SCHOOL OF COMPUTER SCIENCE AND ENGINEERING (SCSE)

Bachelor of Engineering Computer Engineering (Hons)
Bachelor of Engineering Computer Science (Hons)
With the pervasiveness of technology in our lives, it is important to understand the limits and capabilities of the technology that we use. SCSE programmes prepare students for a successful life beyond the course of study by providing a strong foundation in both theory and practice through a project-based curriculum. Students are encouraged to adopt a life-long learning approach and adapt to ever-changing technology.

Many career opportunities will be opened to SCSE students with a curriculum accredited to practice engineering at a professional level. The NTU Global Immersion Programme will allow students a chance to broaden their horizon through partnerships with multiple prestigious international universities. Graduates will be fully equipped with in-depth theoretical knowledge as well as highly relevant technical, communication and professional skills.
Pioneering Smarter Technology in a Connected World

STRONG FOUNDATION IN THEORY AND PRACTICAL LIFE-LONG LEARNING ADAPTABILITY HIGHLY RELEVANT SKILLS
UNDERGRADUATE

All SCSE programmes are accredited by the Engineering Accreditation Board (EAB) of Institution of Engineers Singapore (IES).

Full Time Programmes (Honours Based on Merit):
Bachelor of Engineering (Computer Engineering)
Bachelor of Engineering (Computer Science)*

Double Degree in Business &
Computer Engineering/Computer Science
Bachelor of Business** awarded by Nanyang Business School
and Bachelor of Engineering (Computer Engineering or Computer Science)

* Part Time Course Available - Refer to scse.ntu.edu.sg for more details.
** With Specialisation in Business Analytics

COMPUTER ENGINEERING

YEAR 1
- Engineering Mathematics I
- Engineering Mathematics II
- Introduction to Computational Thinking
- Inventions and Innovations in Computing
- Digital Logic
- Engineering Communication I
- English Proficiency
- Introduction to Sustainability: Multidisciplinary Approaches and Solutions (online course)

YEAR 2
- Algorithms
- Object Oriented Design and Programming
- Digital Systems Design
- Circuits and Signal Analysis
- Operating Systems
- Ethics and Moral Reasoning
- Liberal Arts
- Computer Organisation and Architecture
- Data Structures
- Discrete Mathematics
- Engineers and Society
- Science and Technology
- Unrestricted Elective
- Absolute Basics for Career by MLCPS (Margaret Lien Centre for Professional Success)
- Software Engineering
- Microprocessor-based Systems Design
- Advanced Computer Architecture
- Sensors, Interfacing and Control
- Engineering Communication II
- Business and Management
- Unrestricted Elective

YEAR 3
- Microcontroller Programming
- Multidisciplinary Design Project
- Computer Networks
- Technical Elective 1
- Unrestricted Elective
- Entrepreneurship and Innovation
- Digital Signal Processing
- Technical Elective 2
- Technical Elective 3
- Unrestricted Elective
- Professional Internship

YEAR 4
- Final Year Project
- Digital Communications
- Technical Elective 4, 5 and 6
- Unrestricted Elective
- Career Power Up! By MLCPS
- Specialisations
  - Embedded System
  - Networking and Mobility
  - Digital Media
  - Information and Cyber Security
  - High Performance Computing
## PROGRAMMES

### Double Degree in Economics and Computer Engineering/Computer Science

Bachelor of Arts in Economics awarded by School of Humanities and Social Sciences and Bachelor of Engineering (Computer Engineering or Computer Science)

### Computer Engineering/Computer Science with a Second Major in Business

Bachelor of Engineering in Computer Engineering / Computer Science and Master of Science (by invitation only)


### Integrated Programmes

Bachelor of Engineering in Computer Engineering / Computer Science and Master of Science (by invitation only)

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### COMPUTER SCIENCE

#### YEAR 1
- Discrete Mathematics
- Introduction to Computational Thinking
- Inventions and Innovations in Computing
- Digital Logic
- Engineering Communication I
- Introduction to Sustainability: Multidisciplinary Approaches and Solutions
- English Proficiency
- Unrestricted Elective

#### YEAR 2
- Algorithms
- Object Oriented Design and Programming
- Computer Graphics and Visualisation
- Human Computer Interaction
- Operating Systems
- Ethics and Moral Reasoning
- Liberal Arts

#### YEAR 3
- Advanced Software Engineering
- Multidisciplinary Design Project
- Net Centric Computing
- Technical Elective 1
- Entrepreneurship and Innovation
- Unrestricted Elective

#### YEAR 4
- Final Year Project
- Compiler Techniques
- Technical Elective 4, 5 and 6
- Unrestricted Elective
- Career Power Up! by MLCPS

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Specialisations
- Networking and Mobility
- Digital Media
- Information and Cyber Security
- High Performance Computing
- Information Systems
- Intelligent Systems

Computer Engineering

The programme combines a distinctive fusion of computer engineering and electronics engineering. Rapid advances in microelectronics and computer science have created a need for a special kind of engineer. The broad knowledge of programming and electronics, coupled with the specialist skills in software and hardware interfacing make our Computer Engineers immensely suitable for a wide range of professions within the IT industry.

This project has demystified the workings of a computer by exploring its very core, breaking down complexities into binary simplicities and circuitry. It allowed us to examine a well-established system and add personal characteristics to it. Designing a microprocessor required imaginative design just as much as sound engineering. However, the cornerstone of good design is, undoubtedly, a good team.

Computer Engineering Students
Advanced Computer Architecture is one among many other hardware programmes taught and the course will facilitate the students to develop in-depth understanding of the design principles of a computer system. Students will complete this course with a useful appreciation and understanding of processor design issues relating to simplicity of implementation, performance-enhancement techniques and power-reduction methods. Understanding of processor design is important for both computer engineering as well as computer science students.

Computer engineering students acquire adequate knowledge and skill to design their own processor that achieves the desired performance. In particular, they learn how to design cache and pipeline data-path to improve performance and to overcome the challenges of realising and leveraging parallelism in current and future processors.
Computer science students are also trained to understand the functionality and important features of the hardware present in the processors so that they can effectively write programmes and design software. The students will be able to develop programmes to achieve high performance through awareness of data-path and memory design along with the parallelism at instruction, data, and thread level. They will be able to understand the technical aspect of a CPU while selecting a computer system to be used for certain level of performance. The undergraduate programmes by the school also enable our students to acquire the necessary skills and knowledge to design their own mobile application. From project management, programming and designing, students will get to learn about the intricacies of developing a mobile app. The other modules in SCSE, such as Algorithms and Human Computer Interaction will enable students to hone other skills apart from programming.

“Packgr, created by our team as part of our Software Engineering module, is a mobile app that helps companies collect feedback about their product packaging. At the same time, users are able to use it as a private packaging diary. We’re really excited to be able to work on projects that are applicable to everyday life. To top it off, getting to work and play alongside friends has made this a fun and enjoyable experience!”

Computer Science Students
Computer Science is concerned with the efficient application of computer technology, through the design of software algorithms and data structures, design methodologies and language paradigms. The programme emphasises the practical design of efficient and reliable software to meet specifications. Computer Science focuses more on software design and construction, and does not include subjects on circuits, basic electronics or digital communications.
It was an enjoyable project where I gained a lot of experience and knowledge during the process. The project encompassed both aspects of hardware and software. Hardware involved creating the robot; software required me to programme the robot’s behaviour and an Android application to control the robot. A Windows application was also created to perform data analysis. It was a challenging and rewarding project that spanned over a year. Fortunately, my supervising professor, Nicholas Vun, was always there to guide me.

_Ho Yuan Fa, Computer Engineering_

Brain-Computer Interfaces (BCIs) is a direct communication pathway between the brain and an external device, allowing a user to interact with a computer system using thoughts. The aim of our project was to use a non-invasive Brain-computer Interface to control the movement of a quadcopter. A framework was developed to convert EEG signals into commands to drive the quadcopter through a wireless interface with great success. The project has also allowed the team to apply what was learnt during the programme via applications in biological navigation and neuro-prosthetics, contributing to its success.

_Vincent Tan Teck Leong, Computer Engineering_
Precision Landing of Drones using Real Time Kinematic-GPS (RTK-GPS): The project was aimed at fixing the current problem with Unmanned Aerial Vehicle (UAV) autonomous landing. Current algorithms have an error of up to two meters in autonomous landing. Thus, it is not possible to have a precise landing for drones. The team used the technology of a RTK-GPS kit from SwiftNav – a company that specialises in manufacturing RTK-GPS kits with high-accuracy, to determine precise landing location of the drone. The result was a landing error of only a few centimeters, a stark contrast to the current algorithms. The team also made use of vision based algorithms to further ensure the precision of the landing. The applications of such an algorithm allows the team to be able to land the drones on moving targets, undulating terrain or on unstable surfaces such as water bodies.

Nikhil Venkatesh, Computer Engineering
**Final-Year Project**

**Human Gesture Control of Multiple Quadcopter Drones**: The project aimed to develop a framework for controlling multiple quadcopters by a single person using Human-Computer Interaction. In this project, we used touch interface and LEAP motion controller to navigate the flight control system via first person view of live video streaming from the drones. The touch interface served as a front-end, enabling the user to monitor the behaviour and to receive live feeds from the drone while the LEAP motion controller uses hand gestures to principle the drone, providing an intuitive way of control. The platform independent framework currently uses Java programming for the interface and a broadcast mechanism for communication with the drones.

*Utsav Garg, Computer Science*
The 13 weeks were full of valuable and rewarding experiences. As a team, where each member is from a different origin and discipline, we worked together towards a common goal — to be the best team for MDP (to build an MVP robot). Our interactions with each other during our weekly meetings and lab sessions allowed us to learn so many things about one another, such as culture and religion, as well as our strengths and weaknesses as an individual. Whenever one encountered an issue which was difficult to solve, we would help to think of possible solutions or approaches to tackle the issue together.

It brought us great joy when we learned that not only have we succeeded in overcoming the challenges posed to us in this module, but we have also clinched first place among our peers in the leaderboard challenge. Our time and efforts placed into this project were well-spent and definitely well-rewarded.

Best MDP Team
At SCSE, we nurture, empower and equip students with the knowledge and experience they need to take on the world. This means offering a myriad of programmes for a well-rounded education.
Enhanced Learning in Infocomm Technology (ELITE) Programme

In collaboration with the Infocomm Development Authority (IDA), SCSE now offers the Enhanced Learning in Infocomm Technology (ELITE) programme to its students. Supported by IDA and its many partners, this multi-faceted programme aims to give undergraduates the opportunity to sharpen their skills through a variety of activities that seek to complement a classroom-based learning experience.

Exciting NTU Programmes

NTU offers an array of Global Programmes for both incoming international exchange students as well as outgoing students. These programmes provide an opportunity for students to develop global perspectives and connect with people of diverse cultures to broaden their learning experience.

To complement our diverse student population, NTU offers comprehensive global education opportunities with other top-notch universities including Massachusetts Institute of Technology (MIT), Stanford University, Waseda University, Tokyo University, Peking University, Fudan University, Indian Institutes of Technology Delhi and Cornell University.

NTU Work and Study

Designed to enhance the learning experience at NTU, the programme provides students the experience of studying and working abroad. Students are able to enhance their resume with the opportunity to intern at multinational companies, leading companies and start-up ventures in well-known high technology parks. In addition, students can build a global network by spending a semester abroad.
Ms Gao He, 21, a fourth-year Computer Engineering student at Nanyang Technological University who minors in business, was drawing a four-figure pay during her 10-week internship at a multinational investment banking firm.

"The working hours in investment banks are longer than those in other industries as there were meetings with our US or UK counterparts that were held after office hours because of the time difference. Despite the long hours, I have managed to learn a lot through this internship that has aided in my growth."

Gao He, Computer Engineering

Mr Zhou Xinzi earned a high four-figure monthly salary during a three-month internship at the Microsoft headquarters in Redmond, Washington, in the United States. He was a fourth-year Computer Engineering student at Nanyang Technological University.

Mr Zhou, who was on the Dean’s List, says:

"At Microsoft, they treat the interns very well. I think it’s partly because they want to encourage us to sign on full-time. But I think it’s also the culture in the US to pay interns almost as much as full-timers."

Zhou Xinzi, Computer Engineering

"Being a student of SCE* has given me an edge over the others when I applied and got selected for an internship with Google. The technical and soft skills that I have learnt from my course have allowed me to excel the legendary tough Google interviews. Upon acceptance, NTU Career Attachment Office (CAO) provided guidance and made sure that I had everything I needed for the internship, and that I settled down well in a foreign country.

At the end of the internship, the greatest achievement for me was to witness the deployment of codes that I have created for Google, to be used by millions in the world. It also made me realise that SCE* has prepared me well for the real working world of computer engineering. I couldn’t be more thankful for that."

Dillon Amadeo Wirantono Goej, Computer Science
“At the end of my year 2, Swiss Federal Institute of Technology Lausanne (EPEL) offered me a summer research internship. I was one of the 50 Bachelors and Masters students chosen from a pool of over 1500 applicants. After Switzerland, I was once again given the opportunity to go on an exchange programme with Columbia University where I spent the next summer exploring and enjoying New York City.

Prerna Chikersal, Computer Science

“Georgia Institute of Technology was the destination of my exchange journey. The grading system employed by the university was one of the biggest surprises as consistency is emphasized and valued at an utmost level. Graded homework, projects, quizzes, class participation and final exams all played an equal part in contributing to the final grade, hence the need to be consistent in the results delivered.

Being able to experience a different schooling style allowed me to gain new experiences and brought out a new and positive paradigm shift upon returning to Singapore. I have learned that one needs to be consistent in life in order to deliver the best results and that was a lesson I wouldn’t be able to learn if I had not signed up for the exchange programme.

Wong Ying Fu, Computer Science

“Going for an exchange programme to the University of Ontario Institute of Technology (UOIT), Canada, was one of the best learning and life experiences I’ve had. Out of all the experiences, I valued the cultural exchange and friendships forged most. This exchange programme has given me opportunities to challenge and understand myself better. Being forced to step out of my comfort zone and to adapt to an entire different environment was definitely not an easy journey, which made it all the more memorable. Shivering in the freezing Canadian winter, layering up just to step outside (which I never will in Singapore) and whipping up home-cooked meals together with friends are some experiences I treasure most. All in all, this exchange marks the highlight of my university life.

Tan Ser Han, Computer Science
Computer Science and Engineering graduates will often find themselves encountering situations which require problem analysing and solution finding. There will also be problem formulation, design, implementation, debugging, troubleshooting and testing to be done as well as using advanced communications or multi-media equipment to reach an outcome through successful teamwork.
Industry Ready Graduates – A strong foundation in the disciplines of computer engineering and computer science means that graduates of SCSE are able to use their skills to continually experience breakthroughs that enable people to communicate more seamlessly, manage their environments more effectively and lead more comfortable lives than ever before.

No matter which industry they are in, graduates of SCSE are able to provide innovative solutions.

SCSE graduates are employed in companies such as:

- Accenture Pte Ltd
- Agilent Technologies Singapore Pte Ltd
- Bank of America
- Borland Singapore
- Centre for Strategic Infocomm Technologies
- A*STAR Science and Engineering Research Council
- Creative Technology
- Credit Suisse
- Crimson Logic Pte Ltd
- DBS Bank Ltd
- Defence Science and Technology Agency
- DSO National Laboratories
- ESPN Star Sports
- Yokogawa Singapore
- ExxonMobil Asia Pacific Pte Ltd
- Facebook
- Google Inc.
- Hewlett-Packard Singapore (Pte) Ltd
- Microsoft Corporation
- NexLabs Pte Ltd
- NOKIA Pte Ltd
- PayPal International
- PSA Corporation Ltd
- PricewaterhouseCoopers
- SAP Asia Pte Ltd
- Samsung Asia Pte Ltd
- Singapore Airlines
- SingTel Ltd
- Singapore Technologies group of companies
- Standard Chartered Bank
- Ubisoft Singapore Studio
- United Overseas Bank Limited Co.
I definitely owe it to the School of Computer Engineering* in NTU for it was through the academic rigor of her Computer Science Programme that I was able to further develop the knowledge and skills that would serve me well after graduation. It has been said that education is not the filling of a pail, but the lighting of a fire and in that aspect, I feel that the curriculum we have gone through has lit the fire in us as opposed to just filling our heads with knowledge. The transition from school to the working world is seldom an easy one, but thanks to the knowledge and lessons imparted by the dedicated faculty, it has been a smooth one for me.

Ong Wei Xi, Elysia
Autodesk Asia Pte Ltd
Web UI Developer
B. Eng Computer Engineering
(Class of 2014)

Achieving such good results upon graduation would not have been possible without the nurturance and guidance of my professors. NTU SCE* gave me the unique opportunity to interact and collaborate with a group of students from diverse backgrounds, countries and cultures. SCE* also encouraged us to go beyond our limits of knowledge and to be inquisitive and innovative. Through the challenging curriculum, I have learnt various skill sets that enable me to perform my utmost best in my current career. Web UI was not something I studied while I was in Computer Engineering, however, it was an area which I was interested in and pursued despite not having any knowledge in it. SCE* taught me to persevere and I have no doubt that my SCE* experience has given me a competitive advantage in my career.

Jonathan Samraj
Infocomm Development Authority of Singapore
Telecom Cyber Security Cluster
B. Eng Computer Engineering
(Class of 2014)
I joined DSO National Laboratories as a Junior Software Engineer immediately after graduation in 2007 and have never looked back since. It has been a fruitful eight years of journey at DSO, where I work with some of the best minds in Singapore's prestigious defence R&D organisation. I am now a Software Lead managing multiple safety-critical software systems and I work with complex software in embedded systems. My journey in this challenging field would not have been possible if not for the comprehensive education in the Computer Engineering programme in SCE*. I am also fortunate to have the opportunity to work with two very promising juniors from NTU SCE* in my team and I look forward to working with more SCE* juniors in the future!

Ang Weixiang, Henry
Lead Software Engineer,
DSO National Laboratories
B. Eng Computer Engineering
(Class of 2007)

The NTU SCE* curriculum has a practicum component for each module and this has helped me to translate conceptual theories into practice. I am deeply grateful for this way the programme was structured because it has taught me to apply the skills in the real world. The school has also provided me with many valued career opportunities which I appreciate a lot.

Loh Jia Wen, Doreen
Software Engineer,
Oracle Singapore
B. Eng Computer Science
(Class of 2014)

I can boldly say that I would not have received this prestigious accolade if it weren’t for the support of my lecturers, who have been most helpful and have gone the extra mile to help me. They guided my learning process and constantly ensured that I was discovering new sources to gather the information I needed. Choosing engineering was an obvious choice as I was always interested in knowing how things work, but realising the rising global impact of the infocomm industry, I chose to join SCE* to be part of this dynamic field.

Ng Li-Fang, Hilda
Senior Software Engineer,
IHIS Pte Ltd
Google Anita Borg Scholarship Recipient 2012
B. Eng Computer Engineering
(Class of 2013)
Our Alumni

SCE* challenged me in great ways to explore different options that in turn helped me find what I wanted to do in life. SCE* built the right foundation for the entrepreneur in me that taught me key lessons and skill-sets which helped me immensely in my journey after graduation. The School offered me a great platform to try and test all my hypothesis paving the way for my entrepreneurial journey.

Chinmay Malaviya
Co-Founder and VP of Business Development, Food Panda (Global)
B.Eng Computer Engineering (Class of 2012)

I would say that part of my achievements can be attributed to the engineering training that I have received from SCE*. Logical thinking and reasoning are important in my line of work. I’ve learnt to always questioned myself in whatever I do; to find out if this is the best way or is there a better way of achieving the desired results.

Marcus Cheng
Founder & Director of ACCLIVIS Technologies
B. Eng Computer Engineering (Class of 2005)
Read more about Marcus, http://www.hey.ntu.edu.sg/04_features_feat2a.html

The School has been very supportive of students’ research. We were always given a lot of leeway to experiment and discuss our ideas. That helped a lot when I went into Google as I was very comfortable sharing my ideas with my colleagues and we had no qualms about trying out new things, just like in school.

Tan Chade-Meng
Google’s Jolly Good Fellow
Bachelor of Applied Science in Computer Technology (Class of 1995)
Read more about Chade Meng, http://www.chademeng.com/meng_bio.html

* School of Computer Engineering (SCE) is the predecessor of School of Computer Science and Engineering (SCSE)
ADMISSION CRITERIA

GCE ‘A’ Level
Pass in H2 Level Mathematics, and
Pass in H2 Level Biology/Chemistry/Computing/Physics, and
Pass in H1 Level/’O’ Level Physics* or equivalent.

International Baccalaureate
Pass in HL Mathematics, and
Pass in HL Biology/Chemistry/Computer Science/Physics, and
Pass in SL Physics** or equivalent.

NUS High School Diploma
Major CAP of 2.0 in Mathematics, and
Major CAP of 2.0 in Biology/Chemistry/Physics, and
Overall CAP of 2.0 in Physics* or equivalent.

International & Other Qualifications
Pass in Senior High School Level Mathematics, and
Pass in Senior High School Level Biology/Chemistry/Physics, and
Pass in Junior High School Level Physics^^

Diploma Holders
Applicants should have a relevant diploma from one of the local polytechnics and those with a Certificate of Merit, Diploma with Merit or Diploma with Distinction may apply for any programme in NTU.

For the list of acceptable local diplomas and exempted courses, please visit, http://www.ntu.edu.sg/url/localdiploma.html

Notes
*Pass in H1 Level I ‘O’ Level Physics is only applicable to applicants who have not read H2 Level Physics.
**Pass in SL Physics is only applicable to applicants who have not read HL Physics.
*Overall CAP of 2.0 in Physics is only applicable to applicants who have not majored in Physics.
^^Pass in Junior High School Level Physics is only applicable to applicants who have not read Senior High School Level Physics.

For more information, go to Undergraduate Admissions at www.ntu.edu.sg/admissions