NEW PROGRAMME
Bachelor of Science (Honours) in Physics and Mathematical Sciences (Double Major)

Our 4-Year Degree Programmes

AY2021-22 Curriculum Structure

Our current website, spms.ntu.edu.sg, will be updated to ntu.edu.sg/spms, from April 2021.
MESSAGE FROM THE HEAD

Founded in 2005, the Division of Mathematical Sciences (MAS) has come a long way, starting with five faculty members and an intake of 47 undergraduate students in August 2005. The graduate programme was established in 2006. Currently, MAS has 35 faculty members, around 50 graduate students, and over 1000 undergraduate students enrolled in several degree programmes: Mathematical Sciences, Mathematical Sciences with Minor in Finance, Mathematical Sciences & Economics (Double Major), Mathematical & Computer Sciences (Double Major), and Data Science & Artificial Intelligence.

Our faculty is highly active in research, and we have established a vibrant research culture that our undergraduates participate in and benefit from. We have a constant stream of academic visitors from all over the world, hosting workshops and conferences on a regular basis.

MAS is strongly committed to high-quality undergraduate education. The curriculum of our direct honours degree programme is designed with an emphasis on solid mathematical foundations, job relevance, and flexibility of course choice. Motivated and strong students can opt to take special advanced courses, and to participate in undergraduate research projects, supervised independent study courses, and overseas exchange programmes.

Associate Professor
Chan Song Heng
Head, Division of Mathematical Sciences
FOUR-YEAR DEGREE PROGRAMMES

BACHELOR OF SCIENCE (HONOURS) IN MATHEMATICAL SCIENCES
- Offers a good mix of fundamental, as well as applied, computational, and industrial aspects of Mathematics and Statistics.
- 18 months of foundational courses, followed by specialisation in one of four tracks: Pure Mathematics, Applied Mathematics, Statistics, or Business Analytics.

In partnership with Nanyang Business School (NBS)

BACHELOR OF SCIENCE (HONOURS) IN MATHEMATICAL SCIENCES WITH MINOR IN FINANCE
- Emphasises the use of mathematical methods in finance and economics. Building on the Mathematical Sciences curriculum, students take additional NBS courses in Banking and Finance.

In partnership with the School of Computer Science and Engineering (SCSE)

BACHELOR OF SCIENCE (HONOURS) IN MATHEMATICAL AND COMPUTER SCIENCES (DOUBLE MAJOR)
- Intended for students seeking careers in financial technology, cybersecurity, and data analytics, or postgraduate degrees in Mathematics, Computer Science, and related disciplines.
- Curriculum provides a strong foundation in core mathematical concepts, and in-depth training in one of four areas at the interface of Mathematical Sciences and Computer Science: Theoretical Computer Science, Cryptography and Cybersecurity, Financial Modelling, and Data Science.

In partnership with the Division of Physics and Applied Physics (PAP)

BACHELOR OF SCIENCE (HONOURS) IN PHYSICS AND MATHEMATICAL SCIENCES (DOUBLE MAJOR)
- Intended for students interested in research careers requiring strong computational and problem-solving skills or students pursuing postgraduate degree in Physics and Mathematical Sciences.
- Curriculum equips students an understanding of physical world through mathematical rigour and insights. It covers courses at the interface of Physics and Mathematics such as Differential Geometry, Algebraic Topology, Quantum Mechanics, General Relativity.

In partnership with the School of Social Science (SSS)

BACHELOR OF SCIENCE (HONOURS) IN MATHEMATICAL SCIENCES AND ECONOMICS (DOUBLE MAJOR)
- Intended for students interested in quantitative jobs in the financial services industry.
- Curriculum covers numerical, computational and statistical mathematical methods, as well as quantitative methods in economics. Graduates will have a strong interdisciplinary skillset, and a strong background in statistics and economics.

Scan to find out more about our programmes!
## CURRICULUM OVERVIEW

### BACHELOR OF SCIENCE (HONOURS) IN MATHEMATICAL SCIENCES WITH MINOR IN FINANCE

Offered in partnership with the Nanyang Business School (NBS)

In addition to the curriculum of Major in Mathematical Sciences, students read 15 Academic Units of banking and finance courses offered by NBS. The choice of courses includes:
- Business Finance
- Financial Modelling
- Derivative Securities
- Bank Risk Management

### BACHELOR OF SCIENCE (HONOURS) IN MATHEMATICAL SCIENCES AND ECONOMICS (DOUBLE MAJOR)

Offered in partnership with the School of Social Science (SSS)

### APPLIED MATHEMATICS / PURE MATHEMATICS / STATISTICS TRACK

<table>
<thead>
<tr>
<th>Year 1 + 2</th>
<th>Courses Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2 + 3</td>
<td>Specialisation Track and Electives, Final Year Project or Professional Internship</td>
</tr>
<tr>
<td>Sample Courses for Pure Mathematics Track</td>
<td>Real and Complex Analysis, Differential Geometry, Number Theory, Topology</td>
</tr>
<tr>
<td>Sample Courses for Applied Mathematics Track</td>
<td>Numerical Analysis, Scientific Computing, Optimisation, Cryptography</td>
</tr>
<tr>
<td>Sample Courses for Statistics Track</td>
<td>Statistics, Data Analysis, Regression Analysis, Time Series Analysis</td>
</tr>
</tbody>
</table>

### BUSINESS ANALYTICS TRACK

<table>
<thead>
<tr>
<th>Year 1 + 2</th>
<th>Courses Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Business Operations &amp; Processes, Fundamentals of Management</td>
</tr>
<tr>
<td>Year 3 + 4</td>
<td>Final Year Project or Professional Internship, Data Management, Decision Tools for Managers, Financial Analytics &amp; Reporting, Business Intelligence, Principles of Economics, Operations Research</td>
</tr>
<tr>
<td></td>
<td>Courses from NBS</td>
</tr>
</tbody>
</table>

| Year 1 | Microeconomics, Macroeconomics |
| Year 2 | Econometrics, Mathematical Economics |
BACHELOR OF SCIENCE (HONOURS) IN MATHEMATICAL AND COMPUTER SCIENCES (DOUBLE MAJOR)

Offered in partnership with the School of Computer Science and Engineering (SCSE)

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Data Structures</th>
<th>Courses from SCSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2</td>
<td>Object Oriented Design &amp; Programming</td>
<td>Software Engineering</td>
</tr>
<tr>
<td>Year 3 + 4</td>
<td>Courses from Specialisation Track and Electives</td>
<td>Final Year Project or Professional Internship</td>
</tr>
</tbody>
</table>

Sample Courses for Theoretical Computer Science:
- Parallel Computing
- Advanced Topics in Algorithms

Sample Courses for Cryptography and Cybersecurity:
- Cyber Physical System Security
- Digital Forensics

Sample Courses for Data Science Track:
- Machine Learning
- Data Analytics and Mining

Sample Courses for Financial Modelling Track:
- Advanced Data Management
- Neural Networks

BACHELOR OF SCIENCE (HONOURS) IN DATA SCIENCE AND ARTIFICIAL INTELLIGENCE

Offered in partnership with the School of Computer Science and Engineering (SCSE)

In this programme, students will explore the emerging field of data science and artificial intelligence, by mastering the synergistic disciplines of computer science and statistics.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Data Structures</th>
<th>Courses from SCSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2</td>
<td>Object Oriented Design and Programming</td>
<td>Human Computer Interaction Software Engineering</td>
</tr>
<tr>
<td>Year 3</td>
<td>Artificial Intelligence</td>
<td>Data Analytics and Mining</td>
</tr>
<tr>
<td>Year 4</td>
<td>Cryptography and Network Security</td>
<td>Data Science for Business</td>
</tr>
</tbody>
</table>

BACHELOR OF SCIENCE (HONOURS) IN PHYSICS AND MATHEMATICAL SCIENCES (DOUBLE MAJOR)

Offered in partnership with the Division of Physics and Applied Physics (PAP)

<table>
<thead>
<tr>
<th>Year 1+2</th>
<th>Optics, Vibrations and Waves</th>
<th>Courses from PAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 3</td>
<td>Quantum Mechanics</td>
<td>Statistical Mechanics</td>
</tr>
<tr>
<td>Year 4</td>
<td>Major Prescribed Elective courses + Final Year Project</td>
<td></td>
</tr>
</tbody>
</table>

Courses from PAP:
- Optics
- Vibrations and Waves
- Relativity and Quantum Physics
- Thermal Physics
- Quantum Mechanics
- Statistical Mechanics
- Major Prescribed Elective courses
- Final Year Project

Scan to find out more about all programmes!
CAREER PROSPECTS

Due to the versatility provided by mathematical training, our graduates play a leading role in fields as diverse as finance, information technology, and biotechnology. Mathematics provides a superb foundation for developing job-specific skills, and is therefore valued by numerous employers.

INDUSTRY

1. Public Administration and Defence
2. Finance and Insurance
3. Information and Communication
4. Education and Research
5. Advertising Services and Market Research
6. Other Sectors

* Source: Graduate Employment Survey 2018

COMMON JOB TITLES

Public Administration and Defence
- Economist
- Policy Analyst
- Statistician

Finance and Insurance
- Actuary
- Financial Analyst
- Market Analyst
- Quantitative Analyst
- Risk Analyst
- Statistician

Information and Communication
- Applications Programmer
- Database Administrator
- IT Security Specialist
- IT Testing
- Software Engineer
- Systems Programmer

Education and Research
- Teacher
- Education Consultant
- Research Scientist

Other Sectors
- Health Services Manager
- Logistics Specialist
- Management Consultant
- Operations Research Analyst
- Resource Manager
PROFESSIONAL INTERNSHIPS

Our undergraduate programmes emphasise the importance of practical training. Students are given the opportunity to undergo a professional internship, varying from 10 to 22 weeks, during their course of study. This internship can be conducted at a private or public organisation, either locally or overseas.

Companies our undergraduates have interned at:

- Agilent Technologies Singapore
- A*STAR
- DSO National Laboratories
- Facebook
- Go-Jek Singapore
- Grab
- GroupM Singapore
- HP Inc
- Milliman
- OCBC Bank

In my final year as an Applied Mathematics undergraduate, I did a stint at Grab with the Data Science department. The programming courses in the SPMS curriculum positioned me well for the role. My supervisors at Grab were very friendly and offered their help whenever I needed guidance, making my time there a very enriching one. My work involved web scraping and data processing, and some of the skills I gained have proven useful in my subsequent role at a proprietary trading firm.

ELWIN SIM
Junior Trader at Flow Traders
BSc (Hons) in Mathematical Sciences, Class of 2018

In the vacation after my third year, I did an internship with Facebook, Singapore, doing account management and data analytics as part of the sales and marketing team. Being the only intern with science background did not demoralise me at all. I was happy that I was able to bring to the team a unique set of skills. Studying mathematics allowed me to develop certain analytical and critical-thinking skills, and I was able to identify insights and pick out trends more quickly than my peers.

VALERIE EVANGELIN LAURENT
Account Manager at Facebook Singapore
BSc (Hons) in Mathematical Sciences and Economics

Scan to find out more about our internship programmes!
The history of mathematical optimisation dates to ancient Greece, when mathematicians such as Euclid and Heron solved optimisation problems in geometry. Since then, it has developed into a major field of mathematics, with numerous applications such as design of complex electronic circuits, the imaging of biological samples, computer-aided selection of financial portfolios, and more. My research focuses on the design and analysis of algorithms for solving optimisation problems, and improving our theoretical understanding of optimisation problems.

When you connect your laptop or phone to a WiFi access point, part of the data is corrupted by the time it reaches the antennas! And when you post a picture on Facebook, it is stored on a computer that may experience disk failure, which is why Facebook used to store redundant copies on different computers. To cope with such scenarios, data must be protected by redundancy schemes, which arise from the mathematical field of coding theory. I work on devising such coding schemes, with the aim of providing reliability at low cost.

Many pieces of everyday technology, from airplanes to tennis rackets, are made of composite materials, which contain many different components mixed together. Composites can be extremely durable and light, and can possess properties not found naturally. My research looks at how the properties of a composite material are affected by its constituents, a complicated topic where advanced mathematics plays an essential role. I use my expertise to design efficient algorithms that allow computers to solve the complex equations governing the physics of composite materials.

In the era of big data, data can be produced and stored cheaply and on a massive scale. Scientific advances, as well as economic activities, are becoming more data-driven, bringing new opportunities and challenges for data analysis and statistics. My research aims to establish rigorous statistical frameworks for big data analyses, especially for economic and financial data. Mathematical analysis can provide rigorous guidance on many issues, such as the robustness of big data solutions.
ALUMNI AND STUDENT TESTIMONIALS

BAI ZHONGZHENG
Data Scientist at First Derivatives
BSc (Hons) in Mathematical Sciences and Economics, Class of 2017

During my studies, I embarked on a research project studying a socio-economic model of how competition affects cooperation. The project was definitely challenging. Besides devoured countless research papers, I had to programme a computer experiment for participants. The skills I picked up during the project were transferrable to non-academic contexts. I am now a part-time quantitative analyst at a FinTech startup, where my research and programming skills are put to good use.

Studying at SPMS is wonderful. The professors find interesting ways to help me understand concepts better and are always ready to answer questions. My courses are interesting, and enable me to challenge myself. I was also given the opportunity to participate in SPMS orientation camp, as part of the SPMS outreach committee. This has enabled me to really develop myself.

SELVARAJ BHARATHA
BSc (Hons) in Mathematical Sciences with Minor in Finance

The faculty members are really approachable and open to new ideas. For my final year project, I acquired data from a social sciences project and wanted to analyse it with advanced statistical methods. Even though this was my personal initiative, a professor agreed to guide and supervise me. The project allowed me to experience the end-to-end process of research, and prepared me for my current job as a policy maker at the Ministry of Education.

SAMUEL TEO
Centre for Strategic Infocomm Technologies (CSIT)
BSc(Hons) in Mathematical Sciences Cryptologist, Class of 2013

Mathematics and economics are highly relevant to the world we are living in. During my time in SPMS, I ‘learned how to learn’, and came to understand the importance of understanding and applying concepts, not just regurgitating answers. The foundational knowledge I acquired at SPMS brought me to where I am today, and will definitely be useful in ways I’ve yet to discover. I am and will always be proud to be an SPMS Alumna!

LI YONGMING
BSc (Hons) in Mathematical Sciences

Studying mathematics, especially cryptography, prepared me for my current job as a cryptologist in CSIT (the Centre for Strategic Infocomm Technologies). Besides familiarity with theoretical issues in cryptography, I have the ability to solve problems analytically, and to pick up quantitative skills in multiple domains. Having gone through a rigorous curriculum, I am more resilient and better equipped to face challenges.

LUIZA LEE
Business Development, Institutional Sales Nomura Asset Management
BSc (Hons) in Mathematics and Economics, Class of 2014

The SPMS mathematics programme offers many learning opportunities outside the core curriculum. I had the opportunity to do a project involving natural language processing and text analytics. My advisor, Dr Fedor Duzhin, guided me through the process of reading the latest research papers, and how to learn independently about cutting-edge research.

LI ENLIN
Student in the Doctor of Medicine Programme at Duke–NUS Medical School
BSc (Hons) in Mathematical Sciences, Class of 2014

Studying mathematics gave me a strong foundation in critical thinking, which has served well in understanding concepts from other disciplines. I also benefited from the freedom and opportunities in MAS and SPMS to explore beyond my comfort zone, including the accelerated curriculum programme and overseas exposure.

AARON CHIANG
Senior Assistant Director (Placement & Scholarships Policy), Student Placement and Services Division, Ministry of Education
BSc (Hons) in Mathematical Sciences, Class of 2011

The SPMS mathematics programme offers many learning opportunities outside the core curriculum. I had the opportunity to do a project involving natural language processing and text analytics. My advisor, Dr Fedor Duzhin, guided me through the process of reading the latest research papers, and how to learn independently about cutting-edge research.
OVERSEAS EXPERIENCE

I did my final year project overseas in France at Institut National des Sciences Appliquées de Toulouse. Professor Nicolas Privault, the lecturer for the financial mathematics course in NTU, kindly agreed to supervise me and helped me to secure a project with Professor Anthony Réveillac from INSA Toulouse. My project is concerned with principal-agent problems. Simply put, I am investigating how best a boss should pay a worker. It is exciting to see how these real-world problems can be formulated mathematically and subsequently solved for specific scenarios to yield useful results. I have also had the chance to learn French and immerse myself in the culture during my stint at INSA Toulouse. Doing my FYP overseas has truly broadened my horizons not just in mathematics, but also the world in general.

My experience in MAS has been amazing and wonderful. There are many overseas events sponsored for us undergraduate students, from mathematics competitions to overseas forums. Personally, I am most grateful for the opportunity to join the Heidelberg Laureate Forum, an annual event in Germany where young researchers are given the chance to interact with pre-eminent computer scientists and mathematicians. Not only did the school fully sponsor my whole trip there, the professors wrote me an amazing recommendation letter that allowed me to be selected. Of 1500 applicants, only 200 were selected, and fewer than 10 were undergrads. The laureates we met included Andrew Wiles, who proved Fermat’s Last Theorem, Barbara Liskov, a computing pioneer who created one of the first high-level programming languages, and many others. It was really an inspiring trip.

I chose mathematics because it is a subject that interests me. Here at MAS, I have numerous opportunities, one of which was the chance to participate in the International Mathematics Competition for University Students (IMC), an annual mathematics competition held that year in Blagoevgrad, Bulgaria. It was a wonderful experience! I got to meet mathematics students from all over the world, all of whom were passionate about mathematics. I also got to learn more about Bulgaria, its history and culture. There was an excursion to Melnik, a town in the mountains with many historical buildings. We also got to explore Blagoevgrad, and visited the local museum and farmers’ market. On top of it all, I managed to win a first prize in the competition (2016)!
### The Nanyang Scholarship

Awarded to students who excel academically, with strong leadership potential and outstanding CCA track records.

- Full coverage of subsidised tuition fees (after Tuition Grant).
- Living allowance of S$6,500 per academic year.
- Accommodation allowance of up to S$2,000 per academic year.
  (Applicable to scholarship holders who reside in NTU hostels only.)
- Travel grant of S$5,000 for an overseas programme (one-off).
- Computer allowance of S$1,750 (one-off).
- Priority for Overseas Programme.
- Participation in Scholars Orientation Programme, Scholars Award Ceremony, Outreach Programmes, and Eminent Speaker Series.
- No bond is attached to the Nanyang Scholarship apart from the three-year bond applicable to all Singapore PRs and international students under the MOE Tuition Grant Scheme.

### The College of Science Scholarship

Awarded to students with a record of good academic performance.

- Full coverage of subsidised tuition fees (after Tuition Grant).
- Living allowance of S$5,000 per academic year.
- No bond is attached to the College Scholarship apart from the three-year bond applicable to all Singapore PRs and international students under the MOE Tuition Grant Scheme.

### Admission Requirements

<table>
<thead>
<tr>
<th>Programme</th>
<th>GCE A-Level Requirements</th>
<th>Polytechnic Diploma Requirements</th>
<th>International Baccalaureate Diploma Requirements</th>
<th>NUS High School Diploma Requirements</th>
<th>International &amp; Other Qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical Sciences</td>
<td>Good H2 level pass in Mathematics</td>
<td>Good GPA in a relevant diploma, and good grades in at least 2 Mathematics modules</td>
<td>Mathematics at Higher Level</td>
<td>Major CAP of 2.0 in Mathematics</td>
<td>Mathematics at Senior High School Level/IB Higher Level</td>
</tr>
<tr>
<td>Mathematical Sciences with Minor in Finance</td>
<td>Good H2 level pass in Mathematics</td>
<td>Good GPA in a relevant diploma, and good grades in at least 2 Mathematics modules</td>
<td>Mathematics at Higher Level</td>
<td>Major CAP of 2.0 in Mathematics</td>
<td>Mathematics at Senior High School Level/IB Higher Level</td>
</tr>
<tr>
<td>Mathematical Sciences &amp; Economics (Double Major)</td>
<td>Good H2 level pass in Mathematics, and good pass in General Paper or Knowledge &amp; Inquiry</td>
<td>Good GPA in a relevant diploma, and good grades in at least 2 Mathematics modules</td>
<td>Mathematics at Higher Level</td>
<td>Major CAP of 2.0 in Mathematics</td>
<td>Mathematics at Senior High School Level/IB Higher Level</td>
</tr>
<tr>
<td>Data Science &amp; Artificial Intelligence</td>
<td>Good H2/HL/A Level or equivalent pass in Mathematics and either Physics, Chemistry, Biology or Computing</td>
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</tr>
</tbody>
</table>

For enquiries pertaining to scholarships:
Tel: (65) 6790 4115
Email: FinAid@ntu.edu.sg

For enquiries pertaining to financial assistance:
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Email: FinAid@ntu.edu.sg

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Student Services Centre, #03-01
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