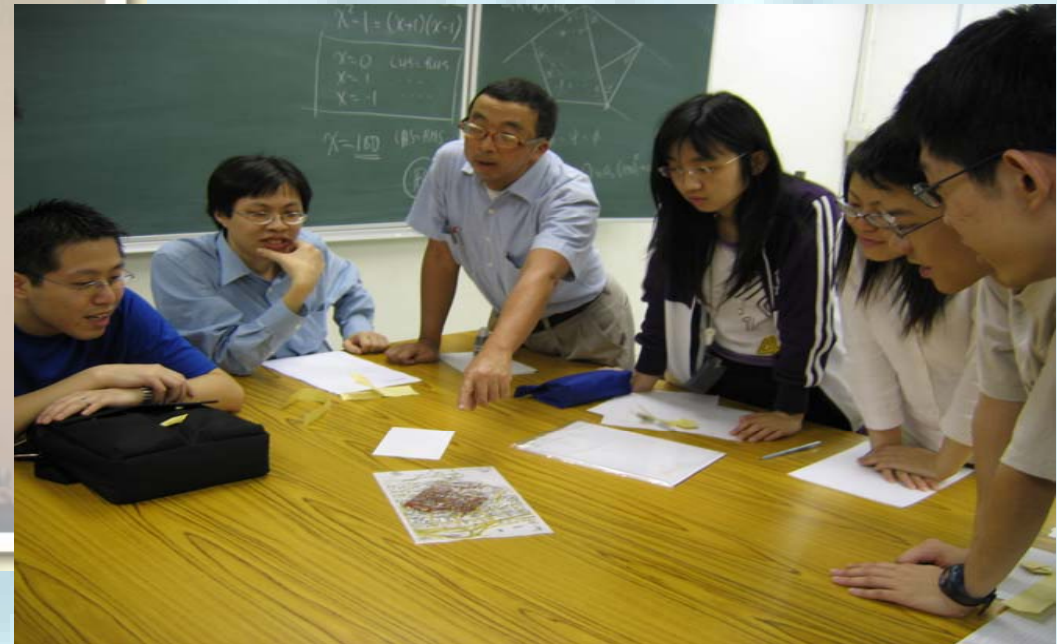


Prof. M.C.Liu

World expert in
Goldbach's
conjecture

Fields-Medallist, Prof. Alan Baker

YSCN0002 Mathematics: A Cultural Heritage



The emphasis is placed on appreciating, contemplating and discussing about the beauty, the utility and the "Way" of mathematics

MATH2000, MATH3000:

Mathematics Projects

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
- Geometry of polynomials

**Capstone
requirement (non-
credit bearing):
Exchange experiences**

University of California, Berkeley



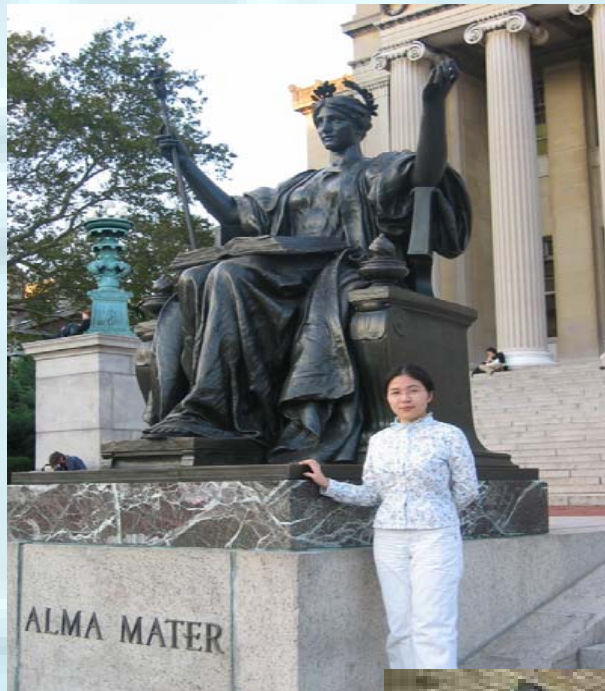
University of California, Berkeley



University of Lund

Further studies

**Columbia
University**



MIT



New York University



*What should I do if I want to
do 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 (MATH2000 or MATH3000 level), subject to prerequisite requirements.

Minor in Mathematics

If you are interested in mathematics and would like to do 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 do a minor in math and plan to do a master/PhD in economics/finance, the following courses are recommended

MATH2401 Analysis I

MATH2901/3902 Operations Research I and II

MATH2904 Introduction to Optimization

MATH2906 Financial Calculus

STAT3301 Time-series Analysis

STAT3316 Advanced Probability

Minor in Mathematics

If you would like to do a minor in math and plan to do 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

STAT3316 Advanced Probability

Bridging Courses in Mathematics

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

For more information, please visit the following link

http://hkumath.hku.hk/~wkc/advisor_major.htm

Further Enquiries : Course selection Advisers

Year One:

Dr. YK Lau (yklau@maths.hku.hk)

Dr. TW Ng (ntw@maths.hku.hk)

Year Two and Three:

Dr. PW Wong (ppwwong@maths.hku.hk)

Dr. SP Yung (spyung@hkucc.hku.hk)

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

The End