**NEW PROGRAMME**

**Bachelor of Science (Honours) in Applied Physics with Second Major in Microelectronics Engineering**

This selective Second Major programme is run in collaboration with the School of Electrical and Electronic Engineering (EEE). Students receive a rigorous training in physics, and then learn about how to apply their physics knowledge for microelectronic engineering, with courses in integrated circuits, microprocessors, and more. It is an academically challenging programme at the frontier of applied physics and electronics engineering, that provides students with a fundamental understanding of how microelectronic devices work, and how to design and implement them.

Graduates of this programme are well-placed for careers in high-tech industries, particularly in the research and development of microelectronic devices.

Launched in AY2020-21

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**Our 4-Year Degree Programmes**

<table>
<thead>
<tr>
<th>Programme</th>
<th>Description</th>
<th>Launch Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science (Honours) in Physics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor of Science (Honours) in Applied Physics (Double Major) NEW</td>
<td>In collaboration with the Division of Mathematical Sciences (MAS)</td>
<td>AY2020-21</td>
</tr>
</tbody>
</table>

For admission criteria, please refer to: https://tinyurl.com/PAPAdmission

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**AY2021-22 Curriculum Structure**

Starting from AY2021-22, all undergraduate degree programmes in SPMS will incorporate the curriculum structure of the Interdisciplinary Collaborative Core (ICC). Please refer to Figure 1 below for more information.

**Interdisciplinary Collaborative Core (ICC)**
- Common university wide core (7 courses focusing on key transferable skills and grand challenges)
- Foundational core (including effective communication, digital literacy, and a mandatory Professional Internship or Attachment)
- Co-curricular modules

**Major Requirement**
(Core and Major Prescribed Electives)

**Broadening & Deepening Electives (BDE)**

* BDE allows for undergraduates to either broaden their interests by reading courses that are outside their disciplines; or deepen their skills by reading more challenging and advanced topics within their chosen discipline.

**Curriculum Overview:**

**Bachelor of Science (Honours) in Physics/Applied Physics**

<table>
<thead>
<tr>
<th>Year</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Core Courses (Mechanics, Optics, Vibrations and Waves, Electricity and Magnetism, Relativity and Quantum Physics, Physics Laboratory, Calculus, Linear Algebra, etc.)</td>
</tr>
<tr>
<td>02</td>
<td>Core Courses (Quantum Mechanics, Electromagnetism, Thermal Physics, Analytical Mechanics, Physics Laboratory, etc.)</td>
</tr>
<tr>
<td>03</td>
<td>Elective Courses for Physics (Atomic Physics, Chaotic Dynamical Systems, Cosmology, etc.)</td>
</tr>
<tr>
<td>04</td>
<td>Either Honours Project + Professional Attachment or Professional Internship</td>
</tr>
</tbody>
</table>

Advanced Elective Courses (Nanoscale Physics, Nuclear Physics, Quantum Electronics, etc.)

* Further information on the curriculum for other undergraduate programmes, and modules can be found on our website.

Our current website, spms.ntu.edu.sg will be updated to ntu.edu.sg/spms, from April 2021.
Science and technology play a critical role in the modern economy, and nowadays the most important discoveries and inventions are often not confined to narrow technical specialisations, but draw upon multiple disciplines. Physicists are well-placed to navigate this complex landscape. They are trained in building theoretical models for complex systems, rigorously testing models against real-world data, and designing devices and methods to solve problems. This skill set is increasingly important in numerous technical domains.

In the Division of Physics and Applied Physics, we provide a top-notch physics-based education that imparts useful skills for a broad range of challenging and rewarding jobs. Our graduates have proven well-equipped for finding employment in industrial R&D, data science, computer security, finance, as well as education and academic research.

Our curriculum is designed to emphasise the most relevant topics in physics and applied physics, including both theoretical and experimental aspects. We have a young and dynamic team of faculty members, dedicated to excellence in teaching and research. This includes NTU’s first and only Principal Lecturer, known for his innovations in teaching. Our professors include world-class experts in quantum technology, nanotechnology, superconductivity, photonics, and other topics, who are all eager to share their cutting-edge knowledge. Aside from traditional coursework, our students are exposed to a great deal of cooperative learning and project work.

This brochure provides information about our programmes, as well as testimonials from current students and graduates. If you need more information, please visit our website, and do not hesitate to contact me or any of our other professors. We hope you will pursue your undergraduate education with us!

apiaEE MIN ELBERT
ASSOCIATE PROFESSOR
Head, Division of Physics and Applied Physics

MESSAGE FROM THE HEAD
FOUR-YEAR DEGREE PROGRAMMES

BACHELOR OF SCIENCE (HONOURS) IN PHYSICS

Physics is the science of the natural world at the most fundamental and general levels. Physics students learn a wide variety of topics, including quantum technologies, statistical mechanics, computational physics, particle physics, photonics, and cosmology.

- Equips students with the analytical, computational, and experimental skills to perform research and development at the frontiers of scientific knowledge.
- Emphasis on fundamental topics in physics, such as statistical mechanics, quantum mechanics, condensed matter physics, particle physics, and computational physics.
- Optional course concentration in Nanotechnology.

BACHELOR OF SCIENCE (HONOURS) IN APPLIED PHYSICS

Applied Physics is a discipline specialising in developing technological applications for the latest discoveries in physics. Applied Physics students learn about spintronics, nanotechnology, plasmonics, metamaterials, laser physics, and more.

- Equips students with the skills needed for technology development, based on translating cutting edge scientific discoveries into real-world applications.
- Emphasis on topics at the interface of fundamental science and applications, including nanotechnology, microfluidics, photonics, plasmonics, laser physics, and medical imaging.
- Optional course concentrations in Nanotechnology, Optical Technology, Semiconductor Technology, or Biophysics.

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

This selective Double Major programme is intended for students interested in careers requiring strong computational and problem-solving skills, or postgraduate degree in Physics, Mathematics, and related subjects.

- Selective and academically challenging programme providing rigorous and in-depth training in both physics and mathematics.
- Curriculum equips students an understanding of physical world through mathematical rigour and insights. It covers topics at the interface of physics and mathematics, such as differential geometry and general relativity, topology and condensed matter physics, quantum field theory, and more.

BACHELOR OF SCIENCE (HONOURS) IN APPLIED PHYSICS WITH SECOND MAJOR IN MICROELECTRONICS ENGINEERING

In this selective programme, Applied Physics students earn a Second Major in Microelectronics Engineering by taking courses such as circuit fabrication, microprocessor design, device simulation, and more.

- Selective and academically challenging programme at the frontier of Applied Physics and Electronics Engineering, providing students with a fundamental understanding of how microelectronic devices work, and how to design and implement them.
- Graduates are well-placed for careers in high-tech industries, particularly in the research and development of microelectronic devices.

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

### BSc (Hons) in Physics

**Year 1**
- Mechanics
- Optics, Vibrations and Waves
- Electricity and Magnetism
- Relativity and Quantum Physics
- Physics Laboratory

- Calculus
- Linear Algebra
- Programming in Python

**Year 2**
- Quantum Mechanics
- Electromagnetism
- Thermal Physics
- Analytical Mechanics
- Physics Laboratory II

- Complex Methods
- Group Theory
- Probability and Introduction to Statistics
- Intermediate Mathematics Electives

**Year 3 + 4**
- Statistical Mechanics

  **Physics Electives, including:**
  - Atomic Physics
  - Chaotic Dynamical Systems
  - Classical and Quantum Information
  - Computational Physics
  - Condensed Matter Physics (*)
  - Cosmology
  - Econophysics
  - Electrodynamics
  - Fluid Mechanics
  - Nanoscale Physics (*)
  - Nuclear Physics
  - Quantum Electronics
  - Particle Physics
  - Surface and Interface Physics (*)

  * For optional concentration in Nanotechnology

### BSc (Hons) in Applied Physics

**Year 1**
- Mechanics
- Optics, Vibrations and Waves
- Electricity and Magnetism
- Relativity and Quantum Physics
- Physics Laboratory

- Calculus
- Linear Algebra
- Programming in Python

**Year 2**
- Quantum Mechanics
- Electromagnetism
- Thermal Physics
- Analytical Mechanics
- Physics Laboratory II
- Optics
- Introduction to Lasers (Elective)

- Complex Methods

**Year 3 + 4**
- Physics Laboratory III

  **Applied Physics Electives, including:**
  - Acoustics
  - Biophysics (*)
  - Biomedical Imaging and Sensing
  - Classical and Quantum Information
  - Computational Physics
  - Condensed Matter Physics (*) (*)
  - Fabrication of Micro- and Nano-electronics
  - Medical Physics for Radiotherapy (*)
  - Nanoscale Physics (*) (*)
  - Nuclear Physics
  - Photonics (*)
  - Plasmonics and Metamaterials
  - Quantum Electronics (†)
  - Semiconductor and Spintronic Devices (‡)
  - Soft Condensed Matter Physics (§)
  - Superconductors and Superfluids
  - Surface and Interface Physics (*)

  * For optional concentration in Nanotechnology
  † For optional concentration in Optical Technology
  ‡ For optional concentration in Semiconductor Technology
  § For optional concentration in Biophysics or Medical Physics
CAREER PROSPECTS

Physics and Applied Physics graduates are employed in a wide range of occupations, including research and development (R&D) in industry and academia, education, finance, software development, and other professional positions.

INDUSTRY

1. Education and Research
2. Electrical and Electronics Products
3. Information and Communication
4. Public Administration and Defence
5. Finance and Insurance
6. Other Sectors

* Source: Graduate Employment Survey 2017

COMMON JOB TITLES

**Education and Research**
- Physicist
- Laboratory Manager
- Research Scientist
- Teacher

**Information and Communication**
- Applications Programmer
- Data Scientist
- IT Security Specialist
- Software Engineer

**Electrical and Electronics Products**
- Laboratory Executive
- Operations Manager
- Process Engineer
- Product Engineer
- Technical Support Engineer

**Public Administration and Defence**
- Armed Forces Personnel
- Defence Science Engineer
- Policy Analyst

**Finance and Insurance**
- Financial Analyst
- Financial Consultant
- Quantitative Analyst

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:

- Ace Pacific
- AEM Singapore
- Century Technology
- Ecoponics
- Environmental Solutions (Asia)
- Eurofins Mechem
- Inginim
- Micron Semiconductor Asia
- Robert Bosch (SEA)
- Singapore Health Services (SingHealth)
- Singapore Institute of Manufacturing Technology
- Thermo Fisher Scientific

During my sophomore year, I visited the DSTA career booth at the SPMS job fair to learn more about the role that DSTA plays in harnessing technology for Singapore’s defence. I secured the opportunity to intern at DSTA’s Networked Systems Programme Centre from July to December 2015, where I took part in a project involving data and time series analysis. The rigorous theoretical physics and mathematics courses offered by SPMS gave me a strong foundation for analytical and quantitative skills. I was able to understand the technical issues, and to derive insights from the data using Python and R, as well as specialised data analytics programmes such as RapidMiner, IBM SPSS Statistics and Tableau.

The internship built up my confidence and greatly broadened my skillset. In 2015, I attended a networking session hosted by NTU, and interacted with the hiring managers from DSTA. I secured an interview with the organisation before graduation, and am now an engineer at DSTA’s C4I Development Programme Centre, where I develop sense-making capabilities for maritime security. I feel a sense of pride and achievement, knowing my skills can contribute to the defence and national security of Singapore.

YEOW JUN YI (PICTURED FAR LEFT)
Engineer
Defence Science and Technology Agency
BSc (Hons) in Applied Physics, Class of 2016

Scan to find out more about our internship programmes!
Photonics is the science of controlling and manipulating light. Its applications are wide-ranging, and include lighting, displays, solar panels, fibre-based internet communications, laser surgery, and even advanced manufacturing processes. My research involves devising nanometer-scale devices that alter how light interacts with matter. This line of research involves making use of cutting-edge nanofabrication technologies, newly-discovered materials that have exotic optical properties, as well as clever use of the laws of physics.

CESARE SOCI
ASSOCIATE PROFESSOR
Nanophotonics and Nanotechnology

Quantum science and complexity science seem to be worlds apart. One deals with individual photons and atoms, while the other is associated with large-scale phenomena like weather systems and traffic networks. Yet recent developments reveal that the unique properties of quantum particles can help us understand the data in the environment around us. My research deals with the remarkable features of quantum information – entanglement, non-locality, and quantum superpositions – and their implications for our basic concepts of causality, reality and complexity. I also investigate how these fundamental theories can be used to design quantum protocols to model and simulate problems in the macroscopic world.

GU MILÉ
ASSISTANT PROFESSOR
Quantum Information and Complexity Science

Photons are the light particles that comprise light. They interact with matter and are used to transmit information. The hidden and intricate dance of electrons in materials lies at the heart of our daily interactions with the physical world. For example, electrons enable the bonding between atoms that gives solids their rigidity, and the quantum nature of electronic spin enables modern magnetic data storage technology. My research focuses on theoretically mapping out the possible paths of electrons as they traverse the complicated landscape of a material. I aim to use this fundamental understanding to design new quantum materials and quantum machines. Such “quantum engineering” involves re-imagining how electrons can move together, consistent with the laws of quantum mechanics.

JUSTIN SONG
ASSISTANT PROFESSOR
Quantum Condensed Matter Physics

The hidden and intricate dance of electrons in materials lies at the heart of our daily interactions with the physical world. For example, electrons enable the bonding between atoms that gives solids their rigidity, and the quantum nature of electronic spin enables modern magnetic data storage technology. My research focuses on theoretically mapping out the possible paths of electrons as they traverse the complicated landscape of a material. I aim to use this fundamental understanding to design new quantum materials and quantum machines. Such “quantum engineering” involves re-imagining how electrons can move together, consistent with the laws of quantum mechanics.

S. N. PIRAMANAYAGAM
ASSOCIATE PROFESSOR
Spintronic Devices

Devices such as smartphones and computers, which we use everyday, can store huge amounts of information in tiny volumes, such as SD cards. My research addresses the following questions: What are the limitations to storing information at high densities? What laws of physics can be exploited to make better memory storage devices? How can materials be tailored to push memory technologies further? My laboratory fabricates materials and nanostructures, using techniques such as sputtering and lithography, to serve as prototype memory storage devices. We work closely with industry partners to ensure that the research we do is practical and useful to humankind.

GÜ MILÉ
ASSISTANT PROFESSOR
Spintronic Devices

Gu Mîlî
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I work as an optics engineer in a local company that supplies custom machine vision solutions to end-customers. Most of my work involves designing optical systems for inspecting very specific products, for which there is simply no off-the-shelf solution.

During my time as a Physics and Applied Physics student, apart from learning physics theories, there were plenty of practical opportunities: lab, research, projects, and more. These helped to develop my skills in troubleshooting, data analysis, and, most important of all, critical thinking. In my opinion, this kind of learning experience is particularly valuable in the modern world of multidisciplinary engineering.

Looking back after 4 years, I benefited from a curriculum structured with great foresight. The Division of Physics and Applied Physics recognised the growing importance of computing skills, and incorporated many programming modules into the curriculum. These skills are now my rice bowl as a PhD student working on numerical simulations. Many of my friends have secured positions in the corporate world, such as data analysts. SPMS was the most nurturing of environments. Professors are willing to mentor undergraduates, and the School’s ties to external research institutes provide opportunities to experience research outside of academia. This is the best thing about SPMS - students have countless avenues to explore what interests them.

SPMS is a very friendly place. The coursework is intellectually challenging, and the common areas are cozy and conducive for spending time in. The jovial chatter during term time, anxious exchanges during exam period, the peace and quiet during evenings - all this formed an unforgettable undergraduate life! I am personally grateful for the efficiency and flexibility of the professors, teaching assistants, and staff. I had the chance to teach in classes and laboratories, and to try out Making and Tinkering. I even managed to source for my own internship, and freely explore my research interests. If given the chance, I would like to be back in SPMS.

I enjoyed the opportunity to work on projects as early as freshman year. That allowed me to practise the discipline of Physics, experience the triumphs and pitfalls inherent to research, and appreciate how knowledge evolves. I also participated in the International Physicists’ Tournament (IPT) in Switzerland, and had a wonderful time debating physics with other young scientists globally. Such opportunities for expanding your horizons were abundant, and gave me a very fruitful college experience.

My degree in physics gave me not only a strong mathematical foundation but, more crucially, taught me to think critically. These skills have proven very transferable and have been a major asset in my career as a cognitive and computational neuroscientist.

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Why is hair attracted to combs? Why does metal feel colder than wood? How do pianos produce sound? These everyday phenomena have interested me since I was little, and led me to study Physics. During my undergraduate studies at NTU, these “why” questions have been replaced by “how”, but there are yet more “whys” as I go further in depth into various topics. I enjoyed the opportunities for hands-on training, including my Final Year Project where I did mechanical design, made my own induction coils, conducted experiments, etc. These experiences gave me the confidence to challenge unsolved problems, think out of the box, and be ready for the unexpected.

I was very lucky to have spent 8 years (Undergrad + PhD) in PAP. For me, an SPMS Physics education was not only about picking up technical and technological skills, but also about being curious and developing passion for one’s subject of study. I believe this shaped us to be creative, adaptive and nimble in picking up new skills and knowledge. These are lifelong lessons which impacted me positively beyond the classroom and in the workforce. I would also like to shout out to the friends and professors in SPMS, whose brilliance and determination I am thankful for and humbled by. It was my great fortune to have shared a path with them.

CHUA CHERN FEI
Optics Engineer, Emage Vision Pte Ltd
BSc (Hons) In Applied Physics, Class of 2011

ERICO TJOA
Research Engineer, A*STAR
BSc (Hons) in Physics with Second Major in Mathematical Sciences, Class of 2018

JEREMY LIM ZHEN JIE
PhD Candidate
SUTD Mathematics and Science Cluster
BSc (Hons) in Physics, Class of 2018

TAM QIAN XIN
Teaching Assistant at NTU
BSc (Hons) in Physics, Class of 2013

ANG YUEN SIANG
Postdoctoral Fellow, Harvard University
BSc (Hons) in Applied Physics, Class of 2013

DARRELL TAY
Data Scientist, Agoda
BSc (Hons) in Physics, Class of 2012

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I had the opportunity to complete a semester abroad at the University of Toronto and to do an Overseas FYP at the High Energy Physics group in University College London. I learnt many valuable skills in and outside of Physics, and the experience also gave me a leg up in transitioning into my career as a Data Scientist in London.

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SCHOLARSHIPS

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 $S6,500 per academic year.
- Accommodation allowance of up to $S2,000 per academic year.
- Travel grant of $S5,000 for an overseas programme (one-off).
- Computer allowance of $S1,750 (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 $S5,000 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.

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

For enquiries pertaining to scholarships:
Tel: (65) 6790 6766
Email: ug_scholarships@ntu.edu.sg

Visit our Scholarships page for more details

ADMISSION REQUIREMENTS

Programme | GCE A-Levels | Polytechnic Diploma awarded in Singapore | International Baccalaureate Diploma | NUS High School Diploma | International & Other Qualifications
--- | --- | --- | --- | --- | ---
Physics | Good H2/HL/A Level or equivalent pass in Physics and Mathematics | Good GPA in a relevant diploma, and good grades in at least 2 Mathematics modules | Physics and Mathematics at Higher Level | Major CAP of 2.0 in Physics and Mathematics | Physics and Mathematics at Senior High School Level/IB Higher Level
Applied Physics | Good H2/HL/A Level or equivalent pass in Physics and Mathematics | Good GPA in a relevant diploma, and good grades in at least 2 Mathematics modules | Physics and Mathematics at Higher Level | Major CAP of 2.0 in Physics and Mathematics | Physics and Mathematics at Senior High School Level/IB Higher Level
Physics & Mathematical Sciences (Double Major) | Good H2/HL/A Level or equivalent pass in Physics and Mathematics | Good GPA in a relevant diploma, and good grades in at least 2 Mathematics modules | Physics and Mathematics at Higher Level | Major CAP of 2.0 in Physics and Mathematics | Physics and Mathematics at Senior High School Level/IB Higher Level
Applied Physics with Second Major in Micro-Electronics Engineering | Good H2/HL/A Level or equivalent pass in Physics and Mathematics | Good GPA in a relevant diploma, and good grades in at least 2 Mathematics modules | Physics and Mathematics at Higher Level | Major CAP of 2.0 in Physics and Mathematics | Physics and Mathematics at Senior High School Level/IB Higher Level

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