School of Computing

1 Faculty's Commitment

Brief Introduction

Established in 1998, NUS School of Computing (SoC) is Asia's leading computing school, with an excellent record of nurturing research-driven and enterprising graduates who thrive in various sectors of the economy. From biomedicine to finance and various high-tech industries, it counts among its alumni chief executives and technology architects of multinationals, government agencies, and flourishing start-ups.

SoC comprises two academic departments and is home to 2,000 students, with a quarter of them pursuing graduate studies. Through a well-rounded curriculum taught by a distinguished faculty, its students are empowered to be innovation drivers who are capable of making the world a better place.

The School inculcates in its students computational thinking and life-long learning skills, equipping them with the right balance of scholarly excellence, professionalism, and soft skills. SoC's graduates are highly sought after. Leading computing companies such as Facebook, Google, and Microsoft send recruiters to them to recruit for their engineering centers worldwide. SoC's graduates play a pivotal role in Singapore's effort to improve productivity and streamline government, and to become a leading center for various industries such as finance, logistics, media, and technology.

The School offers undergraduate degree programmes that are undergirded by strong grounding in the fundamentals of computer science, covering three main areas of specialisation: business, computer engineering, and information security. We also offer graduate degree programmes by coursework or research, with greater intensity in focus within these areas of specialisations.

The curricula are designed according to the recommendations of the Association for Computing Machinery (ACM), the Association for Information Systems (AIS), and the Computer Society of the Institute of Electrical and Electronic Engineers (IEEE), which are the foremost authorities in the field of computing. Consequently, the knowledge units that are to be imparted within the curricula are recognised internationally, the practices instilled are sensitive to industrial development, and the pedagogy espoused adheres to tertiary IT education standards worldwide.

The research initiatives at SoC are supported by a number of research laboratories and centres within the School. Fitted with equipment that is funded mainly by research grants, the laboratories and centres provide a common space for people with similar interests to exchange ideas and work together informally.

The School is governed by the Executive Committee, and operates in consultation with an Industry Advisory Board.

Educational Philosophy

The programmes offered by the Department of Computer Science are founded on a wide variety of disciplines, with the goal of producing computer scientists who can integrate computing-related theories and practices, recognise the importance of abstraction, and appreciate the value of good engineering design.

These programmes seek to prepare students for life-long learning that will enable them to move beyond today's technology to meet the challenges of the future. Furthermore, they include professional practices as an integral component of the undergraduate curriculum. These practices encompass a wide range of activities including management, ethics and values, written and oral communication, and team work.

The programmes offered by the Department of Information Systems and Analytics are multidisciplinary in nature. In addition to providing students with a strong foundation in computer science, these programmes also give students the benefits of learning from other disciplines, such as business studies and economics. The modules required by these programmes reflect their objectives, which are to train graduates who are able to develop and manage business information systems and who understand how Internet technology can be deployed in business and organisations. Consequently, students are given the wide option of taking less technical, more business-oriented modules offered by the Department as well as the School of Business.

Please refer to: http://www.comp.nus.edu.sg for up-to-date information on the School.

2 Key Contact Information

For more detailed information, please visit the School's website at: http://www.comp.nus.edu.sg

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3 Undergraduate Education

The School of Computing aims to provide a sound and forward-looking education to equip graduates for careers in IT and related fields. To this end, our courses integrate problem-solving skills with a foundation in IT and business. Graduates will be able to integrate new technology and develop themselves into future IT leaders, and to proceed to further studies.

The School offers direct entry to four-year undergraduate degree programmes, designed to meet the needs of distinct segments of the IT job market, and to better serve students with different interests, background, abilities and career orientation. Four-year programmes are designed to educate tomorrow's technical leaders who will pioneer the development of novel technology. The programmes emphasise in-depth mastery of the scientific, engineering and organisational foundations that underlay the continuing progress in information and communications technologies and their applications. **The maximum candidature period for a four-year programme is five years.**

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3.2 [Degree Requirements](#)

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3.1 Degrees Offered

The School of Computing offers five full-time Bachelor of Computing programmes, leading to:

- Bachelor of Computing in Computer Science;
- Bachelor of Computing in Information Security;
- Bachelor of Computing in Information Systems; and
- Bachelor of Science in Business Analytics

Its Department of Computer Science jointly offers the following full-time Bachelor of Engineering programme with the Department of Electrical and Computer Engineering, Faculty of Engineering:

- Bachelor of Engineering in Computer Engineering

The School also offers a wide array of minors and special programmes to full-time undergraduate students to provide more breadth and depth in their studies.

Please refer to our School's web page at: http://www.comp.nus.edu.sg/cug/ for the latest details on the degree programmes.

3.2 Degree Requirements

3.2.1 Programme Structure

The overall degree requirement is based on Modular Credits, with at least 160 Modular Credits (MCs) for the four-year programmes. <u>To graduate, a student must obtain a Cumulative Average Point (CAP) of not less than 2.00.</u>

Each programme consists of modules divided into three main categories:

1. **Programme Requirements**
2. **University Level Requirements (ULR)**
3. **Unrestricted Electives**

A module can only be counted towards one category. No double counting is allowed.

The **University Level Requirements (ULR)** aim to connect disciplinary knowledge and perspectives with the skills needed for lifelong learning beyond the university. The ULR is worth 20 modular credits.

The principles are to:

• Equip students with general knowledge that extends beyond disciplinary facts, theories and methods, to foster an understanding of how disciplines contribute to an understanding of human society and culture.
• Expose students to a diverse range of knowledge and ideas, disciplinary and cross disciplinary perspectives, approaches, and methods that characterize the range of human understanding and that sparks intellectual curiosity, and promotes tolerance of difference and respect for diversity.
• Emphasize the importance of developing clarity of thought and argumentation, critical thinking and reasoning skills, and an appreciation for debates and balanced viewpoints.
• Integrate learning by facilitating an understanding of complex issues and challenges, and their applications to human society and culture.

Students will be required to read one General Education Module (GEM) from each of the five pillars (total: 20 Modular Credits/MCs) to satisfy the University Level Requirement for General Education. The five pillars are: Asking Questions, Human Cultures, Quantitative Reasoning, Singapore Studies, and Thinking and Expression. Please refer to the GEM website at http://www.nus.edu.sg/registrar/gem for the details.

Unrestricted Electives enable students to pursue their academic interests and aspirations. Students may also use Unrestricted Electives to satisfy partially or wholly the requirements of other programmes. As long as the appropriate prerequisites are met, students can satisfy the Unrestricted Electives requirement by taking modules from any of the Departments/Faculties at any level.

<u>The limit on the number of Level-1000 modules to be counted towards fulfilment of graduation requirements is 60 MCs for 160-MC programmes .</u>

The maximum candidature for:

1. a Bachelor with Honours degree with a minimum of 160 MCs is five years; and
2. a typical double degree programme (which may involve between 180 and 200 MCs) is six years.

Programme Structure for Bachelor of Computing Programmes

Industrial Experience Requirement

Degrees offered by both the Department of Computer Science and Department of Information Systems and Analytics will require 12 MCs of industrial experience content. Students with Polytechnic Diplomas who have completed internship during polytechnic study are exempted 6 MCs of Industry Experience Requirement and only need to complete 3-month internships through CP3202 Internship II (6 MCs) if they **are enrolled for programmes in the Department of Computer Science**. The 6-MC internship exemption for polytechnic graduates is awarded in recognition of their internship experience done during the polytechnic study. These exemptions will be diploma specific as not all diplomas include internships and will be done as part of the Advance Placement Credits granted for the programme requirement.

CP4101 B.Comp. Dissertation

Students in the Department of Computer Science who aim for Honours (Highest Distinction) must pass the CP4101 B.Comp. Dissertation. Students with CAP of 4.00 or higher may opt to replace Industry Experience Requirement by CP4101 B.Comp. Dissertation. Students with CAP of 4.00 or higher after completing at least 70% (i.e. 112 MCs) of the MC requirement for the degree programme may opt to replace the Industry Experience Requirement by CP4101 B.Comp Dissertation (12 MCs). Note that the CP4101 project selection process takes place one semester ahead of the semester in which the students commence CP4101. Thus the students can tentatively select CP4101 projects; but the condition "CAP of 4.00 or higher after completing at least 70% (112 MCs) of the MC requirement for the degree programme" must be satisfied before they can commence CP4101 in lieu of Industry Experience Requirement.

Students doing double degrees, concurrent degrees and CS special programme (except Turing Programme) and other students with CAP of 4.00 or higher, may opt to replace Industrial Experience Requirement by B.Comp. Dissertation.

Students in the Turing Programme are required to complete a B.Comp. Dissertation with research content.

Programme selection or course transfer

Transfer of programmes between the two departments: Computer Science and Information Systems and Analytics follows the course transfer procedure administered by the NUS Office of Admissions at: http://www.nus.edu.sg/oam. Students may request to be transferred into the Bachelor of Engineering

(Computer Engineering) programme at the end of the second semester. Success of transfer will depend on the quota available in the targeted programme and the academic standing of the students.

Programme Structure for Bachelor of Engineering (Computer Engineering)

Please refer to Section S1 of Part II of this bulletin for details.

3.2.2 Advanced Placement Credits and Exemptions

Students who are holders of GCE 'A' Levels, International Baccalaureate or equivalent qualifications* may be granted advanced placement and exemption of up to 20 MCs for Programme requirements based on performance in placement tests set by the relevant host faculty. The placement test should be taken at the point of admission to the University. SoC students can apply to sit for a placement test for CS1010 Programming Methodology if they have prior programming experience.

Polytechnic Graduates admitted to School of Computing

Polytechnic graduates who are admitted to NUS Computing Courses may receive up to 40 MCs of module exemptions from the following lists:
1. Specific exemptions of up to 20 MCs from programme requirements* comprising of one or more modules as determined by the School on a case-by-case basis. Some of these exemptions may require advance placement test.
2. Up to 20 MCs from Unrestrictive Elective Modules (UEMs). The 20 MCs from UEM will NOT be counted as part of the 60-MC limit of level-1000 modules that students are allowed to read in fulfillment of the 160 MCs required for graduation.

*Note:

1. The advanced placement of 20 MCs is equivalent to one semester of advanced standing.
2. The validity period for qualifications presenting for the granting of advanced placement credits is 5 years at the point of admission.

3.2.3 Workload

All students are required to read at least 18 MCs every semester throughout their candidature, except during the following semesters when they are allowed to read fewer MCs:

- the final semester before completion of all graduation requirements for the degree; and
- the semester in which the students are undergoing industrial attachment or doing their final year projects.

Students who fail to sign up for tutorial/laboratory/recitations for their module(s) will be automatically withdrawn from class. The maximum workload permissible per semester will be subjected to approval by the University and home faculty. For the first semester of study, single degree students can sign up no more than 23 MCs. Students doing double degree or concurrent degree programmes can sign up for 6 modules (and not exceeding 27 MCs) in their first semester of study.

3.2.4 Continual Assessment

Continual assessment (CA) will be taken into account and it normally contributes to between 40% and 100% of the final grade of a module unless otherwise stated by the department. Homework, quizzes, tests, practicals, essays, projects, seminar presentations, performance during tutorials, field trips and other project work are bases for continual assessment.

3.2.5 Leave of Absence

Students who require leave of one semester or more should obtain approval in advance of the semester. They should first consult their academic advisors to understand the implications involved. Students must submit an online application via myISIS. Supporting documents must be attached with the application. For medical leave, students must submit the original copy of the medical certificates issued by registered general practitioners to the respective offices, by the next working day for the period of medical leave taken. For students in a Bachelor of Computing programme or Bachelor of Science in Business Analytics programme, all supporting documents must be submitted to the Office of Undergraduate Studies, School of Computing (COM1 #02-19). For students in Bachelor of Engineering (Computer Engineering) programme, all supporting documents must be submitted to Department of Electrical and Computer Engineering, Faculty of Engineering (E4-05-45). Students who apply for term leave of absence beyond Instructional Week 2 are liable to pay fees for the entire semester. <u>Not having attended any classes nor utilizing university's resources are not valid reasons to seek waiver from fee payment</u>. Students who are granted leave before the end of the 2nd Instructional Week will have their modules removed from the records. Those granted leave due to medical reason beyond the 2nd Instructional Week will have Incomplete (IC) grades assigned to their modules. For LOA due to non-medical reason, Withdrawn (W) grades will be assigned to their modules. Students should apply for Special Consideration from examination instead if their application for term LOA starts from Reading week.

3.2.6 Bachelor of Computing in Computational Biology

Overview

The main objective of this programme is to provide a multidisciplinary education, to produce graduates who would be equally at ease with algorithm design and mathematical and statistical analysis as they would be with biochemistry, biology/genetics, and wet-lab know-how. Besides an opportunity to pursue a career in IT, graduates from the programme will also be equipped for a career in the fast-paced pharmaceutical, biomedical or biotechnology industries. This will help meet the demand of the local market for talents with such skill sets. Moreover, the breadth of instructions will pave the way for good students to pursue graduate studies in Bioinformatics.

Programme Structure

The programme is structured such that both Computing and Faculty of Science students share a common core multidisciplinary curriculum (lower division) in their first two years of study.

The lower division embraces a fundamental body of knowledge in which a computational biologist should be proficient. This body of knowledge consists of the following:
- Discrete mathematics and combinatorics, i.e., logic, sets, graphs, counting techniques, etc.;
- Probability and statistics, i.e., sample spaces, random variables, conditioning, distributions, design of experiments, significance tests, statistical inference, etc.;
- Algorithm design and proficiency in some current programming language, i.e., combinatorial algorithms, algorithmic paradigms, analysis and design, working knowledge of current languages (for example, C, C++, Java) and experience in writing actual nontrivial code;
- Organic chemistry and biochemistry;
- Biology and genetics, including a moderate amount of wet-lab experience.

The upper division specialised track trains students in algorithmic design to facilitate the design of computationally efficient software and tools in both centralised and networking environments. Students in this track will pick up skills in software engineering, networking and advanced techniques in algorithmic design. Students may also take modules from the Computational Biology elective list.

Degree Requirements

The Computational Biology programme degree requires at least 160 MCs. Modules are classified as follows (note that every module can only be counted towards satisfying exactly one requirement):

Students will be required to satisfy 12 MCs of industrial experience (mandatory requirement) by doing:

1. A 6-month internship through CP3880 Advanced Technology Attachment Programme (12 MCs)
2. Two 3-month internships through CP3200 Internship (6 MCs) and CP3202 Internship II (6 MCs). With two internships, the student will be able to experience work in two distinct types of

organizations, such as a start-up and a MNC, or in two different industries.

3. IS4010 Industry Internship Programme (12 MCs) from the IS department.
4. A 3-month internship through CP3200 Internship (6 MCs) and an Industry Course (4 MCs)[1]. The remaining 2 MCs may be satisfied using Unrestricted Electives.
5. iLead or NOC [2].
6. Other forms of industry experience approved by the Department of Computer Science.

1. **PROGRAMME REQUIREMENTS (Total of 124 MCs)**

Common Essentials

CS1010   Programming Methodology[3]

CS1020   Data Structures and Algorithms I[4]

CS2010   Data Structures and Algorithms II[4]

CS2100   Computer Organisation

CS2102   Database Systems

CS2103T Software Engineering[5]

ES2660   Communicating in the Information Age

Major Requirements

Level-1000

CM1401 Chemistry for Life Sciences

CS1231   Discrete Structures

LSM1102   Molecular Genetics

LSM1106   Molecular Cell Biology

MA1101R   Linear Algebra I

MA1521   Calculus for Computing

Level-2000

CS2220   Introduction to Computational Biology

CS2101   Effective Communication for Computing Professionals

ES2660 Communicating in the Information Age

Either

LSM2211   Metabolism and Regulation

or

LSM2232   Genes and Genomes

or

LSM2233   Cell Biology

LSM2241   Introductory Bioinformatics

ST2334   Probability and Statistics[6]

<u>Level-3000</u>

CS3230   Design & Analysis of Algorithms

LSM3241   Bioinformatics and Biocomputing

Either

CS3225   Combinatorial Methods in Bioinformatics

or

MA3259   Mathematical Methods in Genomics

Minimum of 12 MCs from the following list[7]:

Either

CS3225   Combinatorial Methods in Bioinformatics

or

MA3259   Mathematical Methods in Genomics

CS3240   Interaction Design

CS3241   Computer Graphics

CS3243   Introduction to Artificial Intelligence

CS3244   Machine Learning

<u>Level-4000</u>

CS4220   Knowledge Discovery Methods in Bioinformatics

LSM4241   Functional Genomics

Industrial Experience Requirement (12 MCs) [8]

Complete 8 MCs by taking modules from CB Elective Course List

<u>Computational Biology (CB) Elective Course List</u>[9]

CS4221   Database Applications Design and Tuning

CS4231   Parallel and Distributed Algorithms

CS4234   Optimisation Algorithms

CS4235   Computational Geometry

CS4237   Systems Modelling and Simulation

CS4243   Computer Vision and Pattern Recognition

CS4244   Knowledge-Based Systems

CS4248   Natural Language Processing

CS5228   Knowledge Discovery and Data Mining

CS5234   Combinatorial & Graph Algorithms

CS5238   Advanced Combinatorial Methods in Bioinformatics

CS5340   Uncertainty Modelling in Artificial Intelligence

2. **UNIVERSITY LEVEL REQUIREMENTS**

As specified in Section 3.2.1.

3. **UNRESTRICTED ELECTIVES**

As specified in Section 3.2.1.

NUS Overseas Colleges (NOC) (Computational Biology)

Students who attend 1-year NUS Overseas Colleges (NOC) may:
1. Count TR3201 Entrepreneurship Practicum (8 MCs) towards computational biology electives.
2. Count TR3202 Start-up Internship Programme (12 MCs) towards Industrial Experience Requirement.
3. Count TR3203E Start-up Case Study and Analysis (8 MCs) towards level-3000 electives. Students should work on a computational biology-related project to take TR3203E. Otherwise, students should take TR3203 instead (which counts towards Unrestricted Electives).

Students who attend 6-month NUS Overseas Colleges (NOC) may:

1. Count TR3202 Start-up Internship Programme (12 MCs) towards Industrial Experience Requirement.
2. Count TR3203E Start-up Case Study and Analysis (8 MCs) towards one level-3000 elective (4 MCs). The remaining 4 MCs counts towards Unrestricted Electives. Students should work on a computational biology-related project to take TR3203E. Otherwise, students should take TR3203 instead (which counts 8 MCs towards Unrestricted Electives).

University Scholars Programme (Computational Biology)

Students in the University Scholars Programme (USP) who choose the Bachelor of Computing (Computational Biology) major will take the Computational Biology programme, but with the following variations:
1. They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).
2. They will not be required to read CS2101 Effective Communication for Computing Professionals. It

is replaced by USP Foundation module: Writing and Critical Thinking.

3. With the special permission from the UROP coordinator and Computational Biology Programme Coordinator, they will read CP3208/CP3209 Undergraduate Research in Computing I/II with a project on computational biology as independent study modules (ISMs), which will be counted as 2 USP Inquiry modules in Sciences and Technologies Basket.

4. They will further complete 3 more USP Inquiry modules (for a total of 8 USP Inquiry modules, including CP3208 and CP3209) and the USP Reflection module (the Senior Seminar). They will have no MCs under the Unrestricted Electives.

TABLE 1: SUMMARY OF DEGREE REQUIREMENTS FOR BACHELOR OF COMPUTING (COMPUTATIONAL BIOLOGY)

MODULES	MCS	SUBTOTALS
UNIVERSITY LEVEL REQUIREMENTS		**20**
PROGRAMME REQUIREMENTS		**124**
Common Essentials		
CS1010 Programming Methodology[10]	4	
CS1020 Data Structures and Algorithms I[11]	4	
CS2010 Data Structures and Algorithms II[11]	4	
CS2100 Computer Organisation	4	
CS2102 Database Systems	4	
CS2103T Software Engineering[12]	4	
ES2660 Communicating in the Information Age	4	
Major Requirements		
Level-1000 CS and LS major requirements		
CM1401 Chemistry for Life Sciences	4	
CS1231 Discrete Structures	4	
LSM1102 Molecular Genetics	4	
LSM1106 Molecular Cell Biology	4	
MA1101R Linear Algebra I	4	
MA1521 Calculus for Computing	4	

MODULES	MCS	SUBTOTALS
<u>Level-2000 CS and LS major requirements</u>		
CS2220 Introduction to Computational Biology	4	
CS2101 Effective Communication for Computing Professionals	4	
Either LSM2211 Metabolism and Regulation or LSM2232 Genes and Genomes or LSM2233 Cell Biology	4	
LSM2241 Introductory Bioinformatics	4	
ST2334 Probability and Statistics[13]	4	
<u>Level-3000 CS and LS major requirements</u>		
CS3230 Design & Analysis of Algorithms	4	
CS3225 Combinatorial Methods in Bioinformatics or MA3259 Mathematical Methods in Genomics	4	
LSM3241 Bioinformatics and Biocomputing	4	
<u>Level-3000 Electives</u>[14]; Choose any <u>three</u> from the following:		
CS3225 Combinatorial Methods in Bioinformatics or MA3259 Mathematical Methods in Genomics CS3240 Interaction Design CS3241 Computer Graphics CS3243 Introduction to Artificial Intelligence CS3244 Machine Learning	12	

MODULES	MCS	SUBTOTALS
<u>Level-4000 CS and LS major requirements</u>		
CS4220 Knowledge Discovery Methods in Bioinformatics	4	
LSM4241 Functional Genomics	4	
Industrial Experience Requirement[15]	12	
8 MCs of modules from Computational Biology Electives course list below: CS4221 Database Application Design and Tuning CS4231 Parallel and Distributed Algorithms CS4234 Optimisation Algorithms CS4235 Computational Geometry CS4237 Systems Modelling and Simulation CS4243 Computer Vision and Pattern Recognition CS4244 Knowledge-Based Systems CS4248 Natural Language Processing CS5228 Knowledge Discovery and Data Mining CS5234 Combinatorial & Graph Algorithms CS5238 Advanced Combinatorial Methods in Bioinformatics CS5340 Uncertainty Modelling in Artificial Intelligence	8	
UNRESTRICTED ELECTIVES		**16**
Grand Total		**160**

[1] Students should consult the CS Deputy Head (CS Programmes) in advance if they are interested in this option as industry courses may not be offered every year.

[2] For students who opt for iLead or NOC, the additional MCs beyond the 12-MCs allocated to Industry Experience Requirement should be taken from Unrestricted Electives and/or exempted modules.

[3] CS1010 (4 MCs) can be replaced by CS1101S Programming Methodology (5 MCs).

[4] CS1020 and CS2010 can be replaced by CS2020 Data Structures and Algorithms Accelerated. The remaining 2 MCs will be added to the Unrestricted Electives Requirements.

[5] Students taking CS2103T Software Engineering must take CS2101 Effective Communication for Computing Professionals in the same semester.

[6] Students should choose ST2131 (Probability) and ST2132 (Mathematical Statistics) in place of ST2334 (Probability and Statistics) if they plan to pursue higher level statistics modules.

[7] With the special permission from the UROP coordinator and Computational Biology Programme Coordinator, CP3208/CP3209 Undergraduate Research in Computing I/II can be used to replace two of the Level-3000 Computational Biology electives if the project is on Computational Biology.

[8] Students in the Department of Computer Science who aim for Honours (Highest Distinction) must pass the CP4101 BComp Dissertation. Students with CAP of 4.0 or higher at the end of their fifth semester of undergraduate study may opt to replace the Industry Experience Requirement by CP4101

BComp Dissertation (12 MCs).

[9] The Computational Biology (CB) Elective Course List may be revised from time to time to include new Computational Biology electives that are introduced and approved by the Department of Computer Science.

[10] CS1010 (4 MCs) can be replaced by CS1101S Programming Methodology (5 MCs).

[11] CS1020 and CS2010 can be replaced by CS2020 Data Structures and Algorithms Accelerated. The remaining 2 MCs will be added to the Unrestricted Electives Requirements.

[12] Students taking CS2103T Software Engineering must take CS2101 Effective Communication for Computing Professionals in the same semester.

[13] Students pursuing a double degree in Computer Science and Mathematics/Applied Mathematics will take ST2131 Probability and ST2132 Mathematical Statistics in place of ST2334 Probability and Statistics

[14] With the special permission from the UROP coordinator and Computational Biology Programme Coordinator, CP3208/CP3209 Undergraduate Research in Computing I/II can be used to replace two of the Level- 3000 Computational Biology electives if the project is on Computational Biology.

[15] Students in the Department of Computer Science who aim for high distinction must pass the CP4101 BComp Dissertation. Students with CAP of 4.0 or higher at the end of their fifth semester of undergraduate study may opt to replace the Industry Experience Requirement by B.Comp Dissertation (12 MCs).

Concurrent Programme with Brown University on Computational Biology

This is a fast-track programme that allows deserving students to obtain the Bachelor of Computing (Computational Biology) from NUS and a Scientiae Magister in Computational Biology in Computer Science from Brown University within five years.

Please refer to Section R7 of Part II of this bulletin for details.

3.2.6 Bachelor of Computing in Computer Science

Overview

The Bachelor of Computing (Honours) in Computer Science or BComp (CS) programme aims to nurture students for a rewarding computing career in various industry sectors. Suitable for those who love hands-on work and keen to apply computing technologies to solve real-world problems, the programme will equip students with the critical knowledge and capacity to take on the world with confidence.

At the time of graduation, students are expected to demonstrate:

• Strong knowledge of computer science foundations and fundamentals, including (a) familiarity with common computer science themes and principles, (b) high-level understanding of systems as a whole, (c) understanding of the theoretical underpinnings of computer science and their influences in practice.
• In-depth knowledge in one or more computer science specialisations.
• Individual competence in applying sound principles and rigorous thinking to (a) analyse an application problem, (b) understand user's requirement, (c) formulate the problem in terms of computation requirements, (c) conceive novel solution ideas, (e) design appropriate solutions that meet the requirements, (f) implement the solution, (g) evaluate the effectiveness of the solution.
• Strong communication skills and ability to work with, and contribute to, a team to bring a range of technologies together to develop computer systems and solutions.
• Ability to engage in continuous professional development.
• Understanding of the responsibilities of an IT professional and the ethical, social, and legal issues related to computing.

Within 3-5 years from graduation, a graduate from the programme is expected to be able to:

• Have a career as IT professional engaging in research and/or development in one or more specialisation of computer science;
• Engage in a supportive or leadership role in a multi-disciplinary, collaborative, team environment;
• Engage in continuous learning of state-of-the-art advances in computer science (including graduate studies);
• Function as an ethical, legal and socially responsible member of the society;
• Apply computing knowledge and skills to contribute positively to the betterment of society.

For a well-rounded education, students pursuing this programme will also acquire knowledge in science, including life sciences, mathematics and physics.

Graduates with the Bachelor of Computing (Honours) in Computer Science degree can position themselves in a large number of exciting fields of work, including project management, knowledge engineering, software architecture, web design, digital media and security consultancy.

Degree Requirements

The Bachelor of Computing (Computer Science) programme requires at least 160 MCs.

Students will be required to satisfy 12 MCs of Industrial Experience Requirement by doing:

1. A 6-month internship through CP3880 Advanced Technology Attachment Programme (12 MCs)
2. Two 3-month internships through CP3200 Internship (6 MCs) and CP3202 Internship II (6 MCs). With two internships, the student will be able to experience work in two distinct types of organizations, such as a start-up and a MNC, or in two different industries.
3. IS4010 Industry Internship Programme (12 MCs) from the IS department.
4. A 3-month internship through CP3200 Internship (6 MCs) and an Industry Course (4 MCs).[1] The remaining 2 MCs may be satisfied using Unrestricted Electives.
5. iLead or NOC .[2]
6. Other forms of industry experience approved by the Department of Computer Science.

PROGRAMME REQUIREMENTS (Total of 120 MCs)

Computer Science Foundation

CS1010   Programming Methodology[3]

CS1231   Discrete Structures

CS2030   Programming Methodology II

CS2040   Data Structures and Algorithms

CS2100   Computer Organisation

CS2103T Software Engineering[4]

CS2105   Introduction to Computer Networks

CS2106   Introduction to Operating Systems

CS3230   Design and Analysis of Algorithms

Computer Science Breadth & Depth

Complete 24 MCs of CS modules by satisfying the following conditions:
1. Satisfy at least one CS Focus Area for BComp (CS) by completing 3 modules in the Area Primaries, with at least one module at level-4000 or above. Computer Science Foundation modules that appear in Area Primaries can be counted as one of the 3 modules towards satisfying a Focus Area.
2. At least 12 MCs are at level-4000 or above.

Complete at least 8 MCs of Computer Systems Team Project modules from the following pairs, or modules approved by the Department of Computer Science:

- CS3201 Software Engineering Project I and CS3202 Software Engineering Project II, or
- CS3216 Software Product Engineering for Digital Markets and CS3217 Software Engineering on Modern Application Platforms, or
- CS3281 Thematic Systems Project I and CS3282 Thematic Systems Project II.

Both CS3216 and CS3217 are 5-MC modules. Students who choose to take CS3216 and CS3217 will count 8-MC towards the Computer Systems Team Project requirement and 2- MC towards Unrestricted Electives. Students must take both CS3216 and CS3217 to complete the Software Engineering Team Project requirement. If a student completed only one of CS3216 and CS3217, he or she has to take another pair of modules to meet the Computer Systems Team Project requirement.

Industry Experience Requirement[5] of at least 12 MCs

<u>IT Professionalism</u>

IS1103/X IS Innovations in Organisations and Society

CS2101 Effective Communication for Computing Professionals

ES2660 Communicating in the Information Age

<u>Mathematics & Sciences</u>

MA1521   Calculus for Computing[6]

MA1101R   Linear Algebra I

ST2334   Probability and Statistics[7]

One Science Module [8]

2. **UNIVERSITY LEVEL REQUIREMENTS (20 MCs)**

As specified in Section 3.2.1.

3. **UNRESTRICTED ELECTIVES (32 MCs)**

As specified in Section 3.2.1. In addition, students without A-level or H2 Mathematics are required to complete the bridging module MA1301/X as part of the Unrestricted Electives.

Computer Science Focus Areas for BComp (CS)

CS modules are organised into Focus Areas of coherent modules according to technical areas of study. A CS Focus Area is satisfied by completing 3 modules from the Area Primaries, with at least one module at 4000-level or above. CS Foundation Modules (CFM) that appear in the Area Primaries can be counted as one of the 3 modules towards satisfying a Focus Area. In this case, a student has to read just two other modules in the Area Primaries to satisfy the Focus Area. Elective modules are grouped into the Focus Areas as a guide for indicating their related areas of study.

- Algorithms & Theory
- Artificial Intelligence
- Computer Security
- Computer Graphics and Games
- Database Systems
- Multimedia Information Retrieval
- Network and Distributed Systems
- Parallel Computing

- Programming Languages
- Software Engineering

Modules classified in each focus area can be found

at: http://www.comp.nus.edu.sg/programmes/ug/focus/

NUS Overseas Colleges (NOC) (Computer Science)

Students who attended NOC programme may:

1. count TR3201 Entrepreneurship Practicum (8 MCs) towards CS3882 Breakthrough Ideas for Digital Markets (4 MCs) and one bridging module at 4 MCs. The mapping to bridging module (MA1301/PC1221/PC1222) applies to CS students with A-level or equivalent qualifications in either Mathematics or Physics. These students replace the missing MCs for the bridging modules with unrestricted electives. Dummy CS codes CSX3741 and CSX3742 will be issued in place of MA1301 and PC1221/PC1222 respectively.
2. count TR3202 Start-up Internship Programme (12 MCs) towards Industrial Experience Requirement.
3. count TR3203 Start-up Case Study and Analysis towards Unrestricted Electives. Students working on computer systems term projects for TR3203 may seek approval to instead take TR3203P, which counts towards CS3201/2 Software Engineering Project I/II or equivalent pairs. Alternatively, TR3203 can be mapped to TR3203E in which 8 MCs of CS-coded electives at level-3000 can be considered for the fulfilment of CS Breadth and Depth Requirements.

University Scholars Programme (Computer Science)

Students in the University Scholars Programme who choose the Bachelor of Computing (Computer Science) major will follow the Computer Science programme, but with the following variations:

1. They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).
2. They will not be required to read CS2101 Effective Communication for Computing Professionals. It is replaced by USP Foundation module: Writing and Critical Thinking
3. They will not be required to read one Science Module (4 MCs). It is replaced by 1 USP Inquiry modules in Sciences and Technologies basket.
4. They will read CS3201 and CS3202 or other modules approved by the Department of Computer Science as independent study modules (ISMs) which will also be counted as 2 USP Inquiry modules in Sciences and Technologies basket.

Table 1: Summary of degree requirements for Bachelor of Computing (Computer Science)

MODULES	MCS	SUBTOTALS
UNIVERSITY LEVEL REQUIREMENTS		20
PROGRAMME REQUIREMENTS		108

MODULES	MCS	SUBTOTALS
Computer Science Foundation	**36**	
CS1010 Programming Methodology [3]	4	
CS1231 Discrete Structures	4	
CS2030 Programming Methodology II	4	
CS2040 Data Structures and Algorithms	4	
CS2100 Computer Organisation	4	
CS2103T Software Engineering [4]	4	
CS2105 Introduction to Computer Networks	4	
CS2106 Introduction to Operating Systems	4	
CS3230 Design and Analysis of Algorithms	4	
Computer Science Breadth and Depth	**44**	
Complete 24 MCs of CS modules by satisfying the following conditions: 1. Satisfy at least one CS Focus Area for BComp (CS) by completing 3 modules in the Area Primaries, with at least one module at level-4000 or above. Computer Science Foundation modules that appear in Area Primaries can be counted as one of the 3 modules towards satisfying a Focus Area. 2. At least 12 MCs are at level-4000 or above.	24	
Complete at least 8 MCs of Computer Systems Team Project modules from the following pairs, or modules approved by the Department of Computer Science: CS3201 Software Engineering Project I and CS3202 Software Engineering Project II, or CS3216 Software Product Engineering for Digital Markets and CS3217 Software Engineering on Modern Application Platforms, or CS3281 Thematic Systems Project I and CS3282 Thematic Systems Project II, or CS3283 Media Technology Project I and CS3284 Media Technology Project II	8	
Industrial Experience Requirement[5]	12	
IT Professionalism	**12**	
IS1103/X IS Innovations in Organisations and Society	4	
CS2101 Effective Communication for Computing Professionals	4	
ES2660 Communicating in the Information Age	4	
Mathematics and Sciences	**16**	
MA1521 Calculus for Computing[6]	4	
MA1101R Linear Algebra I	4	
ST2334 Probability and Statistics[7]	4	
One Science Module [8]	4	

MODULES	MCS	SUBTOTALS
UNRESTRICTED ELECTIVES [9]		**32**
Grand Total		**160**

[1]   Students should consult the CS Deputy Head (CS Programmes) in advance if they are interested in this option as industry courses may not be offered every year.

[2]   For students who opt for iLead or NOC, the additional MCs beyond the 12-MCs allocated to Industry Experience Requirement should be taken from Unrestricted Electives and/or exempted modules.

[3]   CS1010 (4 MCs) can be replaced by CS1101S Programming Methodology (5 MCs).

[4]   Students taking CS2103T Software Engineering must take CS2101 Effective Communication for Computing Professionals in the same semester.

[5]   Students in the Department of Computer Science who aim for Honours (Highest Distinction) must pass the CP4101 BComp Dissertation. Students with CAP of 4.00 or higher after completing at least 70% (i.e. 112 MCs) of the MC requirement for the degree programme may opt to replace the Industry Experience Requirement by CP4101 B.Comp Dissertation (12 MCs). Note that the CP4101 project selection process takes place one semester ahead of the semester in which the students commence CP4101. Thus the students can tentatively select CP4101 projects; but the condition "CAP of 4.00 or higher after completing at least 70% (112 MCs) of the MC requirement for the degree programme" must be satisfied before they can commence CP4101 in lieu of Industry Experience Requirement.

[6]   Students pursuing a double degree in Computer Science and Mathematics/Applied Mathematics are recommended to replace MA1521 Calculus for Computing by MA1102R Calculus.

[7]   Students pursuing a double degree in Computer Science and Mathematics/Applied Mathematics or Second Major in Mathematics will take ST2131 Probability and ST2132 Mathematical Statistics in place of ST2334 Probability and Statistics. Students pursuing a Second Major in Statistics will take ST2131 in place of ST2334.

[8]   Students pursuing Second Major in Mathematics can count ST2132 towards Science Module requirements. Students cannot use ST2132 to meet the requirements of Second Major in Mathematics and have to choose another elective from List II of the Mathematics major. If a student has already taken ST2131 and later quits from the Second Major in Statistics programme, he/she will have to take ST2132 to fulfil the BComp (CS) degree requirements. For all other students: a student who have not taken 'O'-level Physics, may take a Life-Science module to meet this requirement; A student who have 'O'-level

Physics but have not taken 'A'-level / H2 Physics must take either PC1221/X or PC1222/X to meet the Science module requirement; A student who have taken 'A'-level / H2 Physics may take either a Physics, Chemistry, Life-Science, Statistics, or Mathematics module as a Science module. The Science module must be a module from List S1 (recommended) or List S2. Please refer to: http://www.comp.nus.edu.sg/undergraduates/documents/Sciencemodules_S1_S2.pdf for details.

[9] Students without A-level or H2 Mathematics are required to complete the bridging module MA1301/X as part of the Unrestricted Electives.

3.2.8 Bachelor of Computing in Computer Science - Turing Programme

Overview

The Turing Programme for Bachelor of Computing (Computer Science) programme [TP] is yet another special programme in Computer Science. TP aims to nurture students who aspire to engage in pure research careers in Computing. It is most suitable for students who love to solve technically challenging problems and are able to handle theoretical and practical work. Students will be selected for admission to TP based on their performance in selected modules, including CS2309 and CS3230. Students in TP are expected to build sufficient track records by the time they graduate to gain admission into PhD programmes in top schools including SoC. Students in this programme will be assigned CS professors as their mentors to help them to build their research track records.

Degree Requirements

Students in the programme must maintain a minimum CAP of 4.00 in every semester of their studies and must complete the requirements of Bachelor of Computing (Computer Science), with the following variations:

- They may read CS1101S Programming Methodology in place of CS1010.
- They will read CS2309 CS Research Methodology (4 MCs). They will have 32 MCs remaining in the Unrestricted Electives.
- They will take CP3208 and CP3209 Undergraduate Research in Computing I and II (8 MCs) to meet the Software Engineering Team Project requirement.

NUS Overseas Colleges (NOC) - Computer Science - Turing Programme
Students who attended NOC programme may:
1. count TR3201 Entrepreneurship Practicum (8 MCs) towards CS3882 Breakthrough Ideas for Digital Markets (4 MCs) and one bridging module at 4 MCs. The mapping to bridging module (MA1301/PC1221/PC1222) applies to CS students with A-level or equivalent qualifications in either Mathematics or Physics. These students replace the missing MCs for the bridging modules with unrestricted electives. Dummy CS codes CSX3741 and CSX3742 will be issued in place of MA1301 and PC1221/PC1222 respectively.
2. count TR3202 Start-up Internship Programme (12 MCs) towards Industrial Experience Requirement.
3. count TR3203 Start-up Case Study and Analysis towards Unrestricted Electives. Students working on computer systems term projects for TR3203 may seek approval to instead take TR3203P, which counts towards CS3281/2 Thematic Systems Project I/II. Alternatively, TR3203 can be mapped to TR3203E in which 8 MCs of CS electives at level-3000 can be considered for the fulfilment of CS Breadth and Depth Requirements.

University Scholars Programme (Computer Science)

Students in the University Scholars Programme who choose the Bachelor of Computing (Computer Science) major will follow the Computer Science programme, but with the following variations:
1. They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University

Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).

2. They will not be required to read CS2101 Effective Communication for Computing Professionals. It is replaced by USP Foundation module: Writing and Critical Thinking.
3. They will not be required to read one Science Module (4 MCs). These are replaced by one USP Inquiry modules in Sciences and Technologies basket.
4. CP3208 and CP3209 are independent study modules (ISMs) which will also be counted as 2 USP Inquiry modules in Sciences and Technologies basket.

Table 3: Summary of degree requirements for Bachelor of Computing (Computer Science) – Turing Programme

MODULES	MCS	SUBTOTALS
UNIVERSITY LEVEL REQUIREMENTS		**20**
PROGRAMME REQUIREMENTS		**112**

MODULES	MCS	SUBTOTALS
Computer Science Foundation	**36**	
CS1010 Programming Methodology [1]	4	
CS1231 Discrete Structures	4	
CS2030 Programming Methodology II	4	
CS2040 Data Structures and Algorithms	4	
CS2100 Computer Organisation	4	
CS2103T Software Engineering [2]	4	
CS2105 Introduction to Computer Networks	4	
CS2106 Introduction to Operating Systems	4	
CS3230 Design and Analysis of Algorithms	4	
Computer Science Breadth & Depth	**48**	
CS2309 CS Research Methodology	4	
Satisfy 1 CS Focus Area, with 3 CS modules at Level – 4000 or above	24	
CP3208 Undergraduate Research in Computing I	4	
CP3209 Undergraduate Research in Computing II	4	
CP4101 B.Comp. Dissertation (with research content)	12	
IT Professionalism	**12**	
IS1103/X IS Innovations in Organisations and Society	4	
CS2101 Effective Communication for Computing Professionals	4	
ES2660 Communicating in the Information Age	4	
Mathematics and Sciences	**16**	
MA1521 Calculus for Computing [3]	4	
MA1101R Linear Algebra I	4	
ST2334 Probability and Statistics [4]	4	
One Science module [5]	4	

MODULES	MCS	SUBTOTALS
UNRESTRICTED ELECTIVES [6]		**28**
Grand Total		**160**

[1] CS1010 can be replaced by CS1101S Programming Methodology.

[2] Students taking CS2103T Software Engineering must take CS2101 Effective Communication for Computing Professionals in the same semester.

[3] Students pursuing a double degree in Computer Science and Mathematics/Applied Mathematics are recommended to replace MA1521 Calculus for Computing by MA1102R Calculus.

[4] Students pursuing a double degree in Computer Science and Mathematics/Applied Mathematics or Second Major in Mathematics will take ST2131 Probability and ST2132 Mathematical Statistics in place of ST2334 Probability and Statistics. Students pursuing a Second Major in Statistics will take ST2131 in place of ST2334.

[5] Students pursuing Second Major in Mathematics can count ST2132 towards Science Module requirements. Students cannot use ST2132 to meet the requirements of Second Major in Mathematics and have to choose another elective from List II of the Mathematics major. If a student has already taken ST2131 and later quits from the Second Major in Statistics programme, he/she will have to take ST2132 to fulfil the BComp (CS) degree requirements. For all other students: a student who have not taken 'O'-level Physics, may take a Life-Science module to meet this requirement; A student who have 'O'-level Physics but have not taken 'A'-level / H2 Physics must take either PC1221/X or PC1222/X to meet the Science module requirement; A student who have taken 'A'-level / H2 Physics may take either a Physics, Chemistry, Life-Science, Statistics, or Mathematics module as a Science module. The Science module must be a module from List S1 (recommended) or List S2. Please refer to: http://www.comp.nus.edu.sg/undergraduates/documents/Sciencemodules_S1_S2.pdf for details.

[6] Students without A-level or H2 Mathematics are required to complete the bridging module MA1301/X as part of the Unrestricted Electives.

3.2.7 Bachelor of Computing in Computer Science – von Neumann Programme

Overview

The von Neumann Programme for Bachelor of Computing (Computer Science) programme, [vNP] is one of the two special programmes in Computer Science. vNP aims to nurture students who aspire to engage in industry careers emphasising the design of complex computing systems. It is most suitable for students who love to solve complex real-world problems and develop complex computer-based systems for real-world applications. Students pursuing Bachelor of Computing (Computer Science) degree will be invited for admission into vNP based on the performances in selected modules (including CS3281/CS3282 and CS3216/CS3217). Students in this programme will be assigned CS professors and industry partners as their mentors, who will help them to blend academic knowledge and industrial experience into their studies.

Degree Requirements

Students in the programme must maintain a minimum CAP of 4.00 in every semester of their studies and must complete the requirements of Bachelor of Computing in Computer Science, with the following variations:

- They will read CS3219 Software Engineering Principles and Patterns (4 MCs) as an additional Breadth and Depth requirement. They will have 16 MCs remaining in the Unrestricted Electives.
- They will take either:
- CS3281 and CS3282 Thematic Systems Project I and II (8 MCs) with large-scale complex systems development, or
- CS3216 Software Product Engineering for Digital Markets and CS3217 Software Engineering on Modern Application Platforms
- to meet the Software Engineering Team Project requirement
- They must satisfy at least one focus area requirements from the following focus areas: Networks and Distributed Systems, Database Systems, Parallel Computing, Programming Languages, Software Engineering, and Computer Security.Both CS3216 and CS3217 are 5-MC modules. Students who choose to take CS3216 and CS3217 will count 8-MC towards the Computer Systems Team Project requirement and 2- MC towards Unrestricted Electives. Students must take both CS3216 and CS3217 to complete the Software Engineering Team Project requirement. If a student completed only one of CS3216 and CS3217, he or she has to take another pair of modules to meet the Computer Systems Team Project requirement.

NUS Overseas Colleges (NOC) – Computer Science – von Neumann Programme

Students who attended NOC programme may:
1. count TR3201 Entrepreneurship Practicum (8 MCs) towards CS3882 Breakthrough Ideas for Digital Markets (4 MCs) and one bridging module at 4 MCs. The mapping to bridging module (MA1301/PC1221/PC1222) applies to CS students with A-level or equivalent qualifications in either Mathematics or Physics. These students replace the missing MCs for the bridging modules with unrestricted electives. Dummy CS codes CSX3741 and CSX3742 will be issued in place of MA1301 and PC1221/PC1222 respectively.

2. count TR3202 Start-up Internship Programme (12 MCs) towards Industrial Experience Requirement.
3. count TR3203 Start-up Case Study and Analysis towards Unrestricted Electives. Students working on computer systems term projects for TR3203 may seek approval to instead take TR3203P, which counts towards CS3281/2 Thematic Systems Project I/II or equivalent pairs. Alternatively, TR3203 can be mapped to TR3203E in which 8 MCs of CS electives at level-3000 can be considered for the fulfilment of CS Breadth and Depth Requirements.

University Scholars Programme (Computer Science)

Students in the University Scholars Programme who choose the Bachelor of Computing (Computer Science) major will follow the Computer Science programme, but with the following variations:

1. They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).
2. They will not be required to read CS2101 Effective Communication for Computing Professionals. It is replaced by USP Foundation module: Writing and Critical Thinking
3. They will not be required to read one Science Module (4 MCs). These are replaced by one USP Inquiry modules in Sciences and Technologies basket.
4. They will read CS3281 and CS3282 as independent study modules (ISMs) which will be counted as two USP Inquiry modules in Sciences and Technologies basket.

Table 2: Summary of degree requirements for Bachelor of Computing (Computer Science) – von Neumann Programme (vNP)

MODULES	MCS	SUBTOTALS
UNIVERSITY LEVEL REQUIREMENTS		**20**
PROGRAMME REQUIREMENTS		**112**

MODULES	MCS	SUBTOTALS
Computer Science Foundation	36	
CS1010 Programming Methodology[1]	4	
CS1231 Discrete Structures	4	
CS2030 Programming Methodology II	4	
CS2040 Data Structures and Algorithms	4	
CS2100 Computer Organisation	4	
CS2103T Software Engineering [2]	4	
CS2105 Introduction to Computer Networks	4	
CS2106 Introduction to Operating Systems	4	
CS3230 Design and Analysis of Algorithms	4	
Computer Science Breadth & Depth	48	
CS3219 Software Engineering Principles and Patterns	4	
Complete at least 8 MCs of Computer Systems Team Project modules from one of the following pairs: – CS3216 Software Product Engineering for Digital Markets and CS3217 Software Engineering on Modern Application Platform, or – CS3281 Thematic Systems Project I and CS3282 Thematic Systems Project II (with large-scale complex system development)	8	
Satisfy 1 vNP Focus Area with 3 CS modules at level-4000 or aboveAfter satisfying a vNP Focus Area. After satisfying a vNP focus area, a student may choose to satisfy other CS Focus Areas. vNP Focus areas are: – Computer Security – Database Systems – Networking and Distributed Systems – Parallel Computing – Programming Languages – Software Engineering	24	.
Industrial Experience Requirement [3]	12	
IT Professionalism	12	
IS1103/X IS Innovations in Organisations and Society	4	
CS2101 Effective Communication for Computing Professionals	4	
ES2660 Communicating in the Information Age	4	
Mathematics and Sciences	*16*	
MA1521 Calculus for Computing [4]	4	
MA1101R Linear Algebra I	4	
One Science Module [5]	4	
ST2334 Probability and Statistics [6]	4	

MODULES	MCS	SUBTOTALS
UNRESTRICTED ELECTIVES [7]		**28**
Grand Total		**160**

1   CS1010 (4 MCs) can be replaced by CS1101S Programming Methodology (5 MCs).

2   Students taking CS2103T Software Engineering must take CS2101 Effective Communication for Computing Professionals in the same semester.

3   Students in the Department of Computer Science who aim for Honours (Highest Distinction) must pass the CP4101 BComp Dissertation. Students with CAP of 4.00 or higher after completing at least 70% (i.e. 112 MCs) of the MC requirement for the degree programme may opt to replace the Industry Experience Requirement by CP4101 B.Comp Dissertation (12 MCs). Note that the CP4101 project selection process takes place one semester ahead of the semester in which the students commence CP4101. Thus the students can tentatively select CP4101 projects; but the condition "CAP of 4.00 or higher after completing at least 70% (112 MCs) of the MC requirement for the degree programme" must be satisfied before they can commence CP4101 in lieu of Industry Experience Requirement.

4   Students pursuing a double degree in Computer Science and Mathematics/Applied Mathematics or Second Major in Mathematics will take ST2131 Probability and ST2132 Mathematical Statistics in place of ST2334 Probability and Statistics. Students pursuing a Second Major in Statistics will take ST2131 in place of ST2334.

5   Students pursuing Second Major in Mathematics can count ST2132 towards Science Module requirements. Students cannot use ST2132 to meet the requirements of Second Major in Mathematics and have to choose another elective from List II of the Mathematics major. If a student has already taken ST2131 and later quits from the Second Major in Statistics programme, he/she will have to take ST2132 to fulfil the BComp (CS) degree requirements. For all other students: a student who have not taken 'O'-level Physics, may take a Life-Science module to meet this requirement; A student who have 'O'-level Physics but have not taken 'A'-level / H2 Physics must take either PC1221/X or PC1222/X to meet the Science module requirement; A student who have taken 'A'-level / H2 Physics may take either a Physics, Chemistry, Life-Science, Statistics, or Mathematics module as a Science module. The Science module must be a module from List S1 (recommended) or List S2. Please refer to: http://www.comp.nus.edu.sg/undergraduates/documents/Sciencemodules_S1_S2.pdf for details.

6   Students pursuing a double degree in Computer Science and Mathematics/Applied Mathematics or Second Major in Mathematics/Statistics will take ST2131 Probability and ST2132 Mathematical Statistics in place of ST2334 Probability and Statistics.

7   Students without A-level or H2 Mathematics are required to complete the bridging module MA1301/X Introductory Mathematics as part of the Unrestricted Electives.

3.2.10 Bachelor of Computing in Information Security – Co-operative Education Programme

Objective

The Bachelor of Computing in Information Security aims to:

• To provide a broad-based, inter-disciplinary information security undergraduate programme within NUS
• To contribute to the national focus on growing the pool of cyber security professionals in Singapore.
• To produce graduates who are able to understand information security issues and practices from both technical and organisational points of view.

Under the NUS Co-operative Education Programme scheme, students will interleave work and study. A total of 64 weeks will be spent on internship. The three stages of internship are as follows:

- First Internship: <u>special term of Year 1</u> (approx. 12 weeks)
- Second Internship: <u>semester 2 and special term of Year 2</u> (approx. 24 weeks)
- Third Internship: either <u>semester 2 and special term of Year 3</u> OR <u>special term of Year 3 and semester 1 of Year 4</u> (approx. 28 weeks)

Students who withdraw from the Co-operative Education Programme would fall back to the regular information security major and would need to complete all the requirements of the information security major, where extra credits beyond the corresponding internship requirements can be used to fulfill UE requirements.

Graduates of this programme are expected to have possible career choices as software engineers, systems administrators, malware researchers, security analyst, cybersecurity incident responder, and security consultant. They are expected to find employment in industries that deal with sensitive information (e.g., banks, insurance, defence), government organisations (e.g., CSIT, DSO, DSTA, MHA, Cyber Security Agency) and firms that provide security consultation/systems/services (e.g., Symantec, FireEye).

This programme enables students to attain, by the time of graduation:

1. Strong knowledge of computer science foundations and fundamentals, including (a) familiarity with common computer science themes and principles, (b) high-level understanding of systems as a whole, (c) understanding of the theoretical underpinnings of computer science and their influences in practice.
2. An ability to design, implement, and evaluate a computer-based system, process, components, or program to meet the security needs.
3. An understanding of the processes and challenges that support the delivery and management of information security in an organisation.
4. An ability to function effectively in teams to accomplish a common goal.

5. An understanding of professional, ethical, legal, security, and social issues and responsibilities.
6. An ability to communicate effectively with a range of audiences
7. An ability to analyse the local and global impact of computing on individuals, organisations, and society.
8. Recognition of the need for and an ability to engage in continuing professional development
9. An ability to use the current techniques, skills, and tools necessary for information security practice.

Degree Requirements

The Bachelor of Computing (Information Security) requires at least 160 MCs.

Students must pass CP4101 BComp Dissertation in order to graduate with Honours (Highest Distinction). The modular credits will count towards Unrestricted Electives.The students in the NUS Co-operative Education Programme for Information Security can complete the BComp Dissertation in the following ways:

• Option 1: The student can complete CP4101 over Year 3 Semester 2 and Year 4 Semester 2 subject to the approval of the supervisor.
• Option 2: The student can work on CP4101 that is only supervised by academic staff from NUS over Year 4 (Semester 1 and Semester 2). In this case, 6-MC workload for CP4101 during industrial attachment in Year 4 Semester 1 will be treated similar to taking evening modules during internship. Internship III will still be mapped to IFS4201 Information Security Industry Capstone Project (8 MCs) and IFS4202 Information Security Practicum Programme (6 MCs).
• Option 3: The student can complete CP4101 jointly supervised by the industry supervisor and an academic staff from the School of Computing in Year 4. The CP4101 will be initiated when the student is in industry in Year 4 Semester 1 and will be completed in the semester he/she returns to NUS, i.e., Year 4 Semester 2. In this case, Internship III will be mapped to IFS4201 Information Security Industry Capstone Project (8 MCs) and CP4101 BComp Dissertation (First semester). Both IFS4201 and CP4101 are letter-graded.

1. PROGRAMME REQUIREMENTS (Total of 108 MCs)

Computing Foundation (36 MCs)

CS1010   Programming Methodology[3]

CS1231   Discrete Structures

CS2040C Data Structures and Algorithms

CS2100   Computer Organisation

CS2102   Database Systems

CS2105   Introduction to Computer Networks

CS2106   Introduction to Operating Systems

CS2113T Software Engineering & Object-Oriented Programming[4]

IS3103   Information Systems Leadership and Communication

Information Security Requirements (32 MCs)

CS2107   Introduction to Information Security

CS3235   Introduction to Computer Security

IFS4201   Information Security Industry Capstone Project (Part of Internship III)

IS4231   Information Security Management

Complete 12 MCs from the following list of modules:

CS3236   Introduction to Information Theory

either

CS4236   Cryptography Theory and Practice

or

MA4261   Coding and Cryptography

CS4238   Computer Security Practices

CS4239   Software Security

CS5231   Systems Security

CS5321   Network Security

CS5322   Database Security

CS5331   Web Security

CS5332   Biometric Authentication

IFS4101   Legal Aspects of Information Security

IFS4102   Digital Forensics

IS4204   IT Governance

IS4233   Legal Aspects of Information Technology

IS4234   Control and Audit of IS

IS4302   Blockchain and Distributed Ledger Technologies

Other modules approved by the SoC UG Office

Computing Breadth (20 MCs)

Complete 8 MCs of CP-coded, CS-coded or IS-coded modules at level-3000 or above. Industrial Experience Requirement

CP3880   Advanced Technology Attachment Programme (Internship II)

IT Professionalism (8 MCs)

IS1103/X   IS Innovations in Organisations and Society

CS2101   Effective Communication for Computing Professionals

Mathematics and Sciences (12 MCs)

MA1101R   Linear Algebra I

MA1521   Calculus for Computing

ST2334   Probability and Statistics[4]

Co-operative Scheme Additional Requirements (12 MCs)

IFS2200   Information Security Immersion Programme (Internship I)

IFS4202   Information Security Practicum Programme (Part of Internship III)

2. UNIVERSITY LEVEL REQUIREMENTS (20 MCs)

As specified in Section 3.2.1.

3. UNRESTRICTED ELECTIVES (20 MCs)

As specified in Section 3.2.1.

University Scholars Programme (Information Security)

Students in the University Scholars Programme who choose the Bachelor of Computing (Information Security) major will take the Information Security programme, but with the following variations:

1. They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).
2. They will not be required to read CS2101 Effective Communication for Computing Professionals. It is replaced by USP Foundation module: Writing and Critical Thinking.
3. They will read IFS4201 Information Security Industry Capstone Project, which is an 8-MCs independent study modules (ISMs) which will be counted as 2 USP Inquiry modules in Sciences and Technologies Basket.
4. They will use the 16 out of 20 MCs under the Unrestricted Electives to partially fulfil the remaining USP requirements.

Table 5: Summary of degree requirements for Bachelor of Computing (Information Security) – Co-operative Education Programme

MODULES	MCS	SUBTOTALS
UNIVERSITY LEVEL REQUIREMENTS		**20**
PROGRAMME REQUIREMENTS		**108**

MODULES	MCS	SUBTOTALS
Computing Foundation	36	
CS1010 Programming Methodology [4]	4	
CS1231 Discrete Structures	4	
CS2040C Data Structures and Algorithms	4	
CS2100 Computer Organisation	4	
CS2102 Database Systems	4	
CS2105 Introduction to Computer Networks	4	
CS2106 Introduction to Operating Systems	4	
CS2113T Software Engineering and Object-Oriented Programming [4]	4	
IS3103 Information Systems Leadership and Communication	4	
Information Security Requirements	32	
CS2107 Introduction to Information Security	4	
CS3235 Introduction to Computer Security	4	
IFS4201 Information Security Industry Capstone Project	8	
IS4231 Information Security Management	4	
Programme Electives Complete 12 MCs from the following list of modules: CS3236 Introduction to Information Theory CS4236 Cryptography Theory and Practice or MA4261 Coding and Cryptography CS4238 Computer Security Practices CS4239 Software Security CS5231 Systems Security CS5321 Network Security CS5322 Database Security CS5331 Web Security IS4204 IT Governance CS5332 Biometric Authentication IFS4101 Legal Aspects of Information Security IFS4102 Digital Forensics IS4233 Legal Aspects of Information Technology IS4234 Control and Audit of Information Systems IS4302 Blockchain and Distributed Ledger Technologies Other modules approved by the SoC UG Office	12	
Computing Breadth	20	
Complete 8 MCs of CP-coded, CS-coded or IS-coded modules at level-3000 or above.	8	
Industrial Experience Requirement comprising of: IFS2200 Information Security Immersion Programme IFS4202 Information Security Practicum Programme	12	
IT Professionalism	8	
IS1103/X IS Innovations in Organisation and Society	4	
CS2101 Effective Communication for Computing Professionals	4	
Mathematics	12	
MA1101R Linear Algebra I	4	
MA1521 Calculus for Computing	4	

MODULES	MCS	SUBTOTALS
ST2334 Probability and Statistics[5]	4	
UNRESTRICTED ELECTIVES[6]		**32**
Grand Total		**160**

[1]   Students should consult the CS Deputy Head (CS Programmes) in advance if they are interested in this option as industry courses may not be offered every year.

[2]   For students who opt for iLead or NOC, the additional MCs beyond the 12-MCs allocated to Industry Experience Requirement should be taken from Unrestricted Electives and/or exempted modules.

[3]   CS1010 can be replaced by CS1101S Programming Methodology.

[4]   Students taking CS2113T Software Engineering & Object-Oriented Programming must take CS2101 Effective Communication for Computing Professionals in the same semester.

[5]   Students pursuing a Second Major in Mathematics or Statistics will take ST2131 Probability in place of ST2334 Probability and Statistics. The students will take ST2132 as a core module in the second major in Statistics programme and are highly encouraged to take ST2132 as an elective module in the second major in Mathematics programme.   If a student who has already taken ST2131 quits the Second major in Mathematics or Statistics, he/she will have to take ST2132 to fulfil the BComp (Information Security) degree requirements.

[6]   Students without A-level Mathematics are required to complete MA1301 or MA1301X Introductory Mathematics as part of the Unrestricted Electives.

3.2.9 Bachelor of Computing in Information Security

Objective

The Bachelor of Computing in Information Security aims to:

- To provide a broad-based, inter-disciplinary information security undergraduate programme within NUS
- To contribute to the national focus on growing the pool of cyber security professionals in Singapore.
- To produce graduates who are able to understand information security issues and practices from both technical and organisational points of view.

Graduates of this programme are expected to have possible career choices as software engineers, systems administrators, malware researchers, security analyst, cybersecurity incident responder, and security consultant. They are expected to find employment in industries that deal with sensitive information (e.g., banks, insurance, defence), government organisations (e.g., CSIT, DSO, DSTA, MHA, Cyber Security Agency) and firms that provide security consultation/systems/services (e.g., Symantec, FireEye).

This programme enables students to attain, by the time of graduation:

1. Strong knowledge of computer science foundations and fundamentals, including (a) familiarity with common computer science themes and principles, (b) high-level understanding of systems as a whole, (c) understanding of the theoretical underpinnings of computer science and their influences in practice.
2. An ability to design, implement, and evaluate a computer-based system, process, components, or program to meet the security needs.
3. An understanding of the processes and challenges that support the delivery and management of information security in an organisation.
4. An ability to function effectively in teams to accomplish a common goal.
5. An understanding of professional, ethical, legal, security, and social issues and responsibilities.
6. An ability to communicate effectively with a range of audiences
7. An ability to analyse the local and global impact of computing on individuals, organisations, and society.
8. Recognition of the need for and an ability to engage in continuing professional development
9. An ability to use the current techniques, skills, and tools necessary for information security practice.

Degree Requirements

The Bachelor of Computing (Information Security) requires at least 160 MCs.

Students will be required to satisfy 12 MCs of industrial experience (mandatory requirement) by doing:

1. A 6-month internship through CP3880 Advanced Technology Attachment Programme (12 MCs)
2. Two 3-month internships through CP3200 Internship (6 MCs) and CP3202 Internship II (6 MCs).

With two internships, the student will be able to experience work in two distinct types of organisations, such as a start-up and a MNC, or in two different industries.

3. IS4010 Industry Internship Programme (12 MCs) from the IS department.
4. A 3-month internship through CP3200 Internship (6 MCs) and an Industry Course (4 MCs)[1]. The remaining 2 MCs may be satisfied using Unrestricted Electives.
5. iLead or NOC [2].
6. Other forms of industry experience approved by the Department of Computer Science.

1. **PROGRAMME REQUIREMENTS (Total of 108 MCs)**

Computing Foundation (36 MCs)

CS1010   Programming Methodology[3]

CS1231   Discrete Structures

CS2040C Data Structures and Algorithms

CS2100   Computer Organisation

CS2102   Database Systems

CS2105   Introduction to Computer Networks

CS2106   Introduction to Operating Systems

CS2113T Software Engineering & Object-Oriented Programming[4]

IS3103   Information Systems Leadership and Communication

Information Security Requirements (32 MCs)

CS2107   Introduction to Information Security

CS3235   Introduction to Computer Security

IFS4205   Information Security Capstone Project

IS4231   Information Security Management

Complete 12 MCs from the following list of modules:

CS3236   Introduction to Information Theory

either

CS4236   Cryptography Theory and Practice

or

MA4261   Coding and Cryptography

CS4238   Computer Security Practices

CS4239   Software Security

CS5231   Systems Security

CS5321   Network Security

CS5322   Database Security

CS5331   Web Security

CS5332   Biometric Authentication

IFS4101   Legal Aspects of Information Security

IFS4102   Digital Forensics

IS4204   IT Governance

IS4233   Legal Aspects of Information Technology

IS4234   Control and Audit of IS

IS4302   Blockchain and Distributed Ledger Technologies

Other modules approved by the SoC UG Office

Computing Breadth (8 MCs)

Complete 8 MCs of CP-coded, CS-coded or IS-coded modules at level-3000 or above. Industrial

Experience Requirement

IT Professionalism (8 MCs)

IS1103/X   IS Innovations in Organisations and Society

CS2101   Effective Communication for Computing Professionals

Mathematics (12 MCs)

MA1101R   Linear Algebra I

MA1521   Calculus for Computing

ST2334   Probability and Statistics[4]

2. **UNIVERSITY LEVEL REQUIREMENTS (20 MCs)**

As specified in Section 3.2.1.

3. **UNRESTRICTED ELECTIVES (20 MCs)**

As specified in Section 3.2.1.

NUS Overseas Colleges (NOC) – Information Security

Students who attended NOC programme may :
1. count TR3201 Entrepreneurship Practicum (8 MCs) towards Computing Breadth.
2. count TR3202 Start-up Internship Programme (12 MCs) towards Industrial Experience Requirement.
3. count TR3203 Start-up Case Study and Analysis towards Unrestricted Electives. Students working on information security-related projects for TR3203 may seek approval to instead take TR3203P, which counts towards IFS4205 Information Security Capstone Project requirement.

University Scholars Programme (Information Security)

Students in the University Scholars Programme who choose the Bachelor of Computing (Information Security) major will take the Information Security programme, but with the following variations:

1. They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).
2. They will not be required to read CS2101 Effective Communication for Computing Professionals. It is replaced by USP Foundation module: Writing and Critical Thinking.
3. They will read IFS4205 Information Security Capstone Project, which is an 8-MCs independent study modules (ISMs) which will be counted as 2 USP Inquiry modules in Sciences and Technologies Basket.
4. They will further complete 3 more USP Inquiry modules (for a total of 8, including CS3205) and the USP Reflection module (the Senior Seminar). They will have 16 MCs under the Unrestricted Electives.

Table 4: Summary of degree requirements for Bachelor of Computing (Information Security)

MODULES	MCS	SUBTOTALS
UNIVERSITY LEVEL REQUIREMENTS		20
PROGRAMME REQUIREMENTS		108

MODULES	MCS	SUBTOTALS
Computing Foundation	36	
CS1010 Programming Methodology [4]	4	
CS1231 Discrete Structures	4	
CS2040 Data Structures and Algorithms	4	
CS2100 Computer Organisation	4	
CS2102 Database Systems	4	
CS2105 Introduction to Computer Networks	4	
CS2106 Introduction to Operating Systems	4	
CS2113T Software Engineering and Object-Oriented Programming [4]	4	
IS3103 Information Systems Leadership and Communication	4	
Information Security Requirements	32	
CS2107 Introduction to Information Security	4	
IFS4205 Information Security Capstone Project	8	
CS3235 Introduction to Computer Security	4	
IS4231 Information Security Management	4	
Programme Electives Complete 12 MCs from the following list of modules: CS3236 Introduction to Information Theory CS4236 Cryptography Theory and Practice or MA4261 Coding and Cryptography CS4238 Computer Security Practices CS4239 Software Security CS5231 Systems Security CS5321 Network Security CS5322 Database Security CS5331 Web Security CS5332 Biometric Authentication IS4204 IT Governance IFS4101 Legal Aspects of Information Security IFS4102 Digital Forensics IS4233 Legal Aspects of Information Technology IS4234 Control and Audit of Information Systems IS4302 Blockchain and Distributed Ledger Technologies Other modules approved by the SoC UG Office	12	
Computing Breadth	20	
Complete 8 MCs of CP-coded, CS-coded or IS-coded modules at level-3000 or above.	8	
Industrial Experience Requirement	12	
IT Professionalism	8	
IS1103/X IS Innovations in Organisation and Society	4	
CS2101 Effective Communication for Computing Professionals	4	
Mathematics	12	
MA1101R Linear Algebra I	4	
MA1521 Calculus for Computing	4	

MODULES	MCS	SUBTOTALS
ST2334 Probability and Statistics[5]	4	
UNRESTRICTED ELECTIVES[6]		**32**
Grand Total		**160**

[1] Students should consult the CS Deputy Head (CS Programmes) in advance if they are interested in this option as industry courses may not be offered every year.

[2] For students who opt for iLead or NOC, the additional MCs beyond the 12-MCs allocated to Industry Experience Requirement should be taken from Unrestricted Electives and/or exempted modules.

[3] CS1010 can be replaced by CS1101S Programming Methodology.

[4] Students taking CS2113T Software Engineering & Object-Oriented Programming must take CS2101 Effective Communication for Computing Professionals in the same semester.

[5] Students pursuing a Second Major in Mathematics or Statistics will take ST2131 Probability in place of ST2334 Probability and Statistics. The students will take ST2132 as a core module in the second major in Statistics programme and are highly encouraged to take ST2132 as an elective module in the second major in Mathematics programme.   If a student who has already taken ST2131 quits the Second major in Mathematics or Statistics, he/she will have to take ST2132 to fulfil the BComp (Information Security) degree requirements.

[6] Students without A-level Mathematics are required to complete MA1301 or MA1301X Introductory Mathematics as part of the Unrestricted Electives.

3.2.11

Objective

The four-year IS programme will provide students with a deep appreciation of the organisational context of ICT; strong proficiency in the design and development of value-adding infocomm solutions; and strong proficiency in the cost effective management of infocomm projects. This multidisciplinary education on information systems focuses on the application and management of information technology to enhance the effectiveness of organisations and businesses. It also analyses the impact and trends of technology and the relevant implications for the economy and society.

IS graduates will be equipped with relevant knowledge to target short- to medium-term positions such as techno-strategist, ICT solutions architect, systems integrator, business process consultant/analyst, and infocomm project manager. Possible employers include end users of ICT, system integrators, consulting firms, market research firms, regulatory agencies and investment advisors.

Specialisations

Students can also package their own specialisations by reading modules that satisfy the specialisation requirements. Specialisations provide students the opportunity to gain focused, in-depth knowledge in specialised areas where information systems are deployed.

To be awarded with specialisations, students have to complete 6 modules (24 MCs) in the list of modules included for a specialisation. Students can only choose to pursue one of the three specialisations.

To be awarded the **Electronic Commerce Specialisation**, students must satisfy the followings:

Compuslory modules:
IS3150 Digital Media Marketing
IS4151 Pervasive Technology Solutions in Financial Services
IS4261 Designing Tech Business Innovation

Choose three modules from the following list of modules:
IS3261 Mobile Apps Development for Enterprise
IS4228 Information Technologies in Financial Services
IS4231 Information Security Management
IS4240 Business Intelligence Systems
IS4243 Information Systems Consulting

To be awarded the **Financial Technology Specialisation**, students must satisfy the followings:

Compulsory modules:

IS4228 Information Technologies in Financial Services

IS4302 Blockchain and Distributed Ledger Technologies

IS4303 IT-Mediated Financial Solutions and Platforms

Choose three modules from the following list of modules:

IS3221 Enterprise Resource Planning Systems

IS4231 Information Security Management

IS4233 Legal Aspects of Information Technology

IS4234 Quality Control and Audit of IS

IS4301 Agile IT with DevOps

To be awarded the **Digital Innovation Specialisation**, students must satisfy the followings:

Compulsory modules:

IS3240 Economics of e-Business

IS3251 Principles of Technology Entrepreneurship

IS4261 Designing IT-Enabled Business Innovations

Choose three modules from the following list of modules:

IS3150 Digital Media Marketing

IS3261 Mobile Apps Development for Enterprise

IS4204 IT Governance

IS4233 Legal Aspects of Information Technology

IS4243 Information Systems Consulting

NUS Overseas Colleges (NOC) – Information Systems

Students who attended NOC programme may :
1. count TR3201 Entrepreneurship Practicum (8 MCs) partially in lieu of CP4101 BComp Dissertation (4 out of 12 MCs) and replace one IS programme elective at level-3000 (4 MCs).
2. count TR3202 Start-up Internship Programme (12 MCs) towards Industrial Experience Requirement (i.e. IS4010 Industry Internship Programme).
3. count TR3203 Start-up Case Study and Analysis (8 MCs) partially in lieu of CP4101 B.Comp Dissertation (8 out of 12 MCs).

University Scholars Programme (Information Systems)

Students in the University Scholars Programme who choose the Bachelor of Computing (Information Systems) major will take the IS programme, but with the following variations:
1. They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).
2. They will not be required to read IS2101 Business and Technical Communication. It is replaced by

USP Foundation module: Writing and Critical Thinking.

3. They will have 20 (instead of 30) MCs under Unrestricted Electives

4. They will read UROP modules (CP3208 and CP3209) in place of the IS team project module (IS3102). CP3208 and CP3209 are independent study modules (ISMs) which will be counted as 2 USP Inquiry modules in Sciences and Technologies Basket.

5. They will be required to take 24 MCs (6 modules) from the Programme Electives. Among these modular credits, at least 12 MCs (3 modules) must be at level-4000.

Table 6: Summary of degree requirements for Bachelor of Computing (Information Systems)

MODULES	MCS	SUB TOTALS
UNIVERSITY LEVEL REQUIREMENTS Please refer to Section 3.2.1.		20
PROGRAMME REQUIREMENTS		108
Core Modules	72	
CS1010J Programming Methodology	4	
CS1020 Data Structures and Algorithms I	4	
CS1231 Discrete Structures	4	
IS1103/X IS Innovations in Organisations and Society	4	
IS2101 Business and Technical Communication	4	
CS2100 Computer Organisation	4	
CS2102 Database Systems	4	
CS2105 Introduction to Computer Networks	4	
IS2102 Enterprise Systems Architecture and Design	4	
IS2103 Enterprise Systems Server-side Design and Development	4	
IS3103 Information Systems Leadership and Communication	4	
IS3106 Enterprise Systems Interface Design and Development	4	
IS4100 IT Project Management	4	
IS4103 Information Systems Capstone Project	8	
MA1301/X Introductory Mathematics[1]	4	
MA1521 Calculus for Computing or MA1312 Calculus with Applications[2]	4	
ST2334 Probability and Statistics [3]	4	
Programme Electives (PE)	24	

MODULES	MCS	SUB TOTALS
Option 1:		
Choose 6 modules to make up 24 MCs from the list of Programme Electives below. 3 of the 6 modules must be at level-4000.		
Option 2:		
Choose CP4101 and 3 modules to make up 24 MCs from the list of Programme Electives below.CP4101 B.Comp. Dissertation**Financial Technology**		
IS4228 Information Technologies in Financial Services		
IS4302 Blockchain and Distributed Ledger Technologies		
IS4303 IT-Mediated Financial Solutions and Platforms		
IT Solutioning		
CS3240 Interaction Design		
IS3221 Enterprise Resource Planning Systems		
IS4204 IT Governance		
IS4234 Quality Control and Audit of IS		
IS4243 Information Systems Consulting		
IS4250 Healthcare IT and Analytics		
IS4301 Agile IT with DevOps		
IT Business Innovation and Entrepreneurship		
IS3251 Principles of Technology Entrepreneurship		
IS4240 Business Intelligence Systems		
IS4241 Social Media Network Analysis		
IS4261 Designing Tech Business Innovations		
IT Security and Legal Aspects		
CS2107 Introduction to Information Security		
IFS4101 Legal Aspects of Information Security		
IS4231 Information Security Management		
IS4233 Legal Aspects of Information Technology**Digital Business**		
IS3150 Digital Media Marketing		
IS3240 Economics of E-Business		
IS3261 Mobile Apps Development for Enterprise	All modules are 4	
IS4151 Pervasive Technology Solutions and Development**Specialisations**	MCs modules, except	
Students can only choose to pursue one of the three specialisations below:To be awarded the **Electronic Commerce Specialisation**, students must satisfy	CP4101 (12 MCs)	
the followings:Compuslory modules:		
IS3150 Digital Media Marketing		
IS4151 Pervasive Technology Solutions and Development		
IS4261 Designing Tech Business InnovationsChoose three modules from the following list of modules:		
IS3261 Mobile Apps Development for Enterprise		
IS4228 Information Technologies in Financial Services		
IS4231 Information Security Management		
IS4240 Business Intelligence Systems		
IS4243 Information Systems ConsultingTo be awarded the **Financial Technology Specialisation**, students must satisfy the followings:Compulsory modules:		
IS4228 Information Technologies in Financial Services		
IS4302 Blockchain and Distributed Ledger Technologies		
IS4303 IT-Mediated Financial Solutions and Platforms		
Choose three modules from the following list of modules:		
IS3221 Enterprise Resource Planning Systems		
IS4231 Information Security Management		
IS4233 Legal Aspects of Information Technology		
IS4234 Quality Control and Audit of IS		
IS4301 Agile IT with DevOps		
To be awarded the **Digital Innovation Specialisation**, students must satisfy the followings:		
Compulsory modules:		
IS3240 Economics of e-Business		
IS3251 Principles of Technology Entrepreneurship		
IS4261 Designing IT-Enabled Business Innovations		
Choose three modules from the following list of modules:		
IS3150 Digital Media Marketing		
IS3261 Mobile Apps Development for Enterprise		
IS4204 IT Governance		
IS4233 Legal Aspects of Information Technology		
IS4243 Information Systems Consulting		

MODULES	MCS	SUB TOTALS
IS4010 Industry Internship Programme [4]	12	
UNRESTRICTED ELECTIVES [5]		**32**
Grand Total		**160**

1   MA1301/X is waived for students with A-level Mathematics. The 4 MCs gained from the waiver are added to the MCs for Unrestricted Electives. Students on double degree programmes who possess A-level Mathematics or its equivalent are not required to replace the missing MCs for MA1301 with unrestricted electives.

2   MA1521 to be chosen if student wants to keep the option of switching to the Computer Science stream.

3   For students taking Second Major in Statistics, they can replace ST2334 with ST2131 to meet first major requirement. For students taking the Second Major in Mathematics, they can replace ST2334 with both ST2131 and ST2132 to meet first major requirement. The MCs for ST2132 come from UE. For students taking the minor in Mathematics, they can replace ST2334 with ST2131 and take ST2132 as an unrestrictive elective to meet first major requirement.

4   Students can choose to take on any current 12 MCs or more internship-related programmes within the School of Computing (e.g., CP3880 Advanced Technology Attachment Programme (ATAP)) and/or within NUS (e.g., Innovative Local Enterprise Achiever Development (iLEAD) and NUS Overseas College (NOC)) in place of IS4010 Industry Internship Programme to satisfy the industry experience requirement.

5   Students are encouraged to use their unrestricted electives to take modules that will build up their business domain knowledge. Having a strong knowledge of a business domain will provide IS graduates a favorable advantage in employment opportunity in the industry.

3.2.12 Bachelor of Science in Business Analytics

Objective

The emerging phenomena of Big Data – large pools of data sets that can be captured, communicated, aggregated, stored, and analyzed – has presented companies and organisations with trillions of bytes of information about their customers, suppliers, and operations. Millions of networked sensors are also embedded in various devices such as mobile phones and tablet computers to sense, create, and communicate data. Big data is now part of every industry sector and function of the global economy. It is increasingly the case that modern economic activity, innovation, and growth have to take place with data and the related analytic processes, methods and outputs. The discipline of business analytics (BA) enables companies and organisations to realise the full potential of data generated from various business processes, sources and devices, thus improving their speed and effectiveness in generating business insights and intelligence for optimal decision making purposes.

Programme Introduction

The Bachelor of Science (Business Analytics) degree programme is an inter-disciplinary undergraduate degree programme offered by the School of Computing with participation from the Business School, Faculty of Engineering, Faculty of Science, and Faculty of Arts and Social Sciences. This is a four-year direct honours programme which offers a common two-year broad-based inter-disciplinary curriculum where all students will read modules in Mathematics, Statistics, Economics, Accounting, Marketing, Decision Science, Industrial and Systems Engineering, Computer Science and Information Systems. Students in their third and fourth years of study may choose elective modules from two lists of either functional or methodological elective modules. Functional elective modules span business functions or sectors of marketing, retailing, logistics, healthcare, etc. Methodological elective modules include those related to big data techniques, statistics, text mining, data mining, social network analysis, econometrics, forecasting, operations research, etc. In sum, these elective modules span the most exciting and challenging areas of business analytics practice in the industry today.

Programme Learning Objectives

Learning objectives of the Bachelor of Science (Business Analytics) degree programme are:
• To understand the conceptual and methodological foundations of analytical methods and techniques for business analytics, as referenced from disciplines such as computing, engineering, science, mathematics, statistics, business and economics
• To appreciate and understand current business analytics problems in the industry worldwide and be able to identify and resolve practically relevant business analytics questions and issues
• To apply appropriate analytic tools and techniques to resolve complex business analytics problems in various industry sectors and domains
• To cultivate the practices of independent and group learning on the part of students that will prepare them to function effectively for diverse careers in business analytics

NUS Overseas Colleges (NOC) – Business Analytics

Students who attended NOC programme may:

1. count TR3201 Entrepreneurship Practicum (8 MCs) partially in lieu BT4101 BSc Dissertation (4 out of 12 MCs) and replace one Business Analytics programme elective at level-3000 (4 MCs).
2. count TR3202 Start-up Internship Programme (12 MCs) towards Industrial Experience Requirement (i.e. IS4010 Industry Internship Programme).
3. count TR3203 Start-up Case Study and Analysis (8 MCs) partially in lieu of BT4101 BSc Dissertation (8 out of 12 MCs).

University Scholars Programme (Business Analytics)

Students in the University Scholars Programme (USP) who choose the Bachelor of Science (Business Analytics) degree programme will do so with the following variations:

1. They will not be required to read IS2101 Business and Technical Communication in the Core modules requirement. It is replaced by USP Foundation module of Writing and Critical Thinking.
2. They will read the UROP module (CP3208) in place of the Business Analytics Capstone Project module (BT3101) in the Core modules requirement. CP3208 is an independent study module (ISM) which will be counted as 1 USP Inquiry module in the Sciences and Technologies domain.
3. They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).
4. They will not be required to read Unrestricted Electives (20 MCs). These are replaced by the USP Reflection module of Senior Seminar and 4 USP Inquiry modules.
5. In summary, the breakdown of 12 USP modules will fit into these MCs requirement categories:
   • Core: 1 Foundation module (Writing and Critical Thinking replacing IS2101), 1 Inquiry module (CP3208/USP-ISM replacing BT3101)
   • ULR: 3 Inquiry modules and 2 Foundation modules
   • UE: 1 Reflection module and 4 Inquiry modules

Table 7: Summary of degree requirements for Bachelor of Science (Business Analytics)

MODULES	MCS	SUB TOTALS
UNIVERSITY LEVEL REQUIREMENTS Please refer to Section 3.2.1.		**20**
PROGRAMME REQUIREMENTS		**108**
Core Modules	**72**	
BT1101 Introduction to Business Analytics	4	
CS1010S Programming Methodology	4	
CS1020 Data Structures and Algorithms I	4	

MODULES	MCS	SUB TOTALS
EC1301 Principles of Economics[1]	4	
IS1103/X IS Innovations in Organisations and Society	4	
MA1311 Matrix Algebra and Applications, or MA1101R Linear Algebra I[2]	4	
MA1521 Calculus for Computing, or MA1102R Calculus[2]	4	
MKT1705X Principles of Marketing	4	
BT2101 Decision Making Methods and Tools	4	
BT2102 Data Management and Visualisation	4	
CS2010 Data Structures and Algorithms II	4	
IS2101 Business and Technical Communication	4	
ST2334 Probability and Statistics [3]	4	
BT3101 Business Analytics Capstone Project	4	
BT3102 Computational Methods for Business Analytics	4	
BT3103 Application Systems Development for Business Analytics	4	
IS3103 Information Systems Leadership and Communication	4	
BT4240 Machine Learning for Predictive Data Analytics	4	
Programme Electives (PE)	**24**	

MODULES	MCS	SUB TOTALS
Option 1: Choose 6 modules to make up 24 MCs from Lists A, B and C, with at least 2 modules each from Lists A and B. 5 of 6 modules must be at level-4000. **Option 2**: Choose BT4101 and 3 modules to make up 24 MCs from Lists A, B and C, with at least 1 module each from Lists A and B. 2 of 3 modules must be at level-4000.BT4101 B.Sc. DissertationList A (Functional): DBA3712 Dynamic Pricing and Revenue Management IE3120 Manufacturing Logistics IS3240 Economics of E-Business BT4211 Data-Driven Marketing BT4212 Search Engine Optimization and Analytics DSC4213 Analytical Tools for Consulting IS4250 Healthcare Analytics MKT4812 Marketing AnalyticsList B (Analytics Methods): IE2110 Operations Research I [4], or DBA3701 Introduction To Optimisation CS3244 Machine Learning DBA3803 Predictive Analytics in Business BSE4711 Econometrics for Business II BT4221 Big Data Techniques and Technologies BT4222 Mining Web Data for Business Insights IS4241 Social Media Network Analysis IE4210 Operations Research II ST3131 Regression Analysis [4a] ST4245 Statistical Methods for Finance List C (Technology Implementation) IS3221 Enterprise Resource Planning Systems IS3261 Mobile Solutions Design and Development IS4228 Information Technologies in Financial Services IS4302 Blockchain and Distributed Ledger Technologies	All modules are 4 MCs modules, except BT4101 (12 MCs)	
IS4010 Industry Internship Programme [5]	**12**	

MODULES	MCS	SUB TOTALS
UNRESTRICTED ELECTIVES		**32**
Grand Total		**160**

[1] Students have done EC1101E Introduction to Economic Analysis can use it to replace EC1301.

[2] Students are encouraged to take these MA module options should they wish to pursue a more rigorous treatment of the subject topics covered.

[3] For students taking Second Major in Statistics, they can replace ST2334 with ST2131 to meet first major requirement. For students taking the Second Major in Mathematics, they can replace ST2334 with both ST2131 and ST2132 to meet first major requirement. The MCs for ST2132 come from Unrestricted Electives. For students taking the minor in Mathematics, they can replace ST2334 with ST2131 and take ST2132 as an unrestricted elective to meet first major requirement.

[4] Students are encouraged to take IE2110 should they wish to choose IE4210 as an elective module.

[4a] Students who are doing or contemplating to do minor/second major requiring ST3131 such as Statistics which has more than allowed overlap cannot double count ST3131 towards fulfilling the BSc (BA) programme elective requirement.

[5] Students can choose to take on any current 12 MCs or more internship-related programmes within the School of Computing (e.g., CP3880 Advanced Technology Attachment Programme (ATAP)) and/or within NUS (e.g., Innovative Local Enterprise Achiever Development (iLEAD) and NUS Overseas College (NOC)) in place of IS4010 Industry Internship Programme to satisfy the industry experience requirement.

3.2.13 Bachelor of Science in Business Analytics – Co-operative Education Programme

Objective

The emerging phenomena of Big Data – large pools of data sets that can be captured, communicated, aggregated, stored, and analyzed – has presented companies and organisations with trillions of bytes of information about their customers, suppliers, and operations. Millions of networked sensors are also embedded in various devices such as mobile phones and tablet computers to sense, create, and communicate data. Big data is now part of every industry sector and function of the global economy. It is increasingly the case that modern economic activity, innovation, and growth have to take place with data and the related analytic processes, methods and outputs. The discipline of business analytics (BA) enables companies and organisations to realise the full potential of data generated from various business processes, sources and devices, thus improving their speed and effectiveness in generating business insights and intelligence for optimal decision making purposes.

Programme Introduction

The Bachelor of Science (Business Analytics) degree programme is an inter-disciplinary undergraduate degree programme offered by the School of Computing with participation from the Business School, Faculty of Engineering, Faculty of Science, and Faculty of Arts and Social Sciences. This is a four-year direct honours programme which offers a common two-year broad-based inter-disciplinary curriculum where all students will read modules in Mathematics, Statistics, Economics, Accounting, Marketing, Decision Science, Industrial and Systems Engineering, Computer Science and Information Systems. Students in their third and fourth years of study may choose elective modules from two lists of either functional or methodological elective modules. Functional elective modules span business functions or sectors of marketing, retailing, logistics, healthcare, etc. Methodological elective modules include those related to big data techniques, statistics, text mining, data mining, social network analysis, econometrics, forecasting, operations research, etc. In sum, these elective modules span the most exciting and challenging areas of business analytics practice in the industry today.

Programme Learning Objectives

Learning objectives of the Bachelor of Science (Business Analytics) degree programme are:
• To understand the conceptual and methodological foundations of analytical methods and techniques for business analytics, as referenced from disciplines such as computing, engineering, science, mathematics, statistics, business and economics
• To appreciate and understand current business analytics problems in the industry worldwide and be able to identify and resolve practically relevant business analytics questions and issues
• To apply appropriate analytic tools and techniques to resolve complex business analytics problems in various industry sectors and domains

•To cultivate the practices of independent and group learning on the part of students that will prepare them to function effectively for diverse careers in business analytics

University Scholars Programme (Business Analytics)

Students in the University Scholars Programme (USP) who choose the Bachelor of Science (Business Analytics) degree programme will do so with the following variations:

1.   They will not be required to read IS2101 Business and Technical Communication in the Core modules requirement. It is replaced by USP Foundation module of Writing and Critical Thinking.

2.   They will read GER1000 Quantitative Reasoning (4 MCs) as compulsory module for the University Level Requirements (ULR). The remaining 16 MCs in ULR are replaced by the 3 USP Inquiry Modules and 1 USP Foundation module (i.e. University Scholars Seminar).

3.   They will not be required to read Unrestricted Electives (16 MCs). These are replaced by the USP Reflection module of Senior Seminar and 3 USP Inquiry modules.

Table 8: Summary of degree requirements for Bachelor of Science (Business Analytics) – Co-operative Education Programme

MODULES	MCS	SUB TOTALS
UNIVERSITY LEVEL REQUIREMENTS Please refer to Section 3.2.1.		**20**
PROGRAMME REQUIREMENTS		**124**
Core Modules	**84**	
BT1101 Introduction to Business Analytics	4	
CS1010S Programming Methodology	4	
CS1020 Data Structures and Algorithms I	4	
EC1301 Principles of Economics[1]	4	
IS1103/X IS Innovations in Organisations and Society	4	
MA1311 Matrix Algebra and Applications, or MA1101R Linear Algebra I[2]	4	

MODULES	MCS	SUB TOTALS
MA1521 Calculus for Computing, or MA1102R Calculus[2]	4	
MKT1705X Principles of Marketing	4	
BT2101 Decision Making Methods and Tools	4	
BT2102 Data Management and Visualisation	4	
CS2010 Data Structures and Algorithms II	4	
IS2101 Business and Technical Communication	4	
ST2334 Probability and Statistics[2a]	4	
BT3102 Computational Methods for Business Analytics	4	
BT3103 Application Systems Development for Business Analytics	4	
IS3103 Information Systems Leadership and Communication	4	
BT4240 Machine Learning for Predictive Data Analytics [3a]	4	
Programme Electives (PE)	**24**	

MODULES	MCS	SUB TOTALS
Option 1: Choose 6 modules to make up 24 MCs from both List A and List B, with at least 2 modules from each list. 5 of 6 modules must be at 4000 level. **Option 2:** Choose BT4101 and 3 modules to make up 24 MCs from both List A and List B, with at least 1 module from each list. 2 of 3 modules must be at 4000 level. BT4101 B.Sc. Dissertation List A (Business Applications): DBA3712 Dynamic Pricing and Revenue Management IE3120 Manufacturing Logistics IS3240 Economics of E-Business BT4211 Data-Driven Marketing BT4212 Search Engine Optimization and Analytics DBA4811 Analytical Tools for Consulting IS4250 Healthcare Analytics MKT4812 Marketing Analytics List B (Analytical Methods): IE2110 Operations Research I[3], or DBA3701 Introduction To Optimisation CS3244 Machine Learning DBA3803 Predictive Analytics in Business BSE4711 Econometrics for Business II BT4221 Big Data Techniques and Technologies BT4222 Mining Web Data for Business Insights IS4241 Social Media Network Analysis IE4210 Operations Research II ST3131 Regression Analysis [3a] ST4245 Statistical Methods for Finance List C (Technology Implementation): IS3221 Enterprise Resource Planning Systems IS3261 Mobile Solutions Design and Development IS4228 Information Technologies in Financial Services IS4302 Blockchain and Distributed Ledger Technologies	All modules are 4 MCs modules, except BT4101 (12 MCs)	

MODULES	MCS	SUB TOTALS
Co-op Internship Scheme	**32**	
BT2010 Business Analytics Immersion Programme	**6**	
BT4010 Business Analytics Internship Programme [4]	**12**	
BT4011 Business Analytics Capstone Industry Project	**14**	
UNRESTRICTED ELECTIVES		16
Grand Total		160

[1] Students have done EC1101E Introduction to Economic Analysis can use it to replace EC1301.

[2] Students are encouraged to take these MA module options should they wish to pursue a more rigorous treatment of the subject topics covered.

[2a] For students taking Second Major in Statistics, they can replace ST2334 with ST2131 to meet first major requirement. For students taking the Second Major in Mathematics, they can replace ST2334 with both ST2131 and ST2132 to meet first major requirement. The MCs for ST2132 come from UE. For students taking the minor in Mathematics, they can replace ST2334 with ST2131 and take ST2132 as an unrestrictive elective to meet first major requirement.

[3] Students are encouraged to take IE2110 should they wish to choose IE4210 as an elective module.

[3a] Students who are doing or contemplating to do minor/second major requiring ST3131 such as Statistics which has more than allowed overlap cannot double count ST3131 towards fulfilling the BSc (BA) programme elective requirement.

[4] BT4010 is equivalent to IS4010 (which is offered in regular programme).

3.2.13 Bachelor of Engineering in Computer Engineering

Please refer to Section R2 of Part II: Programmes of this bulletin for details.

3.3 Multidisciplinary Programmes

3.3.1 [Double Degree Programme with another Faculty within NUS](#)

3.3.2 [Double Degree Programme in Computer Science/ Information Systems and Business Administration/Business Administration (Accountancy) (Honours/non-Honours)](#)

3.3.3 [Double Degree Programme in Computer Science and Mathematics/Applied Mathematics (Honours/non-Honours)](#)

3.3.4 [Double Degree Programme with French Grandes Écoles](#)

3.3.5 [Double Major Programmes](#)

3.3.6 [Minor programmes](#)

3.3.1 Double Degree Programme with another Faculty within NUS

Students interested in pursuing a double degree with another faculty within NUS can do so by discussing their plans with their academic advisors, as well as the School of Computing's Office of Undergraduate Programmes. Such a self-designed programme provides maximal flexibility for students to pursue multidisciplinary education that fits their goals of education.

Some of the self-planned popular double degree programmes are joint with Mathematics, Quantitative Finance, Business and Geography, to name a few.

Students will apply for the double degree programme by submitting their applications to the Vice Dean (Undergraduate Studies), School of Computing Undergraduate Office, after completing between 60 and 80 MCs. They must obtain the approval of the Faculty in which they are seeking to do the second degree, and ensure that they have met the minimum CAP requirement of 4.00 for consideration and acceptance into the second degree programme.

A student may decide to withdraw or can be asked to withdraw from the double degree programme by withdrawing from the second degree. However, he/she is not allowed to withdraw from the first degree (i.e., the originally offered degree) programme and transfer to the second degree programme. All modules which the student has taken to fulfil the requirements of the second degree will be reflected in the transcript and included in the computation of the CAP.

For Students admitted with effect from AY 2014/15 onwards:
Students who have not achieved a CAP of 3.75 in modules contributing to the original degree, and a CAP of 3.25 for the degree for any two consecutive semesters will be required to withdraw from the double degree programme by withdrawing from the second degree programme. However, this DDP continuation rule is not applicable once a student's total cumulative modular credits exceeds 160 MCs.

The NUS double degree framework is given at :
 http://www.nus.edu.sg/registrar/edu/UG/spugp-double-degree-guidelines.html

(A) University Level Requirements

Students are required to complete 20 MCs for this requirement. Students will be required to read one General Education Module (GEM) from each of the five pillars to satisfy the University Level Requirements for General Education. Please refer to the GEM website at http://www.nus.edu.sg/registrar/gem for the details.

(B) Faculty Requirements

A student reading for a double degree within the same Faculty will only need to fulfil one set of faculty

requirements. If the two degrees are from two Faculties, both sets of faculty requirements will have to be fulfilled.

(C) Major Requirements

At least two thirds of each major must be fulfilled by distinct (i.e., not overlapping) modules. A minimum 60% of major credits of each of the degrees must be letter graded and factored in the CAP of each degree.

(D) Unrestricted Electives

Students will not be required to take Unrestricted Elective (UE) Modules. However, if UE modules are taken, these can be used to count towards the requirement of either degree programme. Modules double counted towards the major requirements of both degrees may not be double counted towards a Minor as well.

(E) Maximum Period of Candidature

The maximum period of candidature will be six years. The two degree programmes must be undertaken and completed within a single continuous candidature period (save for the usual provisions for leave of absence).

(F) Computation of CAP

• The CAP for both degree programmes will be computed separately and the two CAPs, one each for the respective degree programme will be reflected separately on the transcript.
• Students are required to classify their modules every semester by declaring which modules they want to use to fulfil the requirements of each of the two degrees.
• The grades from modules (Singapore Studies, GEMs, faculty requirements or majors) that may be double counted will be used twice to compute the CAP for each of the two degrees.
• If Unrestricted Elective (UE) modules have been taken, the grades obtained will be used to compute the CAP for either one of the two degrees.

(G) Minimum MC Requirements for Double Degrees

The minimum MC requirements for double degrees are as follows:

Double Honours Degrees – 200 MCs

Double Honours and Bachelor Degrees – 180 MCs

The actual total MCs will be dependent on the requirements of each of the two degrees and how much double counting is permitted as specified by the respective Faculties/Departments.

(H) Award of Degree

Two separate degrees will be awarded and two degree scrolls issued, one for each degree.

3.3.2 Double Degree Programme in Computer Science/ Information Systems and Business Administration/Business Administration (Accountancy) (Honours/non-Honours)

Please refer to http://www.nus.edu.sg/registrar/Otherprogs/ddp.html#5_4.

3.3.3 Double Degree Programme in Computer Science and Mathematics/Applied Mathematics (Honours/non-Honours)

Please refer to http://www.nus.edu.sg/registrar/Otherprogs/ddp.html#5_5.

3.3.4 Double Degree Programme with French Grandes Écoles

The School offers Double Degree programmes with French Grandes Écoles, École Polytechnique (X), École Centrale Paris (ECP), École Supérieure d'Electricité (Supélec), École Nationale des Ponts et Chaussées (ENPC), École Nationale des Mines de Paris (ENSMP), TELECOM ParisTech (École Nationale Supérieure des Télécommunications) and ENSTA ParisTech (École Nationale Supérieure de Techniques Avancées) , seven premiere French institutions. The Double Degree Programme (DDP) with French Grandes Écoles provides the opportunities to learn from the best of both worlds, exposure to foreign cultures, networking with Singaporeans and foreigners, and proficiency in a third language.

Outstanding candidates for the double degree programme are selected in their first year. The successful candidates will undergo language preparation, spend their third and fourth year in the French institution, and return to NUS for their fifth (final) year. Students will graduate with a Diplôme d'Ingénieur from the French Grande École and a M.Sc. or M.Comp. from NUS.

For more details, please see: http://www.fddp.nus.edu.sg/.

3.3.5 Double Major Programmes

A second major will consist of at least 48 MCs of modules of which:

1. Only 8 MCs can be double counted.
2. At least 16 MCs must be at Level-3000 or above.

The requirements of a Double Major are as follows:

(A) University Level Requirements

Students are required to complete 20 MCs for this requirement.

(B) Faculty Requirements

Students need to fulfil the faculty requirements of the primary major.

(C) Major Requirements

Students are required to completely fulfil all the requirements of the primary major and the second major. Up to 8 MCs of the modules in the second major can be used to double count towards either the Faculty, Primary Major or Minor requirements.

Students may not need to take Unrestricted Elective (UE) Modules if the ULR and two majors add up to 160MCs or more. USP students must satisfy the prevailing USP requirements. The Advanced Modules can only be drawn from the primary major. The prevailing rules/policy concerning the S/U will apply for Double Major students.

(D) Computation of Cumulative Average Points (CAP)

Since students are graduating with only one degree, there will be a common CAP for both majors.

(E) Minimum MCs Requirements for Double Majors

The minimum MCs requirements for the Double Majors are as follows:

SINGLE DEGREE, DOUBLE MAJOR PROGRAMMES	MINIMUM MC REQUIREMENT
With Honours	160
Without Honours	120

If the above minimum requirements are achieved, it would be possible to complete a Double Major with Honours in one subject within four years. The actual total MCs will depend upon the requirements of the second major.

(F) Residency Requirement

The residency requirement is 50% of the minimum required MCs for the Double Major programme or 80 MCs, whichever is the higher.

(G) Maximum Period of Candidature

The maximum period of candidature for a Double Major is the same as that for a single major under the same degree.

(H) Awards

A Double Major student will only be eligible for award of medals and prizes associated with the primary major unless the medal/prize is to be awarded for best performance in a module. The second major will only be mentioned in the transcript and not on the degree scroll.

3.3.5.1 [Double Major in either Management or Management (Technology)](#)

3.3.5.2 [Double Majors in the Faculty of Arts and Social Sciences](#)

3.3.5.3 [Double Majors in the Faculty of Science](#)

3.3.5.4 [Double Majors in the School of Computing](#)

3.3.5.1 Double Major in either Management or Management (Technology)

SoC students interested in doing a double major programme from the School of Business may refer to section B3 of Part II of this bulletin for double major in either Management or Management (Technology). Details on these two double major programmes are available at:

http://bba.nus.edu/academic-programmes/bba-majors-minors/for-non-business-students/major-minor-in-mgmt and

http://bba.nus.edu/academic-programmes/bba-majors-minors/for-non-business-students/major-in-mgmt-tech respectively. Students are required to apply for the second major and each application will be reviewed on a case-by-case basis.

3.3.5.2 Double Majors in the Faculty of Arts and Social Sciences

SoC students can refer to Section A2 of Part II of this bulletin for details.

3.3.5.3 Double Majors in the Faculty of Science

SoC students can refer to Section L3 of Part II of this bulletin for details.

3.3.5.4 Double Majors in the School of Computing

The School of Computing offers the following second major programmes for non-SoC students:

3.3.5.4.1 [Double Major in Business Analytics](#)
3.3.5.4.2 [Double Major in Computer Science](#)
3.3.5.4.3 [Double Major in Information Security](#)

Students should follow the University's double counting framework for double major programmes that is applicable to their cohort.

3.3.5.4.1 Double Major in Business Analytics

The School of Computing offers a second major in Business Analytics (BZA) for non-SoC students.

Objectives

The objectives for the Second Major in BZA are as follows:

To provide a business analytics programme within NUS for non-computing students who are not studying business analytics and equivalent as the first major;
To contribute to the national focus on growing the pool of knowledge workers who have foundational skill set in business analytics;
To produce graduates who are able to understand business analytics principles and practices and apply it in a multi-disciplinary context.

Student Learning Outcomes

The Second Major in BZA enables students to attain, by the time of graduation:

1. Strong knowledge of business analytics foundations and fundamentals, including (a) familiarity with common business analytics themes and principles, (b) high-level understanding of systems as a whole, (c) understanding of the theoretical underpinnings of business analytics and their influences in practice.
2. Individual competence in applying sound principles and rigorous thinking to (a) analyse a business problem, (b) formulate the problem in terms of analytics requirements, (c) conceive novel solution ideas, (d) design appropriate solutions that meet the requirements, (e) implement the solution, (f) evaluate the effectiveness of the solution.
3. An ability to function effectively in teams to accomplish a common goal.
4. Recognition of the need for and an ability to engage in continuing professional development.

Admission Requirements

For direct admission, students applying for the Second Major in BZA must meet the entry requirement:

For diploma holders: Diploma with at least an A2 in GCE 'O' level Elementary Mathematics or at least a B4 grade in GCE 'O' level Additional Mathematics.
For A-Level Holders: At least a H2 pass in Mathematics.

Existing students from cohort 2016/17 or later who have taken CS1010S (or its equivalent) and BT1101 (or its equivalent) as either part of their degree requirements or Minor in Business Analytics can apply for entry into Second Major in Business Analytics if they obtain B+ or above in both modules.

The second major in BZA programme is **not available** to students in the following degree programmes:

BComp (Information Security)
BComp (Computer Science)
BComp (Computational Biology)

BEng (Computer Engineering)
BComp (Information Systems)
BSc (Business Analytics)
BSc (Data Science and Analytics)

Structure

The Second Major in BZA to be structured as follows:

Business Analytics Foundation = 40 MCs
Business Analytics Verticals = 8 MCs

In total, the 48 MCs requirement for graduation are broken down as follows:

Core modules = 40 MCs
Elective modules = 8 MCs

The table below shows the programme structure in details:

Modules	MCs
Business Analytics Foundation	**40**
BT1101 Introduction to Business Analytics[1]	4
BT2101 Decision Making Methods and Tools	4
BT2102 Data Management and Visualisation	4
BT3102 Computational Methods for Business Analytics	4
BT3103 Application Systems Development for Business Analytics	4
CS1010S Programming Methodology[2]	4
CS1020 Data Structures and Algorithms I[3]	4
CS2010 Data Structures and Algorithms II	4
ST2334 Probability and Statistics[4]	4
ST3131 Regression Analysis	4
Business Analytics Verticals	**8**

Complete 8 MCs of modules in the list below:	4
BT4211 Data-Driven Marketing	4
BT4212 Search Engine Optimization and Analytics	4
BT4221 Big Data Techniques and Technologies	4
IS4241 Social Media Network Analysis	
Grand Total	**48**

[1] BT1101 can be replaced by DSC1007.

[2] CS1010S can be replaced by CS1010/E/S/X/FC/J. But students need to apply for the module substitution as advanced modules may need the taught programming language in CS1010S and it is imperative that students who take CS1010S equivalent are aware of it.

[3] CS1020 can be replaced by CS1020E.

[4] ST2334 can be replaced by ST2131 (Probability) or ST2132 (Mathematical Statistics).

Some of these modules require prerequisites from outside this list. Students must have the prerequisites to take them.

Continuation and Graduation Requirements

The Second Major in BZA is a non-Honours major programme.

The Second Major in BZA will be awarded to students who completed the 48 MCs second major requirement. Students will need to complete the primary major requirements to graduate.

For students following the grade-free first semester policy for S/U option or the enhanced grade-free scheme for S/U Policy: The S/U option is available for modules that are part of a student's second Major requirements if they fall under the criteria stated for their cohort, and as long as the student has at least a minimum 32 MCs of the Second Major requirement earned from modules read in NUS (i.e., graded modules with assigned grade points or modules with an 'S' or 'CS' grade) out of the 48 MCs to fulfill the Second Major requirements towards graduation.

As a continuation requirement, students taking the Second Major in BZA need to obtain at least a B+ grade in both CS1010S (or its equivalent) and BT1101 (or its equivalent). Should S/U option be chosen by students for either (or both) module(s), the raw performance in the module(s), i.e., based on the B+ equivalent marks, will be reviewed. Should a student fail to obtain the grade of B+ and above for both modules, he/she can apply to downgrade to taking the Minor in Business Analytics.

Double Counting Framework for Double Major Programme

For 2014 cohort and beyond, 16 MCs of the 48-MC second major can be double counted with the primary major/programme requirements.

3.3.5.4.2 Double Major in Computer Science

The School of Computing offers a Second Major in Computer Science (CS) for non-SoC students.

Objective

The objectives for a Second Major in CS are as follows:

To provide a computer science programme within NUS for non-computing students;
To contribute to the national focus on growing the pool of technical ICT specialists in Singapore;
To produce graduates who are able to understand computer science principles and practices and apply it in a multi-disciplinary context.

Student Learning Outcomes

The Second Major in CS enables students to attain, by the time of graduation:

i. Strong knowledge of computer science foundations and fundamentals, including (a) familiarity with common computer science themes and principles, (b) high-level understanding of systems as a whole, (c) understanding of the theoretical underpinnings of computer science and their influences in practice.
ii. Individual competence in applying sound principles and rigorous thinking to (a) analyse an application problem, (b) understand user's requirement, (c) formulate the problem in terms of computation requirements, (c) conceive novel solution ideas, (e) design appropriate solutions that meet the requirements, (f) implement the solution, (g) evaluate the effectiveness of the solution.
iii. Strong communication skills and ability to work with, and contribute to, a multi-disciplinary team to bring a range of technologies together to develop computer systems and solutions of multi-disciplinary nature.
iv. Ability to engage in continuous professional development.

Admission Requirements

Students who has taken CS1010/S/E and (CS1020/E or CS2030) as either part of their degree requirements or Minor in Computer Science can apply for entry into Second Major in Computer Science if they obtain B+ or above in both modules.

Structure

The Second Major in CS is structured as follows:

Computer Science Foundation = 32 MCs
Computer Systems Team Project = 8 MCs
Computer Science Electives = 8 MCs

In total, the 48 MCs requirement for graduation are broken down as follows:

Core modules = 40 MCs

Elective modules = 8 MCs

The table below shows the programme structure in details.

Modules	MCs
Computer Science Foundation	**32**
CS1010/S/E Programming Methodology [1]	4
CS1231 Discrete Structures [2]	4
CS2030 Programming Methodology II [3]	4
CS2040 Data Structures and Algorithms [3]	4
CS2100 Computer Organisation[4]	4
CS2103 Software Engineering	4
CS2106 Introduction to Operating Systems [5]	4
CS3230 Design and Analysis of Algorithms	4
Computer Systems Team Project	**8**
Complete 8 MCs of the following pairs, or modules approved by the Department of Computer Science: CS3201/2 Software Engineering Project I/II CS3281/2 Thematic Systems Project I/II CS3216 Software Product Engineering for Digital Markets and CS3217 Software Engineering on Modern Application Platform	8
Computer Science Focus Areas	**8**
Complete 8 MCs of CS coded modules with at least one module at level-3000 or above.	
Grand Total	**48**

1. CS1010/S/E Programming Methodology can be replaced by CS1101S, CS1010J, or CS1010X.
2. CS1231 can be replaced by MA1100. Students without A-level Mathematics are required to complete MA1301 Introductory Mathematics before completing CS1231.
3. CS2030 and CS2040 can be replaced by CS2020 Data Structures and Algorithms Accelerated (6 MCs). The remaining 2 MCs will be added to either the Computer Systems Team Project

requirement or the Computer Science Focus Areas requirement. CS2030 and CS2040 can be replaced by CS1020 or CS1020E Data Structures and Algorithms I (4 MCs) and CS2010 Data Structures and Algorithms II. CS20470 can be replaced by CS2040C.
4. CS2100 Computer Organisation can be replaced by EE2024 Programming for Computer Interfaces.
5. CS2106 Introduction to Operating Systems can be replaced by CG2271 Real-Time Operating Systems.

Continuation and Graduation Requirements

The Second Major in CS is a non-Honours major programme.

The Second Major in CS will be awarded to students who completed the 48 MCs Second Major requirement. Students will need to complete the primary major requirements to graduate.

Double Counting Framework for Double Major Programme

For 2014 cohort and beyond, 16 MCs of the 48 MC Second Major can be double counted with the primary major/programme requirements.

3.3.5.4.3 Double Major in Information Security

The School of Computing offers a second major in Information Security (InfoSec) for non-SoC students.

Objective

The objectives for a Second Major in InfoSec are as follows:

To provide an information security programme within NUS for non-computing students;
To contribute to the national focus on growing the pool of cyber security professionals in Singapore; and
To produce graduates who are able to understand information security issues and practices from an inter-disciplinary point of view.

Student Learning Outcomes

The Second Major in InfoSec enables students to attain, by the time of graduation:

1. Strong knowledge of computer science foundations and fundamentals, including (a) familiarity with common computer science themes and principles, (b) high-level understanding of systems as a whole, (c) understanding of the theoretical underpinnings of computer science and their influences in practice.
2. An ability to design, implement, and evaluate a computer-based system, process, components, or program to meet the security needs.
3. An ability to function effectively in teams to accomplish a common goal.
4. Recognition of the need for and an ability to engage in continuing professional development.
5. An ability to use the current techniques, skills, and tools necessary for information security practice.

Admission Requirements

For direct admission, students applying for the Second Major in InfoSec must meet the entry requirement:

For diploma holders: Diploma with at least an A2 grade in GCE O-level Elementary Mathematics or at least a B4 grade in GCE O level Additional Mathematics.
For A-Level Holders: H2 pass in Computing or Mathematics or Physics; OR a good pass in H1 Mathematics.

Existing students from cohort 2015/16 or later may apply into the Second Major in InfoSec after completing CS1020 (or its equivalent), and CS2107 with B+ or above in each of the modules.

Structure

The second major in InfoSec to be structured as follows:

Computing Foundation = 20 MCs
Information Security Foundation = 8 MCs
Capstone Project = 8 MCs

Information Security Electives = 12 MCs

In total, the 48 MCs requirement for graduation are broken down as follows:

Core modules = 36 MCs
Elective modules = 12 MCs

The table below shows the programme structure in details.

Modules	MCs
Computing Foundation	**20**
CS1010 Programming Methodology or its equivalent	4
CS2040/C Data Structures and Algorithms	4
CS2100 Computer Organisation[1]	4
CS2105 Introduction to Computer Networks[2]	4
CS2106 Introduction to Operating Systems[3]	4
Information Security Requirements	**16**
CS2107 Introduction to Information Security	4
CS3235 Computer Security	4
CS3205 Information Security Capstone Project	8
Information Security Electives	**12**

Complete 12 MCs of modules from one of the following group, with at least 4 MCs at level-3000 or above. **Group I: Data and Software Security** CS2102 Database Systems CS2113 Software Engineering & Object-oriented Programming CS4239 Software Security **Group II: Foundation of Information Security** CS1231 Discrete Structures[4] CS4236 Cryptography Theory and Practice[5] **Group III: Information Systems and Security Management** IS1103/X IS Innovations in Organisations and Society IS3103 Information Systems Leadership and Communication Applications IS4231 Information Security Management	
Grand Total	**48**

1. EE2024 *Programming for Computer Interfaces* can be used in place of CS2100 *Computer Organisation.*
2. EE3204/E *Computer Communication Networks I* can be used in place of CS2105.
3. CG2271 *Real-Time Operating Systems* can be used in place of CS2106.
4. MA1100 can be used in place of CS1231. Students without A-level mathematics are required to complete MA1301 *Introductory Mathematics* before completing CS1231.
5. MA42641 Coding and Crytography can be used in place of CS4236

Continuation and Graduation Requirements

The Second Major in InfoSec is a non-Honours major programme.

Students must complete CS2040/CS2040C, and CS2107 with a grade of at least B+ or above in each of the modules to continue the Second Major in InfoSec programme.

The Second Major in InfoSec will be awarded to students who completed the 48 MCs second major requirement. Students will need to complete the primary major requirements to graduate. Students who did not complete the Second Major in InfoSec requirement but completed the Minor in InfoSec requirement will be awarded the Minor in InfoSec.

Double Counting Framework for Double Major Programme

For 2014 cohort and beyond, 16 MCs of the 48-MC second major can be double counted with the primary major/programme requirements.

3.3.6 Minor Pogrammes

A Minor programme is a coherent course of study. It provides significant depth, but unlike a specialisation, it does so in an additional area outside of the Major. By doing this, it contributes to the breadth of learning envisaged for undergraduate education.

The modular credit (MC) requirement for a Minor programme should be at least 24 MCs. Up to 8 MCs (out of 24 MCs) may be used to meet the requirements for both the Minor and a Major or another Minor, subject to the agreement of the particular department(s), faculty/faculties or programme(s) hosting the Minor.

At least 12 MCs (out of 24 MCs) for any Minor programme must be taken from outside the entire set of modules that are listed for the major(s)/another minor that the student is taking/has taken.

The MCs under Unrestricted Elective module requirements can be used to satisfy the Minor programme requirements.

For students matriculated in AY2014-15 and after: A minimum 16 MCs of the Minor requirements must be earned from modules read in NUS, unless indicated otherwise by Faculties/Departments for specific minors. Modules read at NUS include all modules taught, co-taught, supervised or co-supervised by one or more NUS faculty members. These would consist of graded modules with assigned grade points, or modules with an 'S' or 'CS' grade. The other 8 MCs may be earned through credit transfers, advanced placement and exemptions, provided these MCs are earned from modules deemed relevant to the particular Minor programme.

The Minor programme(s) will be reflected in the student's transcript. Computing students are free to read any minor, subject to availability. Examples include Mathematics, Optical and Semiconductor Technology, and Technopreneurship minors.

The Minor programme(s) will be reflected in the student's transcript.

The following three minors are offered to students outside the School of Computing:
* Business Analytics
* Computer Science
* Information Security
* Information Systems

3.3.6.1 [Minor in Business Analytics](#)

3.3.6.2 [Minor in Computer Science](#)

3.3.6.3 [Minor in Information Security](#)

3.3.6.4 [Minor in Information Systems](#)

3.3.6.1 Minor in Business Analytics

Objectives

The objectives of the Minor in Business Analytics (BZA) are:

- To provide a business analytics minor programme within NUS for non-computing students;
- To produce graduates who are able to understand business analytics principles and practices and apply it in a multi-disciplinary context.

Student Learning Outcomes

The Minor in Business Analytics enables students to attain, by the time of graduation:

- Strong foundational knowledge of business analytics principles, including (a) familiarity with common business analytics methodologies and principles, (b) high-level understanding of data-driven analytics as a whole, (c) understanding of the theoretical underpinnings of business analytics and their influences in practice.
- An ability to function effectively in teams to accomplish a common goal.
- Recognition of the need for and an ability to engage in continuing professional development.

Eligibility

The Minor in Business Analytics programme offers direct admission. Students applying for the Minor in Business Analytics must meet the entry requirement:

- For diploma holders: Diploma with at least an A2 in GCE 'O' level Elementary Mathematics or at least a B4 grade in GCE 'O' level Additional Mathematics.
- For A-Level Holders: At least a H2 pass in Mathematics.

Students from cohort 2016/17 or later who have taken CS1010S (or its equivalent) and BT1101 (or its equivalent) as part of their degree requirements can apply for entry into Minor in Business Analytics starting Semester 1, AY2017-18.

The Minor in Business Analytics programme is not available to students in the following degree programmes offered (or jointly) by the School of Computing:

- BComp (Information Security)
- BComp (Computer Science)
- BComp (Computational Biology)
- BEng (Computer Engineering)
- BComp (Information Systems)
- BSc (Business Analytics)
- BSc (Data Science and Analytics)

Continuation and graduation requirements

The Minor in Business Analytics will be awarded to students who satisfied the 24 MCs minor requirement.

For students following the enhanced grade-free scheme for S/U option: The S/U option is available for modules that are part of a student's Minor requirements if they fall under the criteria stated for their cohort, and as long as the student has at least a minimum 16 MCs of the Minor requirement earned from modules read in NUS (i.e., graded modules with assigned grade points or modules with an 'S' or 'CS' grade) out of the 24 MCs to fulfill the Minor requirements towards graduation.

Students will need to complete the primary major requirements to graduate.

Structure

The Minor in Business Analytics to be structured as follows:

- Core modules = 16 MCs
- Elective modules = 8 MCs

The table below shows the programme structure in details.

Modules	MCs
Core Modules	**16**
BT1101 Introduction to Business Analytics[1]	4
BT2101 Decision Making Methods and Tools	4
BT2102 Data Management and Visualisation	4
CS1010S Programming Methodology[2]	4
Elective Modules	**8**
Complete 8MCs of modules in the list below: BT4211 Data-Driven Marketing BT4212 Search Engine Optimization and Analytics BT4221 Big Data Techniques and Technologies IS4241 Social Media Network Analysis	4 4 4 4

Grand Total	24

[1] BT1101 can be replaced by DSC1007.

[2] CS1010S can be replaced by CS1010/E/S/X/FC/J. But students need to apply for the module substitution as advanced modules may need the taught programming language in CS1010S and it is imperative that students who take CS1010S equivalent are aware of it.

Some of these modules require prerequisites from outside this list. Students must have the prerequisites to take them.

A minimum 16 MCs of the Minor requirements must be earned from modules read in NUS. The other 8 MCs may be earned through credit transfers, advanced placement and exemptions, provided these MCs are earned from modules deemed relevant to the particular Minor programme.

3.3.6.2 Minor in Computer Science

Objective

This minor will provide students from non-computing disciplines a competent level of programming skill, as well as basic knowledge in the fundamental fields of computing.

Structure

To be awarded a minor in Computer Science, students must pass six modules from the three categories below, with a total of at least 24 MCs.

Category I:
Complete the following module:

CODE	TITLE	MCS
CS1010	Programming Methodology	4

Students may take the equivalents to CS1010. For examples, CS1010E, CS1010J, CS1010S, CS1010X, and CS1101S

Category II:
Complete four modules from the following list:

CODE	TITLE	MCS
CS2030	Programming Methodology II	4
CS2040	Data Structures and Algorithms *	4
CS2100	Computer Organisation	4
CS2102	Database Systems	4
CS2103	Software Engineering ^	4
CS2104	Programming Language Concepts	4
CS2105	Introduction to Computer Networks	4
CS2106	Introduction to Operating Systems	4

CODE	TITLE	MCS
CS2107	Introduction to Information Security	4
CS2108	Introduction to Media Computing	4

* : Students may take CS2040C Data Structures and Algorithms in place of CS2040.

^: Students may take CS2113 Software Engineering & Object-oriented Programming in place of CS2103.

Category III:

Satisfy the total MCs requirement (of 24) by taking one CS module with the following module codes: CS321x, CS322x, CS323x, CS324x

Students may read advanced modules upon approval from the Department of Computer Science, in place of modules listed in the programme B.Eng. (Computer Engineering). Students from the Faculty of Engineering and Computational Science from the Faculty of Science are precluded from reading this minor.

3.3.6.3 Minor in Information Security

The objectives of the Minor in Information Security (InfoSec) are:

• to provide an introduction to information security within NUS for non-computing students;

• to prepare non-computing students to pursue deeper knowledge in information security; and

• to contribute to the national focus on growing the pool of cyber security professionals in Singapore.

The aim of this minor is to provide students basic understanding on cyber security issues and to prepare the students for further education in cyber security, with the ultimate goal of training cyber security manpower for Singapore.

Student Learning Outcomes

The Minor in InfoSec enables students to attain, by the time of graduation:

• Knowledge of IT systems, including (a) familiarity with common themes and principles in computer systems, and (b) high-level understanding of systems as a whole,

• Recognition of the information security needs of a computer-based system, process, components, or program.

• Recognition of the need for and an ability to engage in continuing professional development

Eligibility

Direct admission is available to students in the following degree programmes:

• B. Sc. (Statistics)
• B. Sc. (Business Analytics)
• B. Sc. (Applied Math)
• B. Sc. (Quantitative Finance)
• B. Sc. (Computational Biology)
• B. Eng. (Biomedical Engineering)
• B. Eng. (Electrical Engineering)
• B. Eng. (Industrial & Systems Engineering)
• B. Eng. (Materials Science and Engineering)
• B. Eng. (Mechanical Engineering)

Students applying for the Minor in InfoSec under direct admission must meet the entry requirement:

• For diploma holders: Diploma with at least an A2 grade in GCE O-level Elementary Mathematics or at least a B4 grade in GCE O-level Additional Mathematics.

• For A-Level Holders: H2 pass in Computing or Mathematics or Physics; or a good pass in H1 Mathematics.

In-Progress admissions: Current students from cohort 2015/16 or later who are not in these degree programmes can apply to enter in the Minor in InfoSec programme after completing CS1010 or its equivalents (CS1010E, CS1010J, CS1010S, CS1010X, CS1010FC, CS1101S).

The Minor in InfoSec programme is not available to students in the following degree programmes offered by the School of Computing:

• B. Comp. (Information Security)
• B. Comp. (Computer Science)
• B. Comp. (Computational Biology)
• B. Eng. (Computer Engineering)
• B. Comp. (Information Systems)

Continuation and graduation requirements

Students need to obtain B+ or above in CS2107 or its equivalent to continue in the programme. The Minor in InfoSec will be awarded to students who completed the 24 MCs minor requirement. Students will need to complete the major requirement to graduate.

Structure

Students need to complete CS1010 or its equivalents (CS1010E, CS1010J, CS1010S, CS1010X, CS1010FC, CS1101S) before enrolling into this minor .To complete the minor, students must complete 24 MCs with the following modules:

CODE	TITLE	MCS
CS2040/CS2040C	Data Structures and Algorithms [1]	4
CS2107	Introduction to Information Security	4

Complete 16 MCs from the following list, with at least 4 MCs at level-3000 or above:

CODE	TITLE	MCS
IS1103/X	IS Innovations in Organisations and Society	4
CS2100	Computer Organisation[2]	4
CS2105	Introduction to Computer Networks[3]	4
CS2106	Introduction to Operating Systems[4]	4
CS3235	Computer Security	4
IS3103	Information Systems Leadership and Communication	4
IS4231	Information Security Management	4

A minimum 16 MCs of the Minor requirements must be earned from modules read in NUS. The other 8 MCs may be earned through credit transfers, advanced placement and exemptions, provided these MCs are earned from modules deemed relevant to the particular Minor programme.

Footnotes:

[1] Existing students from earlier cohorts who have completed CS2020 Data Structures and Algorithms Accelerated may replace (CS1020/E or CS2040/C) with CS2020.

[2] Students who are precluded from taking CS2100 may take EE2024 Programming for Computer Interfaces in lieu of CS2100.

[3] Students who are precluded from taking CS2105 may take EE3204/E Computer Communication Networks I in lieu of CS2105.

[4] Students who are precluded from taking CS2106 may take CG2271 Real-Time Operating Systems in lieu of CS2106.

3.3.6.4 Minor in Information Systems

Objective

Information Technology (IT) has become a key component of organisations today. Its impact is felt from the way organisations are structured all the way to the design, development, manufacture and marketing of products. It enables organisational and operational processes. It is also embedded in products and services. It is vital that this key resource is efficiently managed.

The aim of this minor is to introduce students to the key concepts involved in the management of IT. The target audience for this minor consists of both users of technology as well as providers of technology. The course should benefit would-be managers, engineers and entrepreneurs.

Structure

To be awarded a minor in Information Systems, a student must pass a total of six modules, with a total of at least 24 MCs. The student must pass these three modules:

Set A

CODE	TITLE	MCS
IT1001	Introduction to Computing	4
CS1010/E/J/S/X	Programming Methodology	4
IS1103/X	IS Innovations in Organisations and Society	4

or

Set B

CODE	TITLE	MCS
CS1010/E/S/X	Programming Methodology	4
CS1020/E	Data Structures and Algorithms I	4
IS1103/X	IS Innovations in Organisations and Society	4

and any three modules from the following list

CODE	TITLE	MCS
IS3103	Information Systems Leadership and Communication	4
IS3221	Enterprise Resource Planning Systems	4
IS3240	Economics of E-Business	4
IS3251	Principles of Technopreneurship	4
IS4204	IT Governance	4
IS4261	Designing IT-enabled Business Innovations	4

Note:

Some of these modules require prerequisites from outside this list. Students must have the prerequisites to take them.

3.4 Enrichment Programmes

3.4.1 [Advanced Technology Attachment Programme](#)

3.4.2 [Industry Internship Programme](#)

3.4.3 [Student Internship Programme](#)

3.4.4 [Undergraduate Research Opportunity Programme](#)

3.4.5 [University Scholars Programme](#)

3.4.6 [NUS Overseas Colleges Programme](#)

3.4.7 [Student Exchange Programme](#)

3.4.8 [Incubation Project](#)

3.4.1 Advanced Technology Attachment Programme

The Advanced Technology Attachment Programme (ATAP) is a premium industrial attachment programme placing the better among our students in reputable and established organisations for the benefit of both. The objective of the six-month attachment programme is to enable students to apply their computing knowledge in computing-related projects through attachments at organisations.

ATAP aims to broaden students' education by enabling them to appreciate the application of computing knowledge to industry-related projects. Students' progress on projects will be monitored during attachment, and their performance will be assessed at the end of the attachment, based on the interim and final project reports. Students will be given 12 MCs with Completed Satisfactory (CS) grade upon successful completion of the programme.

For more details, please refer to: http://www.comp.nus.edu.sg/programmes/ug/beyond/atap/student/.

3.4.2 Industry Internship Programme

The Industry Internship Programme (IIP) enables students to apply the computing knowledge and skills that they have acquired in class to industry internships in companies/organizations. Students, work in pairs, in industry internships will be jointly guided by supervisors from both the companies/organizations and the school. Their progress on internship projects will be monitored during internship period, and their performance will be assessed through letter grades at the end of the internship. The internship duration will be 6 months, consisting of both a full-time and part-time component. Full-time internship attachment will last for 3 months during the NUS vacation period, and will continue on a part-time basis that will last for 3 months during the NUS study semester. Students will be given 12 MCs upon successful completion of the programme.

More details can be found at: http://www.comp.nus.edu.sg/programmes/ug/beyond/iip/

3.4.3 Student Internship Programme

This internship programme is similar to ATAP in objective and quality, but unfolds in three rather than six months. It places students in established organisations, both local and overseas, so that they may work on industry related projects from government agencies and multinationals in sectors ranging from financial services to interactive digital media and bioinformatics research during their special terms which span from May to July annually. Students will receive 6 credits with Completed Satisfactory (CS) grade under CP3200 on successful completion of the internship.

More details can be found at: http://www.comp.nus.edu.sg/programmes/ug/beyond/sip/

3.4.4 Undergraduate Research Opportunity Programme

The School of Computing offers the Undergraduate Research Opportunity Programme (UROP) in Computing to provide opportunities for research in computing by talented undergraduate students.

The aim of this programme is to foster intellectual exchange and collaboration between undergraduates and academic staff members. It allows undergraduates to participate in active research at the School of Computing, and to experience first-hand the challenges and exhilaration of research, discovery and invention. Students will be working at the frontiers of computing research and this exposure will complement their coursework.

Students will conduct research under the supervision of faculty members of the School of Computing. Typically, the research involves the following activities: problem formulation, literature survey, attending research seminars, proposal and implementation of solution, evaluation, and documentation and presentation of results. The relative importance of each of the above research activities can vary widely, depending on the chosen research topic (ranging from basic research to applied research to innovative application development).

Two modules are offered under the UROP (Computing) programme:

CODE	TITLE	MCS	PREREQUISITES
CP3208	Undergraduate Research in Computing I	4	Pass 60 MCs and with approval from respective department.
CP3209	Undergraduate Research in Computing II	4	CP3208

A student participating in UROP (Computing) takes a two module (8 MCs) sequence spread over two semesters – CP3208 in the first semester, followed by CP3209 in the second semester. Even though each UROP (Computing) module is a one semester module, it is understood that this will also include compulsory full-time research work during the vacation preceding the semester.

It is expected that the student will complete an initial research study on the project in CP3208 (vacation and first semester) and complete the research project in CP3209 (the following vacation and second semester).

Eligibility and Workload

To be eligible for UROP (Computing), a student must have
1. Completed the prerequisites of CP3208, and
2. A minimum CAP of 3.80 (out of 5).

A student who applies for UROP (Computing) is committed to take the two module (8 MCs) sequence of CP3208 and CP3209. CP3208 and CP3209 must be completed before (and not concurrently with) CP4101 (B. Comp. Dissertation). Therefore, a student should plan to finish the CP3208-CP3209 sequence before starting CP4101.

A student can take only one UROP (Computing) module per semester. CP3208 or CP3209 will contribute 4 MCs each to the semester workload.

Administration

The programme is administered by the Office of Special Programmes in the School of Computing. Application for UROP (Computing) is open for either semester. Eligible students can get the application forms from the Office of Special Programmes. More details can be found at:
http://www.comp.nus.edu.sg/programmes/ug/project/urop/

3.4.5 University Scholars Programme

The University Scholars Programme (USP) is a bold initiative to develop the personal, intellectual and leadership abilities of promising men and women enrolled at the National University of Singapore. It aims to foster active learners who can:

- Think and write critically, clearly and effectively;
- Synergise existing ideas, and create new ones;
- Make path-breaking connections within a discipline and among diverse disciplines; and
- Reflect deeply on themselves and their place in society.

The School of Computing is one of the participating faculties in the University Scholars Programme. Computing students who are admitted to the USP are called University Scholars. They can choose to read any one of these four-year honours programmes in the School:
- Bachelor of Computing in Computer Science;
- Bachelor of Computing in Information Security;
- Bachelor of Computing in Information Systems;
- Bachelor of Engineering in Computer Engineering; and
- Bachelor of Science in Business Analytics.

Scholars will also have the unique privilege of declaring his or her final choice of faculty after three to four semesters (provided the criteria are met).

For details on the general University Scholars Programme requirements, please see the Scholars Programme website at: http://usp.nus.edu.sg

Specific requirements for Computing degrees

Students in the University Scholars Programme (USP) who opt for the School of Computing can choose any of the four-year programmes from the School. For each of these programmes, USP students will have to meet the same degree requirements as other SoC students but with the following variations:

All USP students will be taking the following under the Scholars Programme:

The three-tier structure will be as follows:

1. Foundations: 3 modules at 12 MCs

Three modules, all compulsory, are:
- Writing and Critical Thinking
- Quantitative Reasoning Foundation
- University Scholars Seminar

The modules will be offered at level-2000.

2. Inquiry**:** 8 modules at 32 MCs

Eight modules are divided equally between Humanities and Social Sciences and Sciences and Technologies baskets. Every USP student will take four modules from each basket. Students take at least one and up to three ISMs in place of regular inquiry modules. Each ISM will be counted as equivalent to one inquiry module in the appropriate basket. Modules will be offered at both levels 2000 and 3000, and will include current first-tier modules, and some current USP-based advanced modules.

3. Reflection: 1 module at 4 MCs

A single module, the Senior Seminar, designed to bring students together towards the end of their degree in order to reflect on disciplinary knowledge.

Module Substitutions
Students taking single degrees will be able to substitute a maximum of four inquiry modules. SEP students will be able to substitute two inquiry modules per semester of overseas study.

Please refer to the USP website at: http://usp.nus.edu.sg for more details.

3.4.6 NUS Overseas Colleges Programme

The NUS Overseas Colleges programme is an internship programme with strong emphasis on technology entrepreneurship. The focus is on internship in a high- technology start-up located in an entrepreneurial and academic hub. Selected candidates will spend 12 months with a high-technology start-up and be required to take entrepreneurship courses at a designated partner university.

NUS students who participate in any 12-month NOC programme can obtain up to 48 MCs maximum. The composition will be:

- 12 MCs (maximum) for entrepreneurship courses;
- 8 MCs for discipline based courses; and
- 28 MCs for internship work, which could be considered for suitable mappings towards programme requirements by the student's home faculty.

For more information on this programme, please refer to: http://www.nus.edu.sg/noc/

3.4.7 Student Exchange Programme

The NUS Student Exchange Programme (SEP) provides students with the opportunity to study in an overseas partner university, usually for a semester or two, with approval of the School, to further enhance their learning experience. Students from either partner university pay fees only at their home institution while on exchange. The new experience provided by SEP is a once-in-a-lifetime opportunity that will enrich the life of the student forever.

Some of the partner universities include Uppsala University, McMaster University, University of Texas Austin, University of British Columbia, McGill University, University of California, University of Melbourne, Carnegie Mellon University and University of Illinois, Urbana Champaign.

Please visit:
http://www.comp.nus.edu.sg/programmes/ug/beyond/sep/ for details.

3.4.8 Incubation Project

Students who wish to experience the entrepreneurship spirit that permeates the School are welcome to bring their idea, put it into a business plan, and bring it into fruition. The School Incubation Centre provides support to students for their ideas to be germinated into a money-making business. Students could also earn credits towards their degree requirement through registering for CP3109 Incubation Project module. In this module, students will submit their reports to the Incubation Centre Review Committee. The committee will assess students' ability in managing and operating their companies.

Besides the various technopreneurship modules offered by NUS, the School also offers a module on digital entrepreneurship that cover trends in the digital marketplace and emerging high-growth opportunities for digital businesses. The module will highlight issues facing companies with new products and services in an ever-changing digital marketplace. It also focuses on opportunity identification and sources of competitive differentiation, particularly as they relate to digital innovation.

3.5 Financial Assistance and Awards

3.5.1 [Faculty-administered Scholarships](#)

3.5.2 [Faculty-administered Awards/Funds](#)

3.5.3 [Faculty-administered Prizes](#)

3.5.1 Faculty-administered Scholarships

The School administers the following scholarships:
- Computing Scholarship
- Kwan Im Thong Hood Cho Computing Scholarship
- Lim Hong Chin Memorial Scholarship

Details can be found at: http://www.comp.nus.edu.sg

3.5.2 Faculty-administered Awards/Funds

The School administers the following three Awards/Funds:

1. **Computing Alumni Assistance Award**

   The Award will subsidise undergraduates special educational expenses and/or other financial requirements of self-contained educational programmes as determined by the Selection Panel for a one-off assistance up to a maximum value of THREE THOUSAND dollars (S$3,000.00) per award.

   More details can be found at: http://www.comp.nus.edu.sg/programmes/ug/scholarships/caa/

2. **Computing Bursary**

   The Bursary, established from the School's pooled endowed fund, will serve as additional top-up to needy SoC students to cover their tuition fees. Needy students should apply to the Office of Financial Aid before they can be considered for this bursary. The School will provide appropriate amount to students per academic year subject to the availability of funds and student's per capital income (PCI).

3. **Computing Student Development Fund**

   The Fund will subsidise students' overseas study trips and certification course such as those by SAP, IBM, Oracle and Sun and to send graduate students to participate in top academic conferences as determined by the Selection Panel for a one-off assistance up to a maximum value of ONE THOUSAND AND FIVE HUNDRED dollars (S$1,500.00) per student per academic year.

   More details can be found at: http://www.comp.nus.edu.sg/programmes/ug/scholarships/csdf/

3.5.3 Faculty-administered Prizes

Medals and book prizes are awarded to top students at the various stages of study, in recognition of their outstanding academic performance, in addition to the Dean's List. The following are faculty-administered prizes for undergraduates:

BOOK PRIZES	BASIS
Microsoft Prize	Best undergraduate student throughout the course of study in either Computing or Computer Engineering course
Tata Consultancy Services Asia Pacific Prizes	Best second- and third-year students throughout the course of study in either Computing or Computer Engineering course

4 Graduate Education

The Graduate Studies' Office offers comprehensive postgraduate programmes through advanced and in-depth course curriculum, which develops and enhances the candidate's knowledge, and prepares them to address the complex IT issues at their workplaces.

4.1 [Research Programmes](#)

4.2 [Coursework Programme](#)

4.1 Research Programmes

The School welcomes graduates with good academic potential and strong interest in research to be a part of the Graduate Programme. A premier research-based programme leading to a doctoral degree, it is available in both the Department of Computer Science and Department of Information Systems and Analytics.

4.1.1 [Degrees Offered](#)

4.1.2 [Degree Requirements](#)

4.1.3 [Financial Assistance and Awards](#)

4.1.1 Degrees Offered

The School of Computing offers the following research degree programmes:

- Doctor of Philosophy (Ph.D.)
- Master of Science (M.Sc.), if the candidate fails the Qualifying Examination but is allowed to complete as a M.Sc. candidate

4.1.2 Degree Requirements

PhD students admitted to the Department of Computer Science (CS) will follow the structure for the CS PhD programme:

STRUCTURE OF PROGRAMME (COMPUTER SCIENCE)		
Year 1	Semester 1	2 graduate modules + CS6101 (Exploration of CS Research)
	Semester 2	2 graduate modules + Research
Year 2	Semester 1	2 graduate modules + QE
	Semester 2	Research
Year 3	Semester 1	Research + Thesis Proposal + Doctoral Seminar
	Semester 2	Research
Year 4	Semester 1	Research
	Semester 2	Ph.D. Defence (Seminar Presentation + Oral Defence)

CS Ph.D. candidates who are required to complete six graduate modules (24 modular credits) will need to take at least one module each in any three of the five clusters – Algorithm and Theory, Computer Systems, Knowledge Systems, Media Technologies or Programming Language and Software Engineering. Out of the six graduate modules, at least three (12 modular credits) must be at level 6000, and at least another two modules must be at level 5000 (or above). Only a maximum of one level 4000 module is allowed. CS PhD students may take at most two graduate level modules offered by other departments. Students should complete all coursework requirements by the end of third semester.

Ph.D. students admitted to the Department of Information Systems and Analytics (IS) will follow the structure for the IS Ph.D. programme:

STRUCTURE OF PROGRAMME (INFORMATION SYSTEMS)		
Year 1	Semester 1	3 Core Modules
	Semester 2	3 Core Modules + Research + Teaching
Year 2	Semester 1	PhD QE Module (PhD QE I) + 2 Modules + Research + Teaching
	Semester 2	2 Modules + Research + Graduate Research Paper (PhD QE II) + Teaching

STRUCTURE OF PROGRAMME (INFORMATION SYSTEMS)		
Year 3	Semester 1	Research + Teaching
	Semester 2	Research + Thesis Proposal + Teaching
Year 4	Semester 1	Research
	Semester 2	Pre-submission Presentation (before thesis submission) PhD Defense (Seminar Presentation + Oral Defense)

All IS Ph.D. candidates are required to complete six common core modules, spanning the different streams of IS research. This is compulsory for all students to increase their breadth of knowledge. These modules will cover the research methods, theories, and seminar on recent topics in all three IS research tracks: behavioral, technical, and economics.

Upon completion of the common core modules, IS Ph.D students would be directed to a more structured set of modules in one of the three different tracks that they can choose from. Based on their choice of track, they will select four elective modules that ensure breadth and depth of knowledge in their area.

All Ph.D. candidates are required to achieve a minimum CAP of 3.5 (B grade) for the modules taken.

All PhD candidates must pass their Qualifying Examination I (QE I) within 18 months after admission. A maximum of two attempts will be allowed.

The Ph.D. Qualifying Examination for IS Ph.D. students consists of the Ph.D. QE I (PhD QE module IS6000) and Ph.D. QE II (Graduate Research Paper (GRP)). The IS Qualifying Examination I (QE I) which will test the integration of concepts from the common core modules that all students would have taken. Students are to work on the Graduate Research Paper (GRP) after selecting a faculty member as the PhD supervisor, and to participate in lab activities with the view of producing a quality research/survey paper by the third semester. The GRP presentation will be evaluated by a panel not later than the end of the second year of study.

Ph.D. students taking the CS QE are evaluated based on a research-based paper which should contain critical review of research papers and demonstrates problem-solving abilities of the student, both assigned by the student's supervisor. The QE paper will be assigned according to one of the six research clusters for evaluation (Algorithms and Theory, Artificial Intelligence, Computer Systems, Database and Data Mining, Media or Programming Languages and Software Engineering). Students will be required to give a presentation to the panel.

All students' Thesis Advisory Committee (TAC) will be set up after passing the QE, and the student should present his/her research to the TAC. This is to ensure that the TAC is in touch with the student's research

progress.

By end of Year 3, candidates are expected to complete their thesis proposal. The thesis proposal should highlight the significance of the research topic, its goal, the approach adopted, and work to be done. It should be precise and convincing to the examiners that the candidate is proposing a novel area of research and the goal is achievable. The thesis proposal comprises of an open seminar presentation (doctoral seminar), followed by a close-door oral examination.

Duration of Programme

The following maximum candidature periods are inclusive of periods of approved study leave:
- Masters: 36 months
- Ph.D.: 60 months

4.1.3 Financial Assistance and Awards

President's Graduate Fellowship (PGF)

The PGF is awarded to candidates who show exceptional promise or accomplishment in research. A small number of PhD research candidates are selected each semester by the University for the Fellowship. Selected candidates will receive a monthly allowance of S$3,500 (for Singapore citizens) and S$3,000 (international students). The award is tenable for an initial one year and, subject to an annual review of the scholar's research progress, it can be renewable up to a maximum of 4 years.

NUS Research Scholarship

Financial Assistance in the form of the NUS Research Scholarship is available, on a competitive basis to all full-time students who meet the criteria. The Research Scholarship will carry monthly emoluments, plus full tuition fee subsidy. Candidates with good undergraduate degrees in computer science or information systems are invited to apply for research scholarships. These are for pursuing full-time Ph.D. programme in the School. They are tenable for one year in the first instance and renewable annually for up to four years for Ph.D. candidates, subject to satisfactory performance. Research scholars who passed their Ph.D. Qualifying Examination will be awarded an additional top up of S$500 per month (for two years) during their Ph.D. candidature.

SAP Industry PhD Scholar Programme

SAP Asia, in partnership with the National Research Foundation and NUS, is offering the SAP PhD Scholar Programme to outstanding individuals who are keen to pursue a higher academic calling, while working at the forefront of technology in a world leading company.

All candidates must meet the admission requirements of the University's PhD programme and go through all necessary academic milestones.

Teaching or Research Assistantships

Research scholars who have fulfilled their Graduate Assistantship Programme requirements may apply for teaching assistantships with the Departments. Such assistantships will require them to assist in departmental work such as conducting tutorials/laboratory demonstrations, preparation of teaching materials, invigilating at examinations etc.

Full-time graduate students may also apply for part-time research assistantships to assist the Principal Investigators (PI) with specific research duties.

All appointments are subject to the terms and conditions stipulated under such appointments.

International students are also required to abide by the Immigration & Checkpoints Authority (ICA) guidelines.

Graduate Awards

The following graduate awards are given to encourage and recognise continuous and sustained research excellence in graduate research students:

1. **Research Achievement Award**

   This award will be given to outstanding Ph.D. students each academic year, encouraging students to strive towards continuous research achievement during their Ph.D. candidature.

   Award Criteria:
   The recipients of this award will each receive a certificate and $250 cash prize.

   1. Be either a full-time or part-time Ph.D. student throughout the whole semester at the time of award presentation.
   2. Achieved outstanding performance (over a one-year period) in terms of:
      1. Publications in Rank-1 journals/conferences
      2. Registration for patent
      3. Significant system development of either commercial interest or wide usage by organisations not related to the development work
   3. In all cases, the student must be a significant contributor/primary author of the achievement.
   4. Awards will be given out twice a year.

The recipients of this award will each receive a certificate and $250 cash prize.

2. **Dean's Graduate Research Excellence Award**

The Dean's Graduate Award is a prestigious award to be given to senior Ph.D. students who have made significant research achievements during their Ph.D. study, and the award criteria are:

- Deserving recipients to be given this award once throughout their candidature;
- Nomination to be made by supervisors;
- Award only given once per academic year;

Winners will each receive a certificate and $1,000 cash prize.

The judging criteria for Dean's Graduate Awards will be the same as the Research Achievement Award. In addition, nominees must produce strong evidence of sustained research achievements during their course of study.

Students who have been awarded one of the awards will not be able to receive the other simultaneously.

4.2 Coursework Programmes

4.2.1 [Master of Computing](#)

4.2.2 [Master of Science in Business Analytics](#)

4.2.1 Master of Computing

The Master of Computing programme (M.Comp.) offered by the School of Computing, is a comprehensive and challenging graduate programme with area specialisations. It encompasses latest research findings, both applied and fundamental. The programme also provides advanced and in-depth knowledge of IT to prepare the students for challenges in IT career.

Structure of Programme

Candidates admitted to the MComp programme, can apply to one of the following specialisations offered in the School:

- Computer Science; or
- Infocomm Security; or
- Information Systems

Computer Science (CS) and Information Systems (IS) Specialisations

Students are required to pass ten modules, with at least five modules selected from their specialisation (total of 40 modular credits). The remaining five non-specialisation modules can be chosen from level 4000 to 6000 modules offered by the School of Computing. Students are allowed a maximum of two level 4000 modules and two modules (must be at least level 5000) from other faculties.

Dissertation Option

Students in CS or IS specialisations will be allowed the flexibility of taking the dissertation option which is equivalent to four graduate level modules (16 modular credits). Students will need to complete six graduate level modules (24 modular credits), with at least three modules from the area of specialisation. Out of the six modules, students are allowed at most two level 4000 modules.

The dissertation option gives individual students the opportunity for independent study and research in the area of their selected specialisation. This will be carried out under the supervision of an academic staff, and the selection of the topic/area will be done in consultation with the supervisor in the area of expertise.

Infocomm Security (InfoSec) Specialisation

Students enrolled to the Infocomm Security specialisation from August 2015 intake onwards will complete the MComp programme by selecting one of the following structures:

Option 1

InfoSec specialisation students under this option are to complete six graduate level modules (24 modular credits), with at least three modules from the InfoSec specialisation. A maximum of two level 4000 module is allowed.

In addition, they will need to complete a project which culminates with a dissertation (16 modular credits).

Option 2

Students will need to complete eight graduate level modules (32 modular credits), with at least four modules from the InfoSec specialisation. A maximum of two level 4000 modules is allowed.

Students will also complete a one-semester long project (8 modular credits). Students can undertake an external company/agency-proposed InfoSec projects with a SoC faculty member's involvement, or a project proposed solely by an SoC faculty member.

Students are allowed a maximum of two modules (at least level 5000 and above) from other faculties.

The details of the pool of modules available are listed in Annex A in our website: https://www.comp.nus.edu.sg/programmes/#graduates

Duration of Programme

Part-time and full-time candidates taking M.Comp. programme must complete the coursework requirements within the period as shown:

	PART-TIME	FULL-TIME
Maximum Candidature	3 years	3 years

The maximum and minimum workload for part-time candidates are 12 and 4 modular credits respectively, while the maximum and minimum workload for full-time candidates are 20 and 12 modular credits respectively.

Graduation Requirements

Candidates must achieve a final CAP of 3.0 (average grade of B-) to graduate, otherwise their candidature will be terminated.

Financial Assistance and Awards

Loans

All students who are enrolled in full-time coursework programme can request for loans up to 90 percent of their fees. For more information, please refer to: http://www.nus.edu.sg/registrar/edu/gd-fees.html

Awards

In recognition of the excellent performance of the graduate coursework students, the Microsoft Prize will be awarded to the Master of Computing student with the best cumulative average point (CAP) throughout the course of study.

4.2.2 Master of Science in Business Analytics

Please refer to Section S of Part II of this bulletin for details.