Faculty of Engineering

1 Faculty's Commitment

The largest faculty in the University with over 6000 undergraduates and about 3000 graduate students, the Faculty of Engineering sees itself as "a leading engineering school that innovates for a better future", which seeks to "nurture Engineer-Leaders and to address global challenges through research, innovation, inspiration, and influence".

The Faculty of Engineering has been consistently ranked amongst the top universities in Engineering and Technology by the Times Higher Education Supplement in the UK since 2004. The latest London-based Quacquarelli Symonds Ltd (QS) has placed NUS Engineering as amongst the world's top 10. By technical subject, QS has also ranked NUS Civil Engineering 7th best in the world whilst NUS Chemical, Electrical, and Mechanical Engineering were ranked 10th. Our mission is to nurture engineer leaders by providing an education that brings out the full potential and talents of students and equipping them with the knowledge and skills to deliver innovative solutions to complex multidisciplinary problems to bring about a better world through innovation and technology.

The Faculty of Engineering provides a number of flexible and innovative alternative learning pathways. The newest of these are the Design-Centric Programme (DCP) and the Global Engineering Programme (GEP). DCP places a strong emphasis on cross-disciplinary and problem based learning whilst GEP provides an enhanced global learning experience, culminating in the opportunity to undertake graduate studies at the NUS Faculty of Engineering or a top overseas university in the fourth year of study. Through the Faculty of Engineering's Enhancement Programmes, students can choose from a variety of different credit bearing programmes including industrial attachments (local & overseas), short-term internships, technopreneurship programme, innovation programme, undergraduate research opportunities programme, and independent work. These special programmes expose students to the many facets of engineering in a global industry and business setting — from R&D, design, manufacturing, and intellectual property generation and protection, to starting a technology-based business.

Through our Faculty partnerships with industry and leading overseas institutions, our engineering students are ensured exposure to international best practices. As a testimony to the excellent standards of our undergraduate programmes, our degrees are accredited by the Engineering Accreditation Board (EAB) of Singapore, which is a signatory of the Washington Accord. This means that our engineering graduates are recognised as having met the academic requirements for engineering practice in other countries that are also signatories, including Australia, Canada, Hong Kong, Japan, New Zealand, UK, and USA.

Engineer-leaders nurtured by the Faculty through the years have been known for their contributions to technology and innovation. In the early years, the Faculty has advanced in tandem with Singapore's tremendous growth – from industrialisation in the 1960s and 1970s to high-tech manufacturing in the

1980s and subsequently the knowledge-driven industries from the late 1990s. Today, the Faculty is taking on global challenges, reflected in the disciplines being offered, such as Bioengineering, Civil and Environmental Engineering, Materials & Science Engineering, Engineering Science – together with established disciplines such as Mechanical Engineering and Electrical & Computer Engineering. Engineering students in their particular disciplines at the Faculty, now explore overarching themes, such as Engineering in Medicine, Future Transportation Systems, Smart, Sustainable Cities as well as Energy Research for Sustainability. The Faculty continues to produce graduates who have made an impact in the field of engineering and beyond. These include Prof Liew Mun Leong, President and Chief Executive Officer, CaptiaLand Group, and Ms Aw Kah Peng, CEO, Singapore Tourism Board, Mr Tan Gee Paw, Chairman of Singapore PUB and Mr Teh Bong Lim, Group Managing Director of MMI Holdings Ltd, amongst many other notable names.

The Faculty of Engineering offers the following degrees in various engineering disciplines:

- BEng (Hons): Bachelor of Engineering degrees – see section 3 for more details.
- BTech (Hons): Bachelor of Technology degrees (part-time) – see section 4 for more details.
- MEng: Master of Engineering – see section 5 for more details.
- MSc: Master of Science – see section 5 for more details.
- PhD: Doctor of Philosophy – see section 5 for more details.

For up to date information on the Faculty, please visit: www.eng.nus.edu.sg.

A Brief History of the Faculty of Engineering

Widely acknowledged to be the leading engineering institution in Singapore, the NUS Faculty of Engineering is also internationally recognised for the calibre of its educational programmes and research initiatives. The Faculty has a rich history, with its origins in 1955 as a professional engineering programme offered at the University of Malaya.

In 1964, a School of Engineering was established in the campus of the Singapore Polytechnic to offer degree courses in Engineering, with the University of Singapore overseeing standards and awarding the BEng degrees. Its first batch of Engineering students graduated in June 1968. The following year, the School of Engineering at the Singapore Polytechnic was constituted as the Faculty of Engineering of the then University of Singapore. The Faculty then comprised the Civil Engineering, Electrical Engineering, and Mechanical Engineering departments.

In 1972, the Department of Industrial & Systems Engineering was established. The undergraduate degree programme in Chemical Engineering which started in the Department of Chemistry in the Faculty of Science in 1975 was transferred to the Faculty of Engineering in 1979. The Faculty of Engineering remained at the Prince Edward Road campus of the polytechnic until the Kent Ridge campus was completed. The Faculty of Engineering within the National University of Singapore was reconstituted in August 1980 with the merger between the University of Singapore and Nanyang University. In response to the nation’s needs, an undergraduate degree programme in environmental engineering was initiated

by the Department of Chemical Engineering, which subsequently changed its name to the Department of Chemical & Environmental Engineering in 1998.

In July 2000, the Department of Electrical Engineering changed its name to the Department of Electrical & Computer Engineering to reflect its strong research and educational activities in the computer engineering and related areas. The Division of Bioengineering was formed in 2002 and admitted its first batch of bioengineering undergraduate students in that year. In 2003, the Faculty decided to consolidate and enhance the research and educational activities in environmental science and engineering in the Chemical & Environmental Engineering and Civil Engineering departments into a separate Division of Environmental Science & Engineering.

In January 2004, the Chemical Engineering department became the Department of Chemical & Biomolecular Engineering which gives due recognition to the strong biomolecular research and educational activities in the department and to acknowledge the role of biology as an enabling science in chemical engineering. The Department of Materials Science in the Faculty of Science was transferred to the Faculty of Engineering in April 2005. Renamed as the Department of Materials Science & Engineering, it admitted its first batch of students for its bachelor of engineering degree in Materials Science & Engineering in 2005. The Faculty of Engineering teamed up with the Faculty of Science to offer an interdisciplinary programme – the Engineering Science Programme from academic year 2006/2007.

In 2010 the Division of Environmental Science & Engineering merged with the Department of Civil Engineering, to form the Department of Civil & Environmental Engineering.

In 2011, the Division of Bioengineering became a full-fledged department. Another significant milestone in 2011 has been the establishment of the Institute for Engineering Leadership (IEL), which will develop intellectual depth and enhance the engineering leadership potential of individuals and enterprises through research, education, and innovation programmes.

2 Key Contact Information

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Assoc Prof Ashwin KHAMBADKONE	Director, Global Engineering Programme	6516 5157	elekamk
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C. Department of Civil & Environmental Engineering			
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Assoc Prof GOH Siang Huat	MSc (Geotechnical Engineering)	6516 8663	ceegsh
Assoc Prof Mohan GURUSAMY	MSc (Electrical Engineering)	6516 4688	elegm
Assoc Prof HE Jianzhong	MSc (Environmental Engineering)	6516 3385	ceehj
Dr CHUA Pei Wen Vivien	MSc (Hydraulic Engineering and Water Resources Management)	6516 2267	ceecpwv

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Assoc Prof CHAI Kah Hin	MSc (Intellectual Property Management) and MSc (Management of Technology)	6516 2250	iseckh
Assoc Prof CHEN Jingsheng	MSc (Materials Science & Engineering)	6516 7574	msecj
Assoc Prof LU Wen Feng	MSc (Mechanical Engineering)	6516 1128	mpelwf
Dr LOW Ying Min	MSc (Offshore Technology)	6516 4127	ceelowym
Assoc Prof TING Yen Peng	MSc (Safety, Health and Environmental Technology)	6516 2190	chetyp
Assoc Prof LEE Loo Hay	MSc (Supply Chain Management)	6516 2895	iseleelh
Assoc Prof CHAN Weng Tat	MSc (Systems Design and Management)	6516 2576	ceecwt
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Assoc Prof Daniel CHUA	Industrial Attachment and Vacation Internship Programme	6516 8933	engchcd
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Ms LIN Lilian	Assistant Manager for Undergraduate Programme	6516 4494	mpelinl
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MAO – Management Assistant Officer

LT – Laboratory Technologist

3 Undergraduate Education

3.1 Bachelor of Engineering Programme

The Faculty of Engineering offers the following full-time four-year undergraduate programmes leading to the Bachelor of Engineering (Honours) degree:

- Bachelor of Engineering (Biomedical Engineering)
- Bachelor of Engineering (Chemical Engineering)
- Bachelor of Engineering (Civil Engineering)
- Bachelor of Engineering (Computer Engineering)
- Bachelor of Engineering (Electrical Engineering)
- Bachelor of Engineering (Engineering Science)
- Bachelor of Engineering (Environmental Engineering)
- Bachelor of Engineering (Industrial & Systems Engineering)
- Bachelor of Engineering (Materials Science & Engineering)
- Bachelor of Engineering (Mechanical Engineering)

At the point of admission, applicants to the Faculty of Engineering will be able to select a specific engineering programme that they wish to pursue. Alternatively, they can opt for admission to a first-year common engineering programme and decide on a specific engineering programme after one year of study except for BEng (Engineering Science) which has a different programme structure and curriculum (see section 3.2.6). In all cases, admission and streaming after one year in the common engineering programme will be based on merit. Students who are admitted directly into an engineering programme can opt for a transfer of programme in accordance with the prevailing university guidelines.

The Faculty provides engineering students with a number of exciting opportunities through an array of major and minor programmes (see section 3.3) and a host of enhancement programmes (see section 3.4) that aim at broadening their educational scope. The underlying philosophy of the enhancement programmes is to provide engineering students with the opportunities to participate and experience the many facets of industry and business in the global marketplace — from R&D, design, manufacturing, and intellectual property generation and protection, to starting a new technology-based business.

Details about the part-time engineering degrees offered by the Faculty are found in section 4 and btech.eng.nus.edu.sg.

3.1.1 Overview of the Engineering Curriculum

3.1.2 General Degree Requirements

3.1.3 Other Academic Matters

3.1.4 Common Engineering

3.1.5 Global Engineering Programme

3.1.6 Innovation & Design-Centric Programme

3.1.1 Overview of the Engineering Curriculum

TABLE 3.1.1: ENGINEERING UNDERGRADUATE CURRICULUM

UNIVERSITY LEVEL REQUIREMENTS	PROGRAMME REQUIREMENTS[1]		UNRESTRICTED ELECTIVE MODULES
General Education Modules	**Faculty Requirements:** Aim to develop abilities required of well-rounded engineers and includes modules related to Critical Thinking, Writing & Communications, Engineering Ethics & Professionalism and Management Basics.	**Foundational Requirements :** *Foundational* modules in Mathematics, Sciences, Programming/Computing and others. *Discipline-specific* modules for various engineering programmes: Biomedical, Chemical, Civil, Computer, Electrical, Environmental, Industrial & Systems, Materials & Science, and Mechanical.	Unrestricted Elective Modules
Sub-total = 20 MCs (12.5%)	**Sub-total = 11 MCs (6.88%)**	**Sub-total = 109 MCs (68.12%)**	**Sub-total = 20 MCs (12.5%)**
Minimum required for graduation = 160 MCs			

Note [1]: Minimum modular credits required for graduation could be higher than 160MCs for some engineering programmes.

As illustrated in table 3.1.1, the minimum requirements for the Bachelor of Engineering degree programme are as follows:

University Level Requirements : 20 MCs
Programme Requirements* : 120 MCs

Unrestricted Elective Modules* : 20 MCs
Total : 160 MCs

UNIVERSITY LEVEL REQUIREMENTS

Engineering undergraduates have considerable flexibility in their choice of elective study. In addition to technical electives within their discipline (via the programme requirements), students have a wide choice of General Education Modules (GEMs) and Unrestricted Elective Modules (UEMs). These may be chosen and used in the many exciting ways described in this section. Students are strongly encouraged to consider some modules which will prepare them for their future roles as engineer – leaders. In most cases, these should be chosen from the list of business and management modules shown in Table 3.1.1b. Students should seek guidance from the departmental academic advisors on their elective choices.

The 20 MCs of the University Level Requirements (ULR) consist of:
- Five GEMs

General Education Modules

GEMs are different from other modules in two respects. First, they are general because they aim at those aspects of knowledge and abilities that we expect of educated individuals in general, not the knowledge and abilities that are required in the specialisation in a particular discipline or profession. Second, they seek to inculcate higher order qualities of the mind and intellect that make a person educated, as opposed to practical know – how and abilities that might be useful in one's daily life or to contribute to success in one's career. Students are advised to consult nus.edu.sg/gem for further details concerning GEMs.

[Note: The General Education curriculum is currently being reviewed for students who will be admitted in AY2016/17 onwards. Full details will be available in due course. Please consult the above website for further details.]

PROGRAMME REQUIREMENTS

Programme Requirements comprise the Faculty, Foundational and Discipline specific requirements:

- **Faculty Requirements** include modules that aim to develop important abilities required of well-rounded engineers with professional maturity and include modules related to Critical Thinking, Writing & Communications (ES1531 & ES2331, see below); Engineering Ethics & Professionalism (EG2401 Engineering Professionalism);
- **Foundational Requirements** include Mathematics, Sciences, Programming/Computing, and other modules as defined by the student's engineering discipline (details in section 3.2);
- **Discipline Specific Modules** which are core/essential modules, technical electives modules, project modules, industry engagement modules (see below), and independent study modules as defined by the student's engineering discipline (details in section 3.2).

Critical Thinking, Writing & Communications (Faculty Requirements)

One of the hallmarks of a university education is the ability to engage in high-level discourse when undertaking professional and other roles. The ability to critically evaluate problems, ask the right questions, and able to clearly articulate ideas & solutions to problems in oral and written forms is vitally important for aspiring engineers. Throughout the engineering curriculum, emphasis is placed on developing and enhancing critical thinking abilities, and writing & oral skills.

Faculty of Engineering students are **required** to read a Critical Thinking & Writing (CTW) module and a Communications module; preferably read in the **first-year semester of study. ES1531 Critical Thinking & Writing** and **ES2331 Communicating Engineering** offered by the Centre for English Language Communication (CELC) would meet these requirements. ES1531 addresses the need to develop critical thinking and communication skills which will enable engineering students to ask good questions, think & reason well and be able to convince others when they practise their profession. ES2331 provides students with an opportunity to enhance their communication skills through competent and effective use of language in interpersonal, academic and public contexts.

ES1531 Critical Thinking & Writing is designed to prepare students to think, speak, and write critically and effectively. While oral communication skills are emphasized throughout the engineering curriculum, the compulsory oral communications module, **ES2331 Communicating Engineering** provides engineering students further opportunity to harness their communication skills through competent and effective use of language in interpersonal, academic and public contexts, focussing on elements of engineering practice.

Engineering students can read a single module, **ES1501X Academic Expository Writing** (ES1501A, ES1501B, etc.) **in place of ES1531 and ES2331**. ES1501X's content-specific nature allows a contextualised platform to hone argumentation skills required in academic expository writing.

Engineering students who complete the requirements of the University Scholars Programme (USP) and the University Town (UTown) Residential Program need not read ES1531 & ES2331. Computer Engineering students would read another set of writing and communications modules in lieu of ES1531/ES2331 (please read section 3.2.4 for more details).

Good performance in the compulsory CTW and Communication modules is an indicator of ability of students to communicate well and so **would be an important factor when selecting students for special programmes including the Student Exchange Programme.**

Industry Engagement (Programme Requirements)

For students admitted into the BEng programmes from AY2014/2015, industry engagement will feature as a **compulsory requirement**. The type of industry engagement varies according to the engineering

discipline and includes the 6-month industrial attachment/internships, projects with industry, etc. (details in section 3.2). Such industry engagement facilitates a form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skill development in a professional setting. The programme also enables students to learn about the latest developments in various industries and to interact /network with engineers & other professionals as they join in on projects or tasks that help to develop or enhance their skills whilst contributing to the organisation. By participating in internships, students gain invaluable experience that will make them stronger candidates when applying for jobs after graduation. Internships / industrial-attachment are optional for Polytechnic direct-intake students[#] and students undergoing the following special programmes: Double Degree Programmes (DDP), Concurrent Degree Programmes (CDP), Global Engineering Programme[#] (GEP) and Chemical Sciences Programme (CSP). The modular credits for the internship/industrial-attachment for students in these special programmes will be considered as 'Free Electives'. Students should consult their respective programme/department office on the utilisation of the Free Elective modular credits.

[#]GEP and Polytechnic direct-intake students in the Engineering Science Programme are required to fulfil the 12-week Vacation Internship Programme.

Students admitted from AY2016 will also undertake the **specially designed 'Root & Wings Module'** which is a 10-week zero-MC module to sensitise freshmen to the importance of of (i) focus, (ii) self awareness, (iii) interpersonal awareness & effectiveness, and (iv) personal vision for their future careers. Students can then start to plan their education and projects, hone their expertise and experiences and develop a credible portfolio towards their career goals.

UNRESTRICTED ELECTIVES

Unrestricted Elective Modules (UEMs) enable students to pursue their interests without any restrictions. Students may use Unrestricted Elective (UE) space to partially or wholly satisfy exciting academic programmes such as the Enhancement Programmes (see section 3.4), a minor, a second major, or even a second degree. To achieve a greater depth in their engineering major, students may also take engineering technical electives as UEMs.

To achieve a good understanding of the fundamental concepts and underlying principles of systems engineering, including systems thinking, as well as the design and management of complex systems, engineering undergraduates are encouraged to read IE2105 and/or other modules listed in Table 3.1.1c. Those who wish to be equipped with a good foundation of systems engineering principles, and thus better prepared for challenges in an increasing complex and interdependent world throughout their career can also consider a second major in Systems Engineering offered by the Department of Industrial & Systems Engineering.

TABLE 3.1.1C: UNRESTRICTED ELECTIVES OFFERED BY DEPARTMENT OF INDUSTRIAL & SYSTEMS ENGINEERING.

MODULE	PREREQUISITES	PRECLUSIONS
IE2105 Fundamentals in Systems Engineering	None	IE2101
IE2140 Engineering Economy	None	None
IE4240 Project Management	IE2140	None
IE4241 Work, Technology and Organisation	MNO1001	None

Important Advice Concerning UEMs

Students should carefully plan the use of UE and ULR modules which can be used to satisfy the requirements of a number of exciting programmes such as the Enhancement Programmes, Double Degree Programmes, a minor, and a second major . Students should **take note of the 60 MC limit on Level-1000 modules** (see section 3.1.3) when selecting UE and ULR modules.

3.1.2 General Degree Requirements

To be awarded the Bachelor of Engineering degree, students must:

1. Satisfy the Modular Credit (MC) requirements of their specific BEng degree programme,
2. Obtain a cumulative average point (CAP) of 2.00 or higher,
3. Pass the requisite English for Academic Purposes module(s) by the fourth semester (only applicable to students who fail to meet the exemption criteria based on the Qualifying English Test (QET) results), **and**
4. Fulfil all the above within a maximum candidature of five years, unless otherwise approved by the University.

Students are advised to take careful note of the degree requirements. It is the students' responsibility to understand their graduation requirements and plan their course of study appropriately. Important announcements related to curriculum updates will be placed on the Faculty of Engineering website at www.eng.nus.edu.sg/ugrad and on the websites of the respective departments.

The class of honours awarded to a candidate who completes the Bachelor of Engineering degree requirements will be based on the CAP of all modules completed at all levels.

Please carefully read the information on *"Undergraduate Continuation and Graduation Requirements"* at the general information section of the NUS Bulletin (nus.edu.sg/registrar/edu/UG/graduation.html) which provides important information about the minimum standards set for continuation in a programme of study and graduation and covers the following:

- CAP for Continuation and Graduation
- Degree Classification
- Residency Requirement and Maximum Candidature
- Advanced Placement Credits and Exemptions
- Satisfactory / Unsatisfactory (S/U) Option
- MCs excluded from CAP Computation

3.1.3 Other Academic Matters

Exemption Policy for Polytechnic Graduates

Polytechnic graduates who are admitted into BEng programmes may receive **up to 40 MCs** of module exemptions from the following list.

a) Up to 20 MCs from Unrestricted Electives

b) Specific exemptions of up to 20 MCs from programme requirements comprising one or more modules as determined by the student's department on a case-by-case basis. **Some of these exemptions would only be granted subject to the student passing advanced placement tests**. For specific exemptions, please approach your department.

All polytechnic graduates are required to sit for the Qualifying English Test (QET).

Mathematics Bridging Module for Polytechnic Graduates

Polytechnic graduates are required to read the Mathematics bridging module MA1301. Those who have gone through special/advanced Mathematics programmes, subject to the approval of the Faculty, would not have to read MA1301 and can proceed to MA1505 Mathematics I, a compulsory Mathematics module for all engineering students. Engineering Science students read MA1507 in-lieu of MA1505.

Physics Bridging Modules for Polytechnic Graduates and GCE 'A' Level Students without H1 or H2 Physics

GCE 'A' Level students without H1 or H2 Physics are required to read the Physics bridging modules (PC1221 and PC1222). Polytechnic graduate students may also be required to read Physics bridging modules and should check with their respective departments for details.

English Requirement

ES1000 Basic English and/or **ES1103 English for Academic Purposes** must be taken by students who are required to read either one or both of these modules after taking the QET at the time of admission to the Faculty. There are no MCs assigned to either of these modules, but a pass is required for the award of the degree. Students required to read ES1000 should do so in the first semester before reading ES1103 in the second semester. Those required to read only ES1103 should do so in the first semester before proceeding to read modules to satisfy the Critical Thinking & Writing (CTW) and communications requirements.

3.1.4 Common Engineering

In the first year of study, common engineering students are required to read:

- MA1505 Mathematics I
- MA1512 Differential Equations for Engineering
- MA1513 Linear Algebra with Differential Equations
- GER1000 Quantitative Reasoning (GE 1)
- GE in Thinking & Expression
- CS1010E Programming Methodology (mapped to CE2409 for students who enter Civil/Environmental Engineering)
- Engineering Principles and Practice I & II (EG1111 & EG1112)
- Any of the following physics, engineering, and chemistry modules for entry into the various engineering programmes
- PC1431 Physics IE
- PC1432 Physics IIE
- CM1502 General and Physical Chemistry for Engineers

Table 3.1.4 shows the modules that common engineering students with H2 Chemistry/H2 Physics are required to read to **qualify to apply for entry** into the various engineering programmes. Common Engineering students with H2 Chemistry who plan to apply for Chemical Engineering or Environmental Engineering should read CM1502. Students should carefully choose a combination of Physics, Chemistry and Engineering modules which would qualify them to apply for entry into **at least three engineering disciplines**. Common Engineering students who have not read one or more of the required modules for an engineering discipline of interest may still be considered for the various disciplines on a case by case basis.

TABLE 3.1.4: PHYSICS, CHEMISTRY AND ENGINEERING MODULES REQUIRED TO BE READ BY COMMON ENGINEERING STUDENTS TO QUALIFY FOR THE VARIOUS ENGINEERING DISCIPLINES

Engineering Programme	Physics Modules	Engineering Modules	Chemistry Modules
Biomedical	PC1432		–
Chemical	–	–	CM1502
Civil	PC1431	–	–
Electrical	–	–	–
Computer	–	–	–
Environmental	PC1431	–	CM1502
Industrial & Systems	–	–	–

Mechanical	PC1431	–	–
Materials Science	PC1432	–	–

Students who have decided not to enter Mechanical Engineering and Electrical Engineering programmes will be allowed to opt out of EG1111 & EG1112, and to take Engineering Principles and Practice (EPP) modules from other engineering programmes of interest..

For students who have not decided on which engineering programmes to enter, it is advisable to take EG1111 & EG1112 to keep their options open.

3.1.5 Global Engineering Programme

An exclusive programme designed for students with exceptionally high potential, the **Global Engineering Programme (GEP)** provides an enhanced and flexible education with close mentoring that incorporates a global learning experience.

The Programme will lead to the award of two degrees – a Bachelor of Engineering (BEng) at NUS within three years and for those who qualify for admission to a top university, a postgraduate degree in Engineering in their fourth year. Scholarships may be provided for a student's undergraduate studies. Assistance in seeking financial support from external agencies for one year or more of graduate school, depending on the postgraduate programme, will be provided.

Students will enjoy small group learning with close supervision and mentoring by a select pool of faculty staff. GEP students will ride on an accelerated track, with opportunities to gain advanced placement credits, resulting in exemptions from specific modules, as well as to take self-study modules. In addition, students can pursue a summer programme and are expected to spend at least one semester overseas on a student exchange programme (SEP). Specially-tailored Undergraduate Research Opportunity Programme (UROP) projects at NUS or a GEP partner university will provide early research exposure. In order to nurture GEP students to become future engineer leaders, the Faculty of Engineering have crafted modules, such as MT2001 Experiencing Engineering Leadership and SSE1201 Building a Dynamic Singapore – Role of Engineers. Moreover, GEP students will get opportunities to touch base with CEOs from various industries in deep dialogue sessions. More recently, NUS Overseas Colleges (NOC) have created a wonderful opportunity for GEP students to do a 24-25 week internship in Lausanne (Switzerland) or in Munich (Germany) as well as take master courses in EPFL and Technical University of Munich.

Website: www.eng.nus.edu.sg/ugrad/SP_gep.html

Innovation & Design-Centric Programme

The Innovation & Design-Centric Programme (*i*DCP) is one of three pathways for Engineering students who are keen on **design, innovation and enterprise**. Students in the *i*DCP learn how to understand customer and user needs; identify opportunities for innovation; design new products, services, and solutions that are of value to various stakeholders; realise and prototype their designs; and develop business ventures from their creations. The goal of *i*DCP is to produce Engineering graduates who have the **spirit of innovation** and are passionate about their pursuits, be it creating the technology of tomorrow or making a difference in the lives of others.

The *i*DCP employs a **unique learning environment** that emphasises a hands-on, experimental, experiential and collaborative approach to learning. The learning journey is grounded by a **project-based** learning approach where students from **different engineering disciplines** work together on authentic projects that are society or industry-relevant throughout their candidature. Students can work on projects from **diverse fields** that they are passionate about, which are broadly categorised into five major themes:

Aerospace and Autonomous Systems – design and development of complex engineering systems for space missions, underwater vehicles, and unmanned aerial vehicles.
Engineering in Medicine – bridging engineering and medicine to design and develop medical technology for healthcare needs.
Future Transportation Systems – developing sustainable mobility solutions for our societies.
Innovative Systems – creating smart engineering devices to improve everyday life.
Smart and Sustainable Cities – using engineering innovations to address challenges of urbanisation and effective management of limited resources.

More information about these projects may be found on the *i*DCP website:
www.eng.nus.edu.sg/edic/dcp.html

Module requirements

Students in the *i*DCP are required to complete the modules listed in the following table:

Semester	Module	Modular credits (MCs)	Counted towards or replaces
2	Choose ONE from the following: • EG1310 Exploratory Satellite Design • EG2201A Introduction to Design Thinking	4	Unrestricted elective
3	Choose ONE from the following: • EG2301 Case Studies in Engineering • EG2311 Introduction to Space Systems • EG2606B Independent Work (for special projects only)	4	Unrestricted elective
4 to 5	EG3301R DCP Project	12	Design project/capstone
7 to 8	EG4301 DCP B.Eng. Dissertation	12	Research project/capstone

Anytime between 5 and 8	Choose THREE from the following Innovation & Enterprise electives: • BSN3701/TR2202 Technological Innovation • BSN3702/TR3002 New Venture Creation • BNS3703 Entrepreneurial Strategy • MNO3811 Social Entrepreneurship • MT4002 Technology Management Strategy • MT5005 IP Law for Engineers and Scientists • MT5011 Finance for Engineering and Technology Management • MT5911 Venture Funding • MT5920 Enterprise Development • TR2201 Entrepreneurial Marketing (The list of modules offered is tentative and will be updated in due course.)	12	Unrestricted elective or Pathway requirements or Technical electives
Vacation period between 4 and 5	EG3612 Vacation Internship Programme	6	Industry attachment

Application/enrollment

The *i*DCP welcomes all students who are keen about hands-on design and project work and passionate about their pursuits in creating innovative solutions to solve challenging problems. Students must first be enrolled in one of the Bachelor of Engineering programmes before they can join *i*DCP. Year 1 Engineering students will be invited to join *i*DCP after their first semester in NUS, while polytechnic graduates will be invited to apply before they begin their studies in NUS. Non-Engineering students can also be involved in *i*DCP through various means. Email invitations to apply will be sent to eligible students when applications are open.

3.2 Bachelor of Engineering Degree Programmes

3.2.1 Bachelor of Engineering (Biomedical Engineering)

3.2.2 Bachelor of Engineering (Chemical Engineering)

3.2.3 Bachelor of Engineering (Civil Engineering)

3.2.4 Bachelor of Engineering (Computer Engineering)

3.2.5 Bachelor of Engineering (Electrical Engineering)

3.2.6 Bachelor of Engineering (Engineering Science)

3.2.7 Bachelor of Engineering (Environmental Engineering)

3.2.8 Bachelor of Engineering (Industrial & Systems Engineering)

3.2.9 Bachelor of Engineering (Materials Science & Engineering)

3.2.10 Bachelor of Engineering (Mechanical Engineering)

3.2.1 Bachelor of Engineering (Biomedical Engineering)

Students in the Bachelor of Engineering (Biomedical Engineering) Programme are required to fulfil the following requirements to graduate from the programme:

Complete a minimum of 160 MCs with a CAP ≥ 2.0;
Pass all modules in accordance with Table 3.2.1a;
Pass at least four modules of technical electives and two pathway electives as listed in Table 3.2.1b;
Satisfy all other requirements as prescribed by the Faculty of Engineering or the University.

3.2.2 Bachelor of Engineering (Chemical Engineering)

3.2.2.1 Overview

Chemical engineering (ChE) and chemical engineers are essential for many industries such as oil and gas, petroleum refining, petrochemicals, pharmaceuticals, biologics, chemicals, semiconductor/electronic, food, polymers etc. Besides these, chemical engineers find satisfying and rewarding careers in engineering design and consultancy, research institutes, government, educational institutions and finance. All these sectors have been growing and contributing significantly to the manufacturing output in Singapore.

The four-year BEng (Chemical Engineering) programme at NUS educates budding engineers to design, develop, and operate chemical processes by which chemicals, petroleum products, food, pharmaceuticals and consumer goods can be produced economically and safely with minimal environmental impact. In addition, Chemical Engineering students acquire the necessary background and skills to design and develop functional products that benefit society in many ways. Chemical processes involve reactions, heat transfer, separations and biological phenomena to produce useful and valuable products. Accordingly, they study changes in the composition, energy content and/or state of aggregation of materials, taking into consideration the nature of matter and its properties (chemistry), the forces that act on matter (physics), similar aspects of biological materials (biology), and the relationships between them (mathematics). Chemical engineering differs from chemistry and applied chemistry programmes, with its emphasis on industrial applications of chemical reactions, separations and techniques for designing and operating economical, safe and environmentally benign processes.

Programme educational objectives (PEOs) of BEng (Chemical Engineering): Considering expectations of all our stakeholders, Chemical Engineering programme at NUS prepares students with technical expertise, experiences, critical and creative thinking skills, communication skills and other professional attributes. Accordingly, *our graduates are expected to succeed in the following within several years after graduation*:

(1) Excel in careers in the chemical, petroleum, petrochemical, pharmaceutical, food, biotechnology, microelectronics, energy, materials processing or other related industries/organisations;
(2) Pursue advanced degrees and/or certifications for a career in engineering, academia, business, law, medicine, or research and development;
(3) Display leadership, and also contemporary and global outlook; and
(4) Demonstrate high-level of professionalism, ethical and social responsibility, independent learning, and desire for life-long learning.

To achieve the above PEO, the four-year undergraduate Chemical Engineering programme has been designed to provide a complete learning experience by incorporating the three essential components of the university’s curriculum structure, namely, University Level Requirements (ULRs, to provide broad-based education), Programme Requirements (to provide strong background in the discipline) and

Unrestricted Elective Modules (UEMs, to give flexibility to students to meet their own aspirations).

The requirements for the BEng (Chemical Engineering) degree programme ensure a balanced exposure to science, engineering principles and contemporary technology. Besides education in science and technology, students broaden intellectual horizons by taking supporting modules that constitute the ULR and the Faculty Requirements of the Programme Requirements. Building upon many core modules in the first five semesters, technical electives and a research project (dissertation) in the subsequent semesters provide an opportunity to specialize in the student's area of interest. Students have complete freedom to use UEM to take modules that complement individual career plans or to simply pursue personal curiosity and interest. All Chemical Engineering students are exposed to industrial practice through internship, site visits and/or lectures by practising engineers. They are also provided with networking, globalisation and technical/business leadership opportunities through student exchange, overseas colleges, entrepreneurship and minor programmes for broader education.

The student learning outcomes (SLOs) of BEng (Chemical Engineering) programme are as follows. Graduates of this programme should be able to:

a) apply knowledge of mathematics, science and engineering to the solution of complex engineering problems;
b) design and conduct experiments, analyse, interpret data and synthesise valid conclusions;
c) design a system, component, or process, and synthesise solutions to achieve desired needs;
d) identify, formulate, research through relevant literature review, and solve engineering problems reaching substantiated conclusions;
e) use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints;
f) communicate effectively;
g) recognise the need for, and have the ability to engage in life-long learning;
h) understand the impact of engineering solutions in a societal context and to be able to respond effectively to the needs for sustainable development;
i) function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management;
j) understand professional, ethical and moral responsibility; and
k) apply critical thinking through independent thought and informed judgement, and develop creative and innovative solutions.

The BEng (ChE) programme at NUS is accredited by the Engineering Accreditation Board (EAB) of Singapore. EAB is the Singapore signatory of the Washington Accord, and all signatories of this Accord recognise the substantial equivalence of programmes accredited by one of them, in satisfying the academic requirements for the practice of engineering at the professional level. This means ChE graduates from NUS are accepted for engineering practice in the countries that are part of the

Washington Accord. Besides Singapore, signatories in the Washington Accord include Canada, USA, UK, Hong Kong, New Zealand and Australia.

3.2.2.2 Degree Requirements

The following are the requirements for the degree of BEng (ChE):

- Students in the BEng (ChE) programme are required to complete a minimum of 160 MCs with a CAP ≥ 2.0 to graduate from the programme.
- Students are free to choose any combination of the offered technical electives from Table 3.2.2b to satisfy the technical elective and pathway requirements.
- There are three engineering pathways, namely, (a) Research-Focused Pathway (R*f*P) (b) Innovation & Design-Centric Programme Pathway (*i*DCP) and (c) Practicing Professional Pathway (PPP). Please refer to Table 3.2.2c below.
- The default pathway is PPP for all students (no action required). If students want to select R*f*P or *i*DCP pathways, they have to obtain Department's approval and fulfil all requirements to graduate.

Table 3.2.2a: Summary of Modular Requirements and Credits

Modular Requirements		MCs
University Level Requirements		**20**
General Education Modules (GE) (5 Modules, each of 4MCs) •Human Cultures (HC) •Quantitative Reasoning (QR) •Thinking and Expression (T&E) •Singapore Studies (SS) •Asking Questions (AQ)		20
Unrestricted Electives[1]		**32**
Programme Requirements:		
Faculty Requirements:		**6**
ES1531	Critical Thinking & Writing[2]	4
EG2401	Engineering Professionalism	2
Foundation Requirements:		**10**
MA1511	Engineering Calculus	2
MA1512	Differential Equations for Engineering	2
MA1513	Linear Algebra with Differential Equations	2
CM1502	General and Physical Chemistry for Engineers	4
Chemical Engineering Major Requirements:		**80**
CHE Core Subjects:		**64**

CN1101	Chemical Engineering Principles and Practice I	6
CN1102	Chemical Engineering Principles and Practice II	6
CN2101	Material and Energy Balances	3
CN2116	Chemical Kinetics and Reactor Design	4
CN2121	Chemical Engineering Thermodynamics	4
CN2122	Fluid Mechanics	5
CN2125	Heat and Mass Transfer	4
CN3101	Chemical Engineering Laboratory I	4
CN3102	Chemical Engineering Laboratory II	4
CN3121	Process Dynamics and Control	4
CN3132	Separation Processes	4
CN3135	Process Safety, Health & Environment	3
CN3421	Process Modelling and Numerical Simulation	4
CN4122	Process Synthesis and Simulation	3
CN4123R	Final Year Design Project	6
B.Eng. (CHE) – Technical Electives & Pathway Requirement Modules[3] (from Table 3.2.2b)		**16**
EG3611	**Industrial Attachment[4]**	**12**
Total		**160**

[1]24MC of UEM for students in R*f*P, 6MC of UEM for students in *i*DCP

[2]Students who score a Band 1 or Band 2 in Qualifying English Test (QET) will need to take ES1103 English for Academic Purposes (4 MC) before taking ES1531 Critical Thinking & Writing. ES1103 will be counted as 1 UEM. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of ES1531.

[3]Students in R*f*P are required to take two Level 4000 technical electives, two Level 5000 technical electives and CN4118 B.Eng. Dissertation.

Students in *i*DCP are required to take one Level 4000/5000 technical elective.

Students in PPP are required to take two Level 4000/5000 technical electives and two professional

requirement modules. The following technical elective modules can be used to fulfil the professional requirement:

CN4201R: Petroleum Refining
CN4205R: Pinch Analysis and Process Integration
CN4227R: Advanced Process Control
CN4233R: Good Manufacturing Practices in Pharmaceutical Industry
CN4251: Troubleshooting with Case Studies for Process Engineers
CN5191: Project Engineering

Alternatively, it can be accomplished by using modules from minor or double majors, subjected to approval.

[4]Industrial Attachment is optional for students in the following special programmes:

-Double Degree Programme (DDP)
-Concurrent Degree Programme (CDP)
-Global Engineering Programme (GEP)
-Polytechnic direct-intake students

Table 3.2.2b: Technical Elective & Pathway Requirement Modules in ChE[#]

CN4201R	Petroleum Refining	4
CN4203R	Polymer Engineering	4
CN4205R	Pinch Analysis and Process Integration	4
CN4211R	Petrochemicals and Processing Technologies	4
CN4215R	Food Technology and Engineering	4
CN4216R	Electronics Materials Science	4
CN4217R	Processing of Microelectronic Materials	4
CN4221R	Control of Industrial Processes	4
CN4223R	Microelectronic Thin Films	4
CN4227R	Advanced Process Control	4
CN4233R	Good Manufacturing Practices in Pharmaceutical Industry	4
CN4238R	Chemical & Biochemical Process Modeling	4
CN4240R	Unit Operations and Processes for Effluent Treatment	4

CN4241R	Engineering Principles for Drug Delivery	4
CN4245R	Data Based Process Characterization	4
CN4246R	Chemical & Bio-Catalysis	4
CN4247R	Enzyme Technology	4
CN4248	Sustainable Process Development	4
CN4249	Engineering Design in Molecular Biotechnology	4
CN4250	Chemical Product Design	4
CN4251	Troubleshooting with Case Studies for Process Engineers	4
CN4291	Selected Topics in Chemical Engineering	4
CN5111	Optimization of Chemical Processes	4
CN5172	Biochemical Engineering	4
CN5173	Downstream Processing of Biochemical and Pharmaceutical Products	4
CN5181	Computer-Aided Chemical Engineering	4
CN5186	Design and Operation of Process Networks	4
CN5191	Project Engineering	4
CN5222	Pharmaceuticals and Fine Chemicals	4
CN5251	Membrane Science and Engineering	4
CN4118	B.Eng. Dissertation	8

[#] The department reserves the right to decide on the modules to be offered in any given semester.

Table 3.2.2c: Three Engineering Pathways

R*f*P	***i*DCP**	**PPP**
Year 1 and Core Modules (74 MC)	Year 1 and Core Modules (74 MC)	Year 1 and Core Modules (74 MC)
MA1511, MA1512, MA1513, CN1101, CN1102, CM1502, CN2101, CN2121, CN2122, CN2125, CN2116, CN3101, CN3102, CN3121, CN3132, CN3421, CN3135, CN4122, CN4123R	MA1511, MA1512, MA1513, CN1101, CN1102, CM1502, CN2101, CN2121, CN2122, CN2125, CN2116, CN3101, CN3102, CN3121, CN3132, CN3421, CN3135, CN4122, CN4123R	MA1511, MA1512, MA1513, CN1101, CN1102, CM1502, CN2101, CN2121, CN2122, CN2125, CN2116, CN3101, CN3102, CN3121, CN3132, CN3421, CN3135, CN4122, CN4123R
IA (12 MC)	VIP (6 MC)	IA (12 MC)

Two 4000 electives (8 MC)	EG2201A Introduction to Design Thinking (4 MC)	Two 4000/5000 electives (8 MC)
Pathway requirement – Two 5000 electives (8 MC)	EG2301 Case Studies in Engineering (4 MC)	Pathway requirement (8 MC)
B. Eng. Dissertation (8 MC)	EG3301R Design Project (12 MC)	
	EG4301 DCP Dissertation (12 MC)	
	Innovation and Enterprise Electives (3×4 MC)	
	One 4000/5000 elective (4 MC)	
Faculty Requirement (ES1531 and EG2401, 6 MC)		
GE (20 MC)		
UEM (24 MC)	UEM (6 MC)	UEM (32 MC)
160 MC	**160 MC**	**160 MC**

3.2.2.3 Recommended Semester Schedule

The recommended semester schedules for direct entry Chemical Engineering students and Common Engineering Entry students are presented in Table 3.2.2c.

Table 3.2.2c: Recommended Semester Schedule for Direct Entry ChE Students

Modules	MCs	Modules	MCs
Semester 1		**Semester 2**	
CN1101 Chemical Engineering Principles and Practice I	6	CN1102 Chemical Engineering Principles and Practice II	6
MA1511 Engineering Calculus	2	MA1512 Differential Equations for Engineering	2
GE on T&E	4	MA1513 Linear Algebra with Differential Equations	2
GE on SS	4	CM1502 General and Physical Chemistry for Engineers	4
UEM – 1	4	GE on QR	4
Sub-total	**20**	**Sub-total**	**18**
Semester 3		**Semester 4**	
CN2101 Material and Energy Balances	3	CN2125 Heat and Mass Transfer	4
CN2121 Chemical Engineering Thermodynamics	4	CN2116 Chemical Kinetics and Reactor Design	4
CN2122 Fluid Mechanics	5	EG2401 Engineering Professionalism	2
		UEM – 2	4
ES1531 Critical Thinking & Writing[1]	4	UEM – 3	4
GE on AQ	4	GE on HC	4

Sub-total	**20**	**Sub-total**	**22**
Semester 5		**Semester 6[#]**	
CN3101 Chemical Engineering Lab I	4	CN3102 Chemical Engineering Lab II	4
CN3121 Process Dynamics and Control	4	CN4122 Process Synthesis and Simulation	3
CN3132 Separation Processes	4	Technical Elective 1	4
CN3135 Process Safety, Health & Environment	3	Technical Elective 2	4
CN3421 Process Modelling and Numerical Simulation	4	UEM – 4	4
		UEM – 5	4
Sub-total	**19**	**Sub-total**	**23**
Semester 7[#]		**Semester 8**	
		CN4123R Final Year Design Project	6
		Pathway Requirement 2	4
EG3611 Industrial Attachment	12	UEM – 6	4
Pathway Requirement 1	4	UEM – 7	4
		UEM – 8	4
Sub-total	**16**	**Sub-total**	**22**

[1]Students who score a Band 1 or Band 2 in Qualifying English Test (QET) will need to take ES1103 English for Academic Purposes (4MC) before taking ES1531 Critical Thinking & Writing. ES1103 will be counted as 1 UEM

[#]Modules scheduled in Semesters 6 and 7 can be swapped, thus students can also choose to go on IA Industrial Attachment in Semester 6.

3.2.3 Bachelor of Engineering (Civil Engineering)

3.2.3.1 Overview

Today many civil engineers design not structures but software systems to manage construction. They practise in the global market place being involved in the planning, designing and construction of infrastructure, balancing development with care for the environment. New fields and areas of civil engineering practice and research have emerged, involving the planning, design, construction and management of our man-made living habitat which is constantly evolving. New challenges facing civil engineering, such as our changing population profile, rising energy costs and climate change have arisen.

To this end, the Department structures our curriculum to facilitate our students in embarking on career pathways in the increasingly integrated, interdisciplinary nature of the modern civil engineering profession. Whatever their aspirations, our graduates emerge ready for a broad spectrum of career opportunities from developing into leading specialists in their fields to being imbued with multidisciplinary strengths, geared to play leading roles in global infrastructure projects. The curriculum which places emphasis on developing engineering skills with scientific depths and cross disciplinary breadths has the following objectives:

- To ensure that our graduates are equipped with the basic civil engineering core competencies to meet the requirements for the practice of civil engineering in Singapore in accordance to the Professional Engineers Board.
- To ensure that our graduates are able to apply fundamental knowledge of mathematics, science and engineering using modern engineering techniques, skills and tools.
- To ensure that students are exposed to social sciences and humanities so as to appreciate the interdependency between society and infrastructural systems by encouraging multidisciplinary and multi-cultural interaction and work, as well as cross-cultural exchanges and activities.
- To develop and enhance the interpersonal, communication, and leadership skills of students through group design projects and oral presentations.
- To provide opportunities for students to tailor their degree programme to suit the desired engineering and scientific depths and cross disciplinary breadth.
- To inspire graduates to have the curiosity, ability and desire for lifelong learning.
- To prepare graduates for their future careers through instruction on professionalism and ethical responsibilities, interactions with practitioners and opportunities for internships.

The BEng (Civil Engineering) programme is accredited by the Engineering Accreditation Board (EAB) of Singapore and this accreditation of engineering academic programmes is a key foundation for the practice of engineering at the professional level.

3.2.3.2 Degree Requirements

In order to graduate with the BEng (Civil Engineering) degree, students are required to:

- Complete a minimum of 160 MCs with a CAP ≥2.0.
- Pass the modules in accordance with Table 3.2.3a.
- Satisfy all other requirements as prescribed by the Faculty or the University.

Subject to the approval of the Department, students may opt to take a relevant module in another department as one of the three technical electives. The module must be of at least Level-3000 standard and must be taken on a graded basis.

For students aspiring for a First Class Honours Degree, they must obtain at least an 'A-' grade for CE4104 BEng Dissertation.

Students may apply to specialise in Offshore Engineering at start of Stage 3. They must take a Group Design Project and a BEng Dissertation that is related to offshore engineering, OT5202 Analysis & Design of Offshore Structures and CE5307 Wave Hydrodynamics and Physical Oceanography, and complete an Industrial Attachment (EG3611A) for A-level or equivalent students, or a Vacation Internship Programme (EG3612) for Poly direct-entry students in an offshore or marine-related company.

Table 3.2.3a: Summary of Modular Requirements and Credits (for A-level or equivalent students matriculated in AY2015/2016)

MODULAR REQUIREMENTS	MCS
University Level Requirements	20
General Education Modules (GE) (5 Modules, each of 4MCs) • Human and Cultures (H&C) • Quantitative Reasoning (QR) • Thinking and Expression (T&E) • Singapore Studies (SS) • Asking Questions (AQ)	20
Unrestricted Electives	20
Programme Requirements	

MODULAR REQUIREMENTS		MCS
Faculty Requirements:		10
ES1531	Critical Thinking & Writing[1]	–
ES2331	Communicating Engineering (UE)	4
EG2401	Engineering Professionalism	3
ES1102	English[2]	–
HR2002	Human Capital in Organizations	3
Foundation Requirements:		16
MA1505	Mathematics I	4
MA1506	Mathematics II	4
CE1109	Statics and Mechanics of Materials	4
PC1431	Physics IE	4
CE Computing Requirement:		4
CE2409	Computer Applications in Civil Engineering	4
Civil Engineering Major Requirements		
CE Core Subjects:[+]		56
CE2112	Soil Mechanics (G)	4
CE2134	Hydraulics (H)	4
CE2155	Structural Mechanics and Materials (S)	4
CE2183	Construction Project Management (C)	4
CE2184	Infrastructure and the Environment (C)	4
CE2407	Engineering and Uncertainty Analyses	4
ESE3001	Water Quality Engineering (E)	4
CE3115	Geotechnical Engineering (G)	4

MODULAR REQUIREMENTS		MCS
CE3116	Foundation Engineering (G)	4
CE3121	Transportation Engineering (T)	4
CE3132	Water Resources Engineering (H)	4
CE3155	Structural Analysis (S)	4
CE3165	Structural Concrete Design (S)	4
CE3166	Structural Steel Design and System (S)	4
CE Design and Project Modules:		12
CE4103	Design Project	4
CE4104	BEng Dissertation	8
CE Electives:		12
Level 3 Technical Elective Modules		4
Higher Level Technical Elective Modules		8
Industrial Engagement[3]		12
Total		162

[1] BEng students are required to read a Critical Thinking & Writing module (ES1531 Critical Thinking & Writing which also satisfies the General Education (Thinking & Expression) requirement) and a Communications module (ES2331 Communicating Engineering). Alternatively, students can read ES1501X Academic Expository Writing in place of both ES1531 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of ES1531 and/or ES2331.

[2] For students who have not passed or been exempted from the Qualifying English Test at the time of admissions to the Faculty, they have to read ES1000 and/or ES1102. This will be decided by CELC.

[3] For BEng students in the following special programmes: DDPs, CDPs, GEP & CSP, internship / industrial-attachment is optional and the modular credits for the internship/industrial-attachment will be become ‘Free Electives’ i.e., Unrestricted Electives (UE).

+ Letter in the parenthesis indicates the major civil engineering discipline each module belongs to.

Note: Limit on Level-1000 Modules
Students should not read more than 60 MCs of Level-1000 modules towards their degree requirements (minimum of 162 MCs for graduation).

Table 3.2.3b: Technical Elective Modules

Geotechnical Engineering Modules (G)

CE5101 Seepage and Consolidation of Soils
CE5104 Underground Space
CE5105 Anal. & Num. Meth. in Foundation Eng.rg
CE5106 Ground Improvement
CE5107 Pile Foundations
CE5108 Earth Retaining Structures
CE5881 Topics in Geotechnical Engineering †

Environmental Engineering Modules (E)

ESE3101 Solid and Hazardous Waste Management
ESE4401 Water & Wastewater Engineering 2
ESE4405 Urban Water Engineering & Management
ESE5205 Sludge & Solid Waste Management
ESE5402 Industrial Water Control

Structural Engineering Modules (S)

CE4257 Linear Finite Element Analysis
CE4258 Structural Stability and Dynamics
CE5509 Advanced Structural Steel Design
CE5510 Advanced Structural Concrete Design
CE5513 Plastic Analysis of Structures
CE5604 Advanced Concrete Technology
CE5610 Assessment and Retrofit of Concrete Structures
CE5611 Precast Concrete Technology
CE5885 Topics in Structural Engineering †
CE5886 Topics in Concrete Engineering †

Infrastructure Systems Modules (C and T)

CE4221 Design of Land Transport Infrastructure
CE4282 Building Information Modelling for Project Management
CE5204 Pavement Design and Rehabilitation

CE5205 Transportation Planning
CE5207 Pavement Network Management Systems
CE5603 Engineering Economics and Project Evaluation
CE5804 Global Infrastructure Project Management
CE5805 Construction Equipment and Methods
CE5806 Construction Project and Site Control
CE5880 Topics in Project Management Engineering†
CE5882 Topics in Transportation Engineering †
TP5025 Intelligent Transportation Systems
TP5026 Transport Management & Policy
TP5027 Transport & Freight Terminal Management
TP5028 Intermodal Transportation Operations

CE4247 Treatment Plant Hydraulic
CE5307 Wave Hydrodynamics and Physical Oceanography
CE5308 Coastal Processes & Sediment Transport
CE5312 River Mechanics
CE5313 Groundwater Hydrology
CE5883 Topics in Hydraulic & Water Resources
OT5202 Analysis & Design of Offshore Structures
OT5203 Design of Floating Structures
OT5204 Moorings & Risers
OT5205 Offshore Pipelines
OT5206 Offshore Foundations
OT5207 Arctic Engineering
OT5881 Topics in Offshore Engineering †
OT5882 Topics in Subsea Engineering †

Other Technical Modules
CE3101 Integrated Infrastructure Project†
CE3102 Engineering of Socio-Technical Systems
GE2215 Introduction to GIS
GE3238 GIS Design and Practice
CE5702 CE Reliability Analysis and Design†

† depending on the topics covered

3.2.3.3 Recommended Semester Schedule

The recommended semester schedule for CE students is presented in Table 3.2.3b and Poly-Direct Entry in Table 3.2.3c.

Table 3.2.3b: Recommended Semester Schedule for CE Students (AY2015/2016 onwards)

MODULES	MCS	MODULES	MCS
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE	4	CE2134 Hydraulics	4
CE1109 Statics and Mechanics of Material	4	CE2155 Structural Mechanics and Materials	4
CE2409 Computer Applications in Civil Engineering^	4	GE on QR or T&E	4
GE on QR or T&E	4	GE	4
ES1102 English for Academic Purposes *	–		
Sub-total	20	Sub-total	20

* For students who have not passed or been exempted from the Qualifying English Test at the time of admissions to the Faculty, they have to do ES1000 and / or ES1102. This will be decided by CELC. ES1531 must be read and it can be used to fulfil GEM A.

^ CA – 100%

MODULES	MCS	MODULES	MCS
Semester 3		Semester 4	
CE2112 Soil Mechanics	4	CE3115 Geotechnical Engineering	4
CE2183 Construction Project Management	4	CE3132 Water Resources Engineering	4
CE2184 Infrastructure and the Environment	4	CE3155 Structural Analysis	4
CE2407 Engineering and Uncertainty Analyses	4	ESE3001 Water Quality Engineering	4
ES2331 Communicating Engineering	4	GE on H&C	4
Sub-total	20	Sub-total	20
Semester 5		Semester 6	
CE3116 Foundation Engineering	4	Industrial Engagement	12
CE3121 Transportation Engineering	4	UE 1	4
CE3165 Structural Concrete Design	4	UE 2	4
CE3166 Structural Steel Design and System	4		
Technical Elective Module 1	4		
GE on AQ	4		
Sub-total	24	Sub-total	20
Semester 7		Semester 8	
CE4103 Design Project¨	4	CE4104 BEng Dissertation (Cont'd)	4
CE4104 BEng Dissertation	4	UE 4	4
Technical Elective Module 2	4	UE 5	4

MODULES	MCS	MODULES	MCS
Technical Elective Module 3	4	HR2002 Human Capital in Organizations	3
UE 3	4	EG2401 Engineering Professionalism	3
Sub-total	20	Sub-total	18

¨ CE4103 is offered in semester 7 or 8, but take note that allocations for semester 8 are limited and also depending on your specialisation (if any).

Table 3.2.3d: Recommended Semester Schedule for CE students with an accredited Polytechnic Diploma matriculated August 2014

MODULES	MCS	MODULES	MCS
Semester 3		Semester 4	
MA1301 Introductory Mathematics *(fulfils Free Elective 1)*	4	MA1505 Mathematics I	4
CE2155 Structural Mechanics and Materials	4	CE2112 Soil Mechanics	4
CE2184 Infrastructure and the Environment	4	CE2134 Hydraulics	4
PC1431 Physics IE *(upon failure of APC test)*	4	ESE3001 Water Quality Engineering	4
GE on QR or T&E	4	GE on QR or T&E	4

MODULES	MCS	MODULES	MCS
ES1102 English for Academic Purposes **	–		
Sub-total	20	Sub-total	20

Note:

• @ PC1431 is a compulsory module and can be read in any semester if you choose to. Or you can also take PC1221 Fundamental of Physics 1 before taking PC1431.

• ES1531 must be read and it can be used to fulfil GE (T&E).

MODULES	MCS	MODULES	MCS
Semester 5		Semester 6	
MA1506 Mathematics II	4	CE3116 Foundation Engineering	4
CE2183 Construction Project Management	4	CE3165 Structural Concrete Design	4
CE3115 Geotechnical Engineering	4	CE3166 Structural Steel and Design System	4
CE3155 Structural Analysis	4	CE3132 Water Resources Engineering	4
GE on SS	4	Technical Elective Module 1	4
		GE on HC	4
Sub-total	24	Sub-total	24
Semester 7		Semester 8	

MODULES	MCS	MODULES	MCS
CE2407 Engineering and Uncertainty Analysis	4	CE4104 BEng Dissertation (Cont'd)	4
CE4103 Design Project¨	4	Technical Elective Module 3	4
CE4104 BEng Dissertation	4	Technical Elective Module 4	4
CE3121 Transportation Engineering	4	EG2401 Engineering Professionalism	3
Free Elective x 2	8	GE on AQ	4
Sub-total	20	Sub-total	19

¨ CE4103 is offered in semester 7 or 8, but take note that allocations for semester 8 are limited and also depending on your specialisation (if any).

Note:
Polytechnic graduates admitted into BEng programmes with the (12MC) Industrial Engagement requirement, may take the 12-week internship (6MC via EG3612) and/or 'Free Elective' modules in lieu of the 12 MC for EG3611. Students can consider taking their Free Elective module/s during Special Terms.

3.2.3.4 Special Programmes

- Double Degree in Engineering (Civil) and Business Administration*
- Double Degree in Engineering (Civil) and Economics*
- Double Degree in Engineering (Civil) and Accounting*
- Double Degree Programmes with French Grandes Écoles
- Please refer to: www.eng.nus.edu.sg/cee/programmes/BEng_Civil.html

3.2.4 Bachelor of Engineering (Computer Engineering)

Please refer to http://www.nus.edu.sg/nusbulletin/other-multidisciplinaryspecial-programmes/bachelor-of-engineering-computer-engineering-programme/.

3.2.5 Bachelor of Engineering (Electrical Engineering)

3.2.5.1 Overview

The BEng (Electrical Engineering) is offered by the Electrical & Computer Engineering (ECE) Department. Electrical Engineering (EE) deals with the innovative and creative applications of electrical sciences, mathematics and other associated disciplines. ECE technologies drive much of today's development. Nanotechnology and biomedical engineering, interactive and digital media, and distributed computing will see the next wave of major developments. The BEng (Electrical Engineering) curriculum is specially designed to provide its graduates with a head start in these rapidly advancing fields. It provides the requisite balance of breadth and depth for a professional electrical engineering education. It also seeks to establish a solid foundation for lifelong learning throughout an electrical engineer's career.

The structure of the Electrical Engineering programme is designed to prepare engineers who will be:

- technically competent to solve complex problems in electrical engineering and can adapt effectively in a fast changing environment
- able to critically think, analyse and make decisions that give due consideration to global issues in business, ethics, society and the environment.
- able to communicate effectively, act with integrity, and have the inter-personal skills needed to engage in, lead, and nurture diverse teams
- committed to lifelong learning, resourceful, resilient and embrace global challenges and opportunities to make a positive impact in society

The success of the Electrical Engineering programme is assessed through the attainment of learning outcomes. On graduation from the programme, students are expected to be able to:

- apply the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialisation to the solution of complex engineering problems;
- Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusion.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
- Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design

documentation, make effective presentations, and give and receive clear instructions.
- Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
- Graduates of the Electrical Engineering Programme must have the knowledge to analyse and design complex electrical and electronic devices, software, and systems containing hardware and software components. The graduates must have a good understanding of the principles and applications of the basic sciences, engineering science and advanced mathematics, including probability and statistics, differential and integral calculus, linear algebra and complex variables.

The EE programme comprises of four components – a strong core in basic sciences, computing and engineering; technical competence through a minimum of breadth and depth modules; general education; and an enhancement programme. The core provides knowledge and skills considered essential for electrical engineers. In addition to core subjects, these also include group projects, a product design and innovations project, and capstone project. A minimum number of breadth modules ensures that each student is exposed to most aspects of the state-of-the-art EE areas. In addition, students can achieve depth in one or two areas of their choice. General education modules complement the technical education through a wide array of modules in humanities, social sciences, philosophy and professionalism to make our graduates educated members of the global community.

Students are offered a creative learning environment through special enhancement programmes which include activities like independent study modules, research internships, technopreneurship and student exchange programmes. They help students to achieve skills for lifelong learning and prepare them for the work place of the future.

Accreditation of engineering academic programmes is a key foundation for the practice of engineering at the professional level. The BEng (Electrical Engineering) programme underwent a re-accreditation exercise in 2013 and is currently accredited by the Engineering Accreditation Board (EAB) of Singapore for students graduating from the programme up to AY2017/18. Via the accreditation from the EAB, all signatories in the Washington Accord recognise the substantial equivalence of our programmes in satisfying the academic requirements for the practice of engineering at the professional level. This means that our graduates can be accepted for engineering practice in the countries that are part of the Washington Accord. Signatories in the Washington Accord include Canada, USA, UK, Hong Kong, New Zealand, Australia and others.

3.2.5.2 Degree Requirements

Students in the BEng (Electrical Engineering) programme are required to complete a minimum of 160 MCs with a CAP ≥ 2.0 to graduate. In the first stage of the programme, students will receive broad-based training which, in addition to establishing a strong foundation in mathematics and computing, will also be immediately exposed to the use of electrical components and equipment in solving fundamental engineering problems in EE. They will also be introduced to the different areas in EE which are driving the technological developments of today.

In the second stage, students will enrol in core modules that focus on fundamental knowledge in EE. These core modules provide the essential foundation for a variety of specialised technical areas in EE. During their senior years of study, students may specialise in certain fields of EE through their selection of 28 MCs of elective modules. Throughout their programme, they are also expected to broaden their views by reading some general education modules, Engineering Professionalism and Critical Thinking and Writing Students are strongly encouraged to make good use of the 32 MCs of UEM by taking more technical electives to further explore their engineering interest through EE specialisations, or other interest by taking a minor or second major. The complete programme structure is specified in Table 3.2.5a.

Table 3.2.5a: Summary of EE Modular Requirements and Credits

MODULAR REQUIREMENTS	
University Level Requirements (ULR) – General Education (GE) Modules • Human Cultures (GEH) • Quantitative Reasoning (GER) • Thinking and Expression (GET) • Singapore Studies (GES) • Asking Questions (GEQ)	20
Unrestricted Electives (UE) [++]	32
Programme Requirements	
Faculty Requirements:	6
ES1531 Critical Thinking & Writing[1]	4
EG2401A Engineering Professionalism	2

MODULAR REQUIREMENTS	
Foundation Requirements:	16
MA1511 Engineering Calculus	2
MA1512 Differential Equations for Engineering	2
MA1508E Linear Algebra for Engineering	4
IT1007 Introduction to Programming with Python and C	4
PC2020 Electromagnetics for Electrical Engineers	4
Electrical Engineering Major Requirements	
EE Core Subjects:	40
EG1111 Engineering Principles & Practice I	6
EG1112 Engineering Principles & Practice II	6
EE2012 Analytical Methods in Electrical and Computer Engineering	4
EE2023 Signals and Systems	4
EE2026 Digital Design	4
EE2027 Electronic Circuits	4
EE2028 Microcontroller Programming and Interfacing	4
EE2033 Integrated Systems Lab	4
EE3031 Innovation & Enterprise I	4
EE Project Modules:	18
EE4002D/EE4002R Capstone Project	8
EG3611A Industrial Attachment[2]	10
EE Electives:	
Elective Modules from Table 3.2.5b to satisfy the breadth and depth requirements of the BEng (EE) programme.	28
Total	160

[++] EE students are strongly encouraged to take more technical electives to further explore their engineering interest through EE specialisations, or other interest by taking a minor or second major.

[1] BEng students are required to read a Critical Thinking & Writing module (ES1531 Critical Thinking & Writing. Alternatively, students can read ES1501X Academic Expository Writing in place of both ES1531. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of ES1531. For students who does not meet the pre-requisite of ES1531, they need to take ES1103 before ES1531.

[2] For BEng students in the following special programmes: DDPs, CDPs, GEP & CSP, internship / industrial-attachment is optional and the modular credits for the internship/industrial-attachment will be become 'Free Electives' i.e., Unrestricted Electives (UE).

During their senior years of study, students may specialize in certain fields of EE through their selection of 12 MCs of outer core elective modules in Table 3.2.5b and 16 MCs of technical electives from number of areas in Table 3.2.5c as follows: Communications & Networks, Integrated Circuits & Embedded Systems, Control, Intelligent Systems & Robotics, Signal Analysis & Machine Intelligence, Microelectronics Technologies & Devices, Microwave and RF, Power and Energy Systems, Bioelectronic Systems and Information Processing. An outer core elective module enables students to achieve a broad understanding of concepts in the particular area. A technical elective is a higher-level module that provides greater depth and coverage in the particular area.

The outer core modules are organised in eight areas in Table 3.2.5b. Students need to read three modules from a minimum of three areas of outer core modules to achieve exposure to various facets of EE. To achieve depth, students need to read a minimum of four technical electives. All three outer core must add up to at least 12 MCs and technical electives must add up to at least 16 MCs, out of which 8 MCs must be used to fulfil PPP and RFP Pathway requirements. The students opting for iDCP pathway must choose their unrestricted and technical electives as prescribed by the pathway requirements. EE students should read at least 12 MCs of technical elective modules offered by the EE Department (i.e., those with EExxxx module codes). Students may also take additional EE technical elective modules to satisfy the Unrestricted Elective Modules (UEM) and also further their interest in certain areas of engineering based on the recommended tracks. The list of tracks is given in Table 3.2.5d.

Table 3.2.5b: List of Outer Core Modules in the Various Areas

Areas	Outer Core

Microwave & RF System	EE3104C Introduction to RF and Microwave Systems and Circuits
Communications & Networks	EE3131C Communication Systems
Control, Intelligent Systems & Robotics	EE3331C Feedback Control Systems
Integrated Circuit & Embedded Systems	EE3408C Integrated Analog Design
Microelectronics Technology & Devices	EE3431C Microelectronics Materials & Devices
Power & Energy Systems	EE3505C Electrical Energy Systems
Signal Analysis and Machine Intelligence	EE3731C Signal Processing Methods
Engineering Computing	CS2040/C Data Structures and Algorithms

Table 3.2.5c: List of Electives in the Various Areas

Communications & Networks	
EE3204	Computer Communication Networks I
EE4210	Computer Communication Networks II
EE5135	Digital Communications
Integrated Circuits & Embedded Systems	
CG3207	Computer Architecture
EE3407	Analog Electronics
EE4218	Embedded Hardware System Design
EE4415	Integrated Digital Design
EE4434	Integrated Circuit Technology, Design and Testing
EE5903	Real-Time Systems
Control, Intelligent Systems & Robotics	

EE3302	Industrial Control Systems
EE3304	Digital Control Systems
EE4302	Advanced Control Systems
EE4305	Introduction to Fuzzy/Neural Systems
EE4307	Control Systems Design and Simulation
EE4308	Advances in Intelligent Systems and Robotics
ME4245	Robot Mechanics and Control
EE5101R	Linear Systems
Microelectronic Technologies & Devices	
EE3409	Microelectronic Applications for Modern Life
EE4435	Modern Transistors and Memory Devices
EE4436	Fabrication Process Technology
EE4437	Photonics – Principles and Applications
EE4438	Solar Cells and Modules
EE5440	Magnetic Data Storage for Big Data
Power & Energy Systems	
EE4501	Power System Management & Protection
EE4502	Electric Drives and Control
EE4505	Power Semiconductor Devices and ICs
EE4509	Silicon Microsystems
EE4511	Sustainable Energy Systems
EE5702	Advanced Power System Analysis
EE5703	Modelling and Control of Electrical Actuators
EE5711	Modelling and Control of Power Electronic Converters

Signal Analysis and Machine Intelligence	
EE3206	Introduction to Computer Vision and ImageProcessing
EE3701	Digital Media Technologies
EE4212	Computer Vision
EE5907	Pattern Recognition
Microwave & RF	
EE4101	RF Communications
EE4104	Microwave Circuits & Devices
EE4112	HF Techniques
EE5303	Microwave Electronics
Bioelectronic Systems	
EE4603	Biomedical Imaging Systems
BN4404	BioMEMS
BN4406	Biophotonics and Bioimaging
Information Processing	
CS2103	Software Engineering
CS2106	Introduction to Operating Systems
CS3230	Design and Analysis of Algorithms
CS3233	Competitive Programming
CS4231	Parallel and Distributed Algorithms

Table 3.2.5d: Possible Tracks in Electrical Engineering

Advanced Control

Biomedical Systems
Distributed Autonomous Systems
Embedded Systems
Computational Intelligence
Integrated Circuit Technology
Information Storage Materials and Devices
Mechatronics and Automation
Microelectronic Devices
Microwave and RF CAD
Microwave and RF Systems
Networking & Distributed Systems
Power Systems Analysis and Control
Power Electronics, Electric Drives & Semiconductor Devices
Process Control
Renewable Energy Materials & Devices
Sustainable Energy Devices and Systems
VLSI design
Wireless Communications

For details on module selections based on possible specialisation set of modules, please refer to: www.ece.nus.edu.sg/education/undergraduate/ee/Specialization.html

3.2.5.3 Recommended Semester Schedule

The recommended semester schedule for EE students is presented in Table 3.2.5e.

Table 3.2.5e: Recommended Semester Schedule for EE students

MODULES	MCS	MODULES	MCS
Semester 1		Semester 2	
MA1511 Engineering Calculus MA1512 Differential Equations for Engineering	2 2	MA1508E Linear Algebra for Engineering	4
IT1007 Introduction to Programming with Python and C	4	ES1531 Critical Thinking & Writing	4
EG1111 Engineering Principles & Practice I	6	EG1112 Engineering Principles & Practice II	6
GER1000 Quantity Reasoning	4	GEQ1000 Asking Questions	4
ES1103 or GES/GEH/GET*	4	EE2026 Digital Design	4
Sub-total	22	Sub-total	22
Semester 3		Semester 4	
EE2023 Signals and Systems	4	EE2012 Analytical Methods in ECE	4
EE2027 Electronic Circuits	4	PC2020 Electromagnetics for Electrical Engineers	4
EE2028 Microcontroller Programming and Interfacing	4	EE2033 Integrated Systems Lab	4
GES/GEH/GET*	4	Outer core Technical Elective x 1	4
UE* x 2	8	UE* x 1	4
Sub-total	24	Sub-total	20

MODULES	MCS	MODULES	MCS
Semester 5		Semester 6	
EG3611 Industrial Attachment	10	EE3031 Innovation & Enterprise I	4
		EG2401 Engineering Professionalism	2
		Outer core Technical Elective x 2	8
		GES/GEH/GET*	4
		Technical Elective x 1	4
Sub-total	10	Sub-total	22
Semester 7		Semester 8	
EE4002D or EE4002R Capstone Project (over 2 semesters)	4	EE4002D or EE4002R Capstone Project (over 2 semesters))	4
Technical Electives x 2	8	Technical Electives x 2	8
UE* x 2	8	UE* x 2	8
Sub-total	20	Sub-total	20
Total MCs			160

* These GE modules (GES, GET, GEH) and UEs can be read in any semester.

Note: The Department reserves the right to change the curriculum.

3.2.6 Bachelor of Engineering (Engineering Science)

3.2.6.1 Overview

From January 2017 onwards, ESP is hosted and supported by the following three departments (Electrical Engineering and Computing, Mechanical Engineering and Physics). All academic staff working for ESP are pooled from these departments and ESP is now jointly owned by them.

Engineering Science students will read a set of core engineering science modules in the first two years that will provide a strong background in the fundamentals in engineering, science, materials, mathematics and computing. A portion of the curriculum is set aside for non-engineering modules in areas such as engineering professionalism and human relations. These are intended to equip our graduates with the knowledge to function effectively in tomorrow’s workplace. Students will undergo a 12-week research internship during the vacation period following the second or third year of their studies. In the final two years, the curriculum is flexible so that students can pursue interests in any of the following areas of specialisations.

1. Nanoscience and Nanotechnology
2. Computational Engineering Science
3. Photonics and Optics
4. Energy Systems

These courses are specially designed to reduce the common barriers to multidisciplinary work and bring out creative qualities. Graduates will be conferred a Bachelor of Engineering (Engineering Science) degree.

3.2.6.2 Degree Requirements

The following are the requirements for the degree of BEng (Engineering Science):

- Complete a minimum of 160 MCs with a CAP ≥ 2.0;
- Satisfy all requirements as prescribed by the Faculty of Engineering or the University.

For degree requirements, please refer to http://www.esp.nus.edu.sg/curriculum.html (Link does not work with Internet Explorer)

ESP Specialisations

At the end of the second year, students opt for one (or even possibly two) of the four specialisations.

ESP Specialisations in Year 3 and 4
Nanoscience and Nanotechnology
Computational Engineering Science
Photonics and Optics
Energy Systems

For the list of modules within each specialisation, please refer to

www.esp.nus.edu.sg/undergraduate/ESP%20Curriculum/ESP%20Specialisations.pdf

3.2.6.3 Recommended Semester Schedule

Please refer to www.esp.nus.edu.sg/undergraduate/ESP%20Curriculum/ESP%20Overall%20Curriculum.pdf. (Link does not work with Internet Explorer)

3.2.7 Bachelor of Engineering (Environmental Engineering)

3.2.7.1 Overview

The BEng (Environmental Engineering) programme is offered by the Department of Civil and Environmental Engineering. The curriculum is designed to meet student needs in the context of the mission of the Department and the Faculty of Engineering. The programme's educational objectives are:

- Graduates will be technically competent. This includes having the ability to analyse and solve environmental engineering problems by applying mathematics, engineering principles, computer skills, and natural sciences to environmental engineering practice, and using modern engineering techniques, skills, and tools to identify, formulate and solve environmental engineering problems.
- Graduates will be able to apply knowledge and skills from a broad education in order to understand the impact of environmental engineering solutions in a global, societal, and environmental context, consistent with principles of sustainable development.
- Graduates will be prepared for professional practice in environmental engineering and will demonstrate abilities to communicate and work effectively in an ethical manner on professional teams, exhibiting a commitment to life-long learning and professional development in industry, government, and /or academia.

Outcomes

The BEng (Environmental Engineering) programme aims to achieve the following learning outcomes:

- An ability to apply scientific and engineering principles as well as contemporary technology to the discipline.
- An ability to design and conduct experiments, as well as to analyse and interpret data in several areas, which can include air quality and resources, water and land quality and resources, energy systems, and environmental and human health impacts.
- An ability to identify, formulate and solve engineering problems and to design a system, component, or process to meet desired needs.
- An ability to convey technical material through oral presentations and written communications.
- A knowledge of contemporary and emerging environmental issues and a recognition of the need for, and an ability to engage in, life-long learning.
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice with an integrated understanding of professional, societal, and ethical responsibilities and the importance of, and role for, multidisciplinary teams in professional practice.

The four-year undergraduate BEng (Environmental Engineering) programme has been designed to provide a comprehensive learning experience. The Programme Requirements are made up of general Faculty Requirements and Major Requirements of the department that is granting the degree. For a breakdown of the requirements, see Table 3.2.7a.

The requirements for a major in BEng (Environmental Engineering) programme ensure a balanced exposure to science, engineering principles as well as contemporary technology. BEng (Environmental Engineering) programme will provide greater flexibility in the choice of career paths of the graduates. It is anticipated that the students will be more motivated in their learning endeavours to make themselves well prepared to pursue their professional interests in a knowledge-based economy. The BEng (Environmental Engineering) programme at NUS is accredited by Engineering Accreditation Board (EAB)

of Singapore. EAB is a signatory to the Washington Accord. The Washington Accord is an international agreement which provides a mechanism for mutual recognition of the substantial equivalence of engineering academic programmes in satisfying the academic requirements for the practice of engineering at the professional level.

3.2.7.2 Degree Requirements

The following are the requirements for the degree of BEng (Environmental Engineering):

- Students in the BEng (Environmental Engineering) Programme are required to complete with a CAP ≥ 2.0 to graduate from the programme.
- will have to be earned by reading modules in accordance with Table 3.2.7a.
- The students are free to choose any combination of the offered modules from Table 3.2.7b of the technical electives.
- A student must also satisfy other additional requirements that may be prescribed by the Faculty of Engineering or the University.

Students may apply to read Minor in Civil Infrastructure and upon successfully completion of the requirement, student would be sufficiently proficient in core Civil Engineering disciplines. These will provide necessary background and training to better prepare the graduates for a professional role in infrastructure development.

Table 3.2.7a: Summary of Modular Requirements and Credits (for A-level or equivalent students matriculated in AY2015/2016)

MODULAR REQUIREMENTS	MCS
University Level Requirements	20
General Education Modules (GE) (5 Modules, each of 4MCs) • Human and Cultures (H&C) • Quantitative Reasoning (QR) • Thinking and Expression (T&E) • Singapore Studies (SS) • Asking Questions (AQ)	20
Programme Requirements	
Faculty Requirements	
ES1531 Critical Thinking & Writing[1]	–
EG2401 Engineering Professionalism	3
ES1102 English[2]	–

MODULAR REQUIREMENTS		MCS
Environmental Engineering Major Requirements		
Foundation Requirements		
PC1431	Physics IE	4
CE2409	Computer Applications in Civil Engineering	4
CM1502	General and Physical Chemistry for Engineers	4
Basic Engineering Modules:		
CE2134	Hydraulics	4
CE2183	Construction Project Management	4
CE2407	Engineering and Uncertainty Analysis	4
Engineering Process/Infrastructure Engineering (3 of the following courses):		12
CE2112	Soil Mechanics	4
CE2155	Structural Mechanics and Materials	4
CE3132	Water Resources Engineering	4
CN2121	Chemical Engineering Thermodynamics	4
AR2723	Strategies for Sustainable Architecture	4
LSM1401	Fundamentals of Biochemistry	4
Environmental Engineering Core Modules:		28
ESE1001	Environmental Engineering Fundamentals	4
ESE2001	Environmental Processes	4
ESE2401	Water Science & Technology	4
ESE3101	Solid and Hazardous Waste Management	4
ESE3201	Air Quality Management	4
ESE3301	Environmental Microbiological Principles	4

MODULAR REQUIREMENTS	MCS
ESE3401 Water & Wastewater Engineering 1	4
ESE Design and Project Modules	12
ESE4501 Design Project	4
ESE4502R BEng Dissertation	8
(from Table 3.2.7b)	
Industrial Engagement[3]	
Total	162

[1] BEng students are required to read a Critical Thinking & Writing module (ES1531 Critical Thinking & Writing which also satisfies the General Education (Thinking & Expression) requirement) and a Communications module (ES2331 Communicating Engineering). Alternatively, students can read ES1501X Academic Expository Writing in place of both ES1531 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of ES1531 and/or ES2331.

[2] For students who have not passed or been exempted from the Qualifying English Test at the time of admissions to the Faculty.

[3] For BEng students in the following special programmes: DDPs, CDPs, GEP & CSP, internship / industrial-attachment is optional and the modular credits for the internship/industrial-attachment will be become 'Free Electives' i.e., Unrestricted Electives (UE).

Note: Limit on Level-1000 Modules
Students should not read more than 60 MCs of Level-1000 modules towards their degree requirements (minimum of 162 MCs for graduation).

Table 3.2.7b: Technical Elective Modules*

Department of Civil and Environmental Engineering

ESE4301 Wastewater Biotechnology
ESE4401 Water & Wastewater Engineering 2
ESE4403 Membrane Tech in Env Applns
ESE4404 Bioenergy
ESE4405 Urban Water Engineering & Management

ESE4406 Energy and the Environment
ESE4407 Environmental Forensics
ESE4408 Environmental Impact Assessment
ESE4409 Environmental Applications of Adsorption
ESE5201 Combustion Pollution Control
ESE5202 Air Pollution Control Technology
ESE5203 Aerosol Science and Technology
ESE5204 Toxic & Hazardous Waste Management
ESE5205 Sludge and Solid Waste Management
ESE5301 Environmental Biological Principles
ESE5401 Water Quality Management
ESE5402 Industrial Wastewater Control
ESE5403 Water Reclamation & Reuse
ESE5404 Biological Treatment Processes
ESE5405 Water Treatment Processes
ESE5406 Membrane Treatment Process and Modelling
ESE5601 Environmental Risk Assessment
ESE5602 Environmental Management Systems
ESE5603 Pollution Minimisation and Prevention
CE4231 Earth's Climate: Science & Modelling
CE4247 Treatment Plant Hydraulics
CE5307 Wave Hydrodynamics and Physical Oceanography
CE5603 Engineering Economics & Project Evaluation
CE5883A Topics in Hydraulic & Water Resources

* CEE reserves the right to decide on the modules to be offered in any given semester.

Dept of Chemical and Biomolecular Engineering

SH5002 Fundamentals in Industrial Safety
SH5110 Chemical Hazard Evaluation
SH5101 Industrial Toxicology
SH5402 Advanced SHE Management

3.2.7.3 Recommended Semester Schedule

The recommended semester schedule for EVE students is presented in Table 3.2.7b and Poly-Direct entry in Table 3.2.7c.

Table 3.2.7b: Recommended Semester schedule for EVE Students (Cohort AY2015/2016 onwards)

MODULES	MCS	MODULES	MCS
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE	4	GE on QR or T&E	4
ESE1001 Environmental Engineering Fundamentals	4	CE2134 Hydraulics	4
GE on QR or T&E	4	CM1502 General and Physical Chemistry for Engineers	4
CE1109 Statics and Mechanics of Materials	4	CE2122 Soil Mechanics LSM1401 Fundamentals of Biochemistry [Δ]	4
ES1102* English for Academic Purposes	–		
Sub-total	20	Sub-total	20

* Students who have not passed or even been exempted from the Qualifying English Test at the time of admissions to the Faculty, will have to read ES1000 and/or ES1102. This will be decided by CELC. ES1531 must be read and it can be used to fulfil GE (T&E).

MODULES	MCS	MODULES	MCS
Semester 3		Semester 4	
CE2155 Structural Mechanics and Materials[Δ] CN2121 Chemical Engineering Thermodynamics [Δ], or LSM1401 Fundamentals of Biochemistry [Δ], or CM2142 Analytical Chemistry [Δ]	4	LSM1401 Fundamentals of Biochemistry [Δ], or CM2142 Analytical Chemistry [Δ], or AR2723 Strategies for Sustainable Architecture [Δ], or CE3132 Water Resources Engineering [Δ]	4
CE2409 Computer Applications in Civil Engineering	4	ESE2401 Water Science & Technology	4
CE2407 Engineering and Uncertainty Analysis	4	2 x GE	8
ESE2001 Environmental Processes	4	UE 1	4
ES2331 Communicating Engineering	4	UE 2	4
Sub-total	20	Sub-total	24

[Δ] Students are required to read 3 out of the 6 modules listed. LSM1401 and CM2142 are offered in both Semesters. Module choices are subjected to timetable availability and fulfilment of co/pre-requisites, if any.

MODULES	MCS	MODULES	MCS
Semester 5		Semester 6	
ESE3101 Solid and Hazardous Waste Mgmt	4	Industrial Engagement	12
ESE3201 Air Quality Management	4	UE 3	4
ESE3301 Environmental Microbiological Principles	4	UE 4	4

MODULES	MCS	MODULES	MCS
ESE3401 Water & Wastewater Engineering 1	4		
CE2183 Construction Project Management	4		
Sub-total	20	Sub-total	20

MODULES	MCS	MODULES	MCS
Semester 7		Semester 8	
ESE4501 Design Project	4	ESE4502R BEng Dissertation (Cont'd)	4
ESE4502R BEng Dissertation	4	HR2002 Human Capital in Organizations	3
Technical Elective Module 2	4	EG2401 Engineering Professionalism	3
Technical Elective Module 3	4	UE 5	4
GE	4	Technical Elective Module 1	4
Sub-total	20	Sub-total	18

Note: The above schedule can be revised in the event of timetabling constraints.

Table 3.2.7c: Recommended Semester Schedule for BEng (Env Eng) students with an accredited Polytechnic Diploma matriculated August 2014

MODULES	MCS	MODULES	MCS
Semester 3		Semester 4	

MODULES	MCS	MODULES	MCS
MA1301 Introductory Mathematics *(can count towards Free Elective 1)*	4	MA1505 Mathematics I	4
GE on QR or T&E	4	ESE2401 Water Science and Technology	4
ESE1001 Environmental Engineering Fundamentals	4	CM1502 General and Physical Chemistry for Engineers*	4
ESE2001 Environmental Processes	4	GE on QR or T&E	4
PC1431 Physics IE *	4	CE1109 Statics and Mechanics	4
ES1102** English for Academic Purposes	–	GE	4
Sub-total	20	Sub-total	24

* PC1431 or CM1502 will be exempted for those who have passed the APC Test for either one of the modules.

** Students who have not passed or even been exempted from the Qualifying English Test at the time of admissions to the Faculty, will have to read ES1000 and/or ES1102. This will be decided by CELC.

Note:

- Student exempted from MA1301, will take MA1505 in Semester 1 then MA1506 in Semester 2 and CE2407 in Semester 3.
- ES2331 must be read on a graded basis to fulfil UEM

MODULES	MCS	MODULES	MCS
Semester 5		Semester 6	

MODULES	MCS	MODULES	MCS
MA1506 Mathematics II	4	CE2155* Structural Mechanics and Materials (Pre-Req: CE1109), or CM2142* Analytical Chemistry (Pre-Req: CM1101), or AR2723* Strategies for Sustainable Architecture, or LSM1401* Fundamentals of Biochemistry	4
CE2112* Soil Mechanics (Pre-Req: CE1109), or LSM1401* Fundaments of Biochemistry, or CN2121* Chemical Engineering Thermodynamics (Pre-Req: CN1111 and CM1502), or CM2142* Analytical Chemistry (Pre-Req: CM1101 waived if pass CM1502)	4	CE2134 Hydraulics	4
ESE3401 Water and Wastewater Engineering 1	4	Technical Elective Module 1	4
CE2183 Construction Project Management	4	Free Elective Module 2	4
GE	4	Free Elective Module 3	
GE	4		
Sub-total	24	Sub-total	20

* Students are required to read 3 out of 6 modules listed. LSM 1401 and CM 2142 are offered in both semesters. Module choices are subjected to timetable availability and fulfilment of co/pre-requisites, if any.

MODULES	MCS	MODULES	MCS
Semester 7		Semester 8	
ESE3101 Solid & Hazardous Waste Management	4	ESE4502 BEng Dissertation *(cont'd)*	4
ESE3201 Air Quality Management	4	CE2155* Structural Mechanics and Materials (Pre-Req: CE1109), or CE3132 Water Resources Engineering (Pre-Req: CE2134), or AR2723* Strategies for Sustainable Architecture, or CM2142* Analytical Chemistry (Pre-Req: CM1101), or LSM1401* Fundamentals of Biochemistry	4
ESE3301 Environmental Microbiological Principles	4	EG2401 Engineering Professionalism	3
ESE4501 Design Project	4	Technical Elective Module 2	4
ESE4502 BEng Dissertation	4	Technical Elective Module 3	4
CE2407 Engineering and Uncertainty Analysis *(if not taken in earlier semesters)*	4		
Sub-total	24	Sub-total	19

Note:

- The above schedule can be revised in the event of timetabling constraints.
- Polytechnic graduates admitted into BEng programmes with the (12MC) Industrial Engagement requirement, may take the 3-month internship (6MC via EG3612) and/or 'Free Elective' modules in lieu of the 12 MC for EG3611. Students can consider taking their Free Elective module/s during Special Terms.

Please refer to CEE website for any update: www.eng.nus.edu.sg/cee/programmes/BEng_Env.html

3.2.8 Bachelor of Engineering (Industrial & Systems Engineering)

3.2.8.1 Overview

The Department of Industrial Systems Engineering and Management (ISEM) was established in the Faculty of Engineering in 1972. It offers an undergraduate BEng (Industrial & Systems Engineering) degree programme and graduate programmes leading to the MSc (Industrial & Systems Engineering), MEng and PhD degrees.

The domain knowledge of ISE is derived from combinations of engineering, mathematics, statistics, computing and social sciences. The ISE discipline calls for the adoption of a holistic view in resolving problems encountered and developing opportunities presented, coupled with a strong emphasis on efficiency and productivity improvement. Such a perspective provides the decision makers with the capacity for the identification, analysis and design of complex productive systems through an integrated approach. This will lead to effective systems in both the industrial and service sectors.

ISE is unique among the engineering disciplines in that the application of its techniques is not restricted to only specific technological or industrial problems. Its application can be found in a wide range of areas. Versatility is a trait of ISE graduates. Some examples are:

- Manufacturing and engineering industries: process optimisation, systems integration, quality and reliability engineering, human factors engineering, factory physics, just in time, etc.
- Logistics industry: third party logistics, vendor managed inventory, integrators, transportation and distribution networks optimisation, order fulfilment process, etc.
- Defence industry in relation to support of military operations.
- Service industry: management consultancy, risk management, service quality, information systems, project management, banking service strategy, etc.

Programme Educational Objectives

The Programme Educational Objectives of BEng (Industrial & Systems Engineering)'s curriculum strive to equip graduates with the following attributes:

1. Apply fundamental knowledge and skill sets required in the Industrial and Systems Engineering profession.
2. Adopt a systems approach to design, develop, implement and innovate integrated systems that include people, technology, information, energy and resources taking into account global, societal, environmental and economic contexts.
3. Work and communicate effectively with multi-disciplinary team members and different types of stakeholders.
4. Recognize the need and continue to develop skills and knowledge to embrace changes in society and the profession.

To achieve these educational objectives, the curriculum offers students the flexibility of customising their modules for both breadth and depth. The breadth comes in the form of Unrestricted Elective Modules (UEMs), reading other approved engineering, computer science and science modules not covered in the curriculum, enhancement programmes and other international academic exchange programmes. The depth comes from the provision of focused sets of modules, projects and other activities to equip students

with the necessary expertise to operate effectively within particular domains in the field.

Student Learning Outcomes

The Student Learning Outcomes of BEng (Industrial & Systems Engineering)'s curriculum strive to equip graduates with the following attributes:

a. Engineering Knowledge: Apply the knowledge of mathematics, science, and engineering to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, research through relevant literature review, and analyze complex engineering problems to reach substantiated conclusions using mathematics, natural sciences, and engineering sciences.
c. System Design and Development: Design and develop solutions for complex engineering problems including systems, components and/or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d. Investigation: Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create/select and apply appropriate techniques, resources, and modern engineering and IT tools to complex engineering activities with an understanding of the limitations.
f. The engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of professional engineering solutions in a societal and environmental context and to demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of engineering and management principles and economic decision-making, and apply them to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Rapid globalisation forces firms to spread their operations across a greater range and diversity of locations than ever before. The demand for effective integration of these far-flung operations has become the focus of logistics and supply chain management. Furthermore, the easy availability of information raises the expectations of consumers on the quality of products and services offered, which translates into the demand for skills in quality engineering and management. Singapore's economy has also entered a phase where competitiveness of its industry in the global market has to be linked to capability in design and this would require designers with skills which combine the art of design and science of engineering. The depth and breadth of the curriculum will equip students with the necessary skills and knowledge to

address specific challenges in complex integrated multidisciplinary systems and to meet the demands of the Singapore economy.

In summary, we see that the global trend has created the condition of increasing system complexity in which the need for integrative skills becomes more important. We believe that the ISE curriculum can provide the students with the requisite skills to add value in such a world. They will be the ones who will be able to create new opportunities in bringing diverse elements together on account of their systems mind-set.

3.2.8.2 Degree Requirements

Students in the Bachelor of Engineering (Industrial & Systems Engineering) programme are required to fulfil the following requirements to graduate from the programme:

- Complete a minimum of 160 MCs with a CAP ≥ 2.0;
- Pass the modules in accordance with Table 3.2.8a, 3.2.8b and 3.2.8c for Practicing Professional, Research-focused and Innovation & Design Centric Pathways, respectively;
- Satisfy all other requirements as prescribed by the Faculty of Engineering or the University.

Students are advised to refer to Industrial Systems Engineering and Management Department website at www.isem.nus.edu.sg for latest information on BEng (ISE) curriculum.

Table 3.2.8a: Summary of Modular Requirements and Credits for Practicing Professional Pathway (PPP)

Modular Requirements	MCs	MCs	MCs
	Option 1	**Option 2**	**Option 3**
University Level Requirements	**20**	**20**	**20**
General Education Modules (GE) (5 Modules, each of 4MCs) • Human and Cultures (H&C) • Quantitative Reasoning (QR) • Thinking and Expression (T&E) • Singapore Studies (SS) • Asking Questions (AQ)	20	20	20
Unrestricted Electives	**32**	**32**	**32**
Programme Requirements			
Faculty Requirements	**6**	**6**	**6**
ES1531 Critical Thinking and Writing	4	4	4
EG2401A Engineering Professionalism	2	2	2
ES1xxx English [1]			
ISE Foundation Requirements	**20**	**20**	**20**
MA1505 Mathematics I	4	4	4

MA1508E Linear Algebra	4	4	4
CS1010E Programming Methodology	4	4	4
Basket of Science Modules (PC1431/PC1432)	4	4	4
ST2334 Probability and Statistics	4	4	4
ISE Major Requirements	**74**	**74**	**74**
IE1111 Industrial & Systems Engineering Principles & Practice I	6	6	6
IE1112 Industrial & Systems Engineering Principles & Practice II	6	6	6
IE2100 Probability Models with Applications	4	4	4
IE2110 Operations Research I	4	4	4
IE2130 Quality Engineering I	4	4	4
IE2140 Engineering Economy	4	4	4
IE2150 Human Factors Engineering	4	4	4
IE3100M Systems Design Project	12	12	12
IE3101 Statistics for Engineering Applications	4	4	4
IE3110R Simulation	4	4	4
IE4100R BEng Dissertation	–	8	–
IE4102 Independent Study Module	4	–	4
EG3611A Industrial Attachment Programme [2]	–	–	10
EG3612 Vacation Internship Programme [2]	6	6	–
ISE Electives (see Table 3.2.8e)	12	8	8
Pathway Requirements (PPP)	**8**	**8**	**8**
IE4211 Modelling and Analytics	4	4	4
IE4240 Project Management	4	4	4
Total	**160**	**160**	**160**

[1] Students who have not passed or been exempted from the Qualifying English Test at the time of admissions to the Faculty will have to read ES1000 and/or ES1103. This will be decided by CELC.

[2] For BEng students who are from direct poly intake and in the following special programmes: DDPs, CDPs, GEP & CSP, internship/industrial-attachment is optional and the modular credits for the internship/industrial-attachment will become 'Free Electives' i.e., Unrestricted Electives (UE).

Practicing Professional Pathway

- PPP students can select one of the following options to meet the degree requirements:

  Option 1: ISM and VIP (10MCs) + ISE Electives (12MCs)

  Option 2: FYP and VIP (14MCs) + ISE Electives (8MCs)

  Option 3: ISM and IAP (14MCs) + ISE Electives (8MCs)

- PPP students will have to read IE4211 and IE4240 of professional development modules to meet the pathway requirements (8MCs).

Table 3.2.8b: Summary of Modular Requirements and Credits for Research-focused Pathway (R*f*P)

Modular Requirements	MCs
University Level Requirements	**20**
General Education Modules (GE) (5 Modules, each of 4MCs) • Human and Culture (H&C) • Quantitative Reasoning (QR) • Thinking and Expression (T&E) • Singapore Studies (SS) • Asking Questions (AQ)	20
Unrestricted Electives	**32**
Programme Requirements	
Faculty Requirements	**6**

ES1531 Critical Thinking and Writing	4
EG2401A Engineering Professionalism	2
ES1xxx English [1]	
ISE Foundation Requirements	**20**
MA1505 Mathematics I	4
MA1508E Linear Algebra	4
CS1010E Programming Methodology	4
Basket of Science Modules (PC1431/PC1432)	4
ST2334 Probability and Statistics	4
ISE Major Requirements	**74**
IE1111 Industrial & Systems Engineering Principles & Practice I	6
IE1112 Industrial & Systems Engineering Principles & Practice II	6
IE2100 Probability Models with Applications	4
IE2110 Operations Research I	4
IE2130 Quality Engineering I	4
IE2140 Engineering Economy	4
IE2150 Human Factors Engineering	4
IE3100M Systems Design Project	12
IE3101 Statistics for Engineering Applications	4
IE3110R Simulation	4
IE4100R BEng Dissertation	8
EG3612 Vacation Internship Programme [2]	6
ISE Electives (see Table 3.2.8e)	8
Pathway Requirements (R*f*P)	**8**

IE5xxx/IE6xxx (see Table 3.2.8d)	4
IE5xxx/IE6xxx (see Table 3.2.8d)	4
Total	**160**

[1] Students who have not passed or been exempted from the Qualifying English Test at the time of admission to the Faculty will have to read ES1000 and/or ES1103. This will be decided by CELC.

[2] For BEng students who are from direct poly intake and in the following special programmes: DDPs, CDPs, GEP & CSP, internship/industrial-attachment is optional and the modular credits for the internship/industrial-attachment will become 'Free Electives' i.e., Unrestricted Electives (UE).

Research-focused Pathway

- R*f*P student will have to carry out internship in Research Institutions or R&D Labs.
- R*f*P students will have to work on research based FYP.
- R*f*P students will have to read any two 5000 level (or 6000 level) modules from the Basket of Modules for Research-focused Pathway Requirements (see Table 3.2.8d).
- R*f*P students will have to take UROP (Undergraduate Research Opportunities Programme – 4MCs).

Table 3.2.8c: Summary of Modular Requirements and Credits for Innovation & Design Centric Pathway (*i*DCP)

Modular Requirements	MCs
University Level Requirements	**20**
General Education Modules (GE) (5 Modules, each of 4MCs) • Human and Culture (H&C) • Quantitative Reasoning (QR) • Thinking and Expression (T&E) • Singapore Studies (SS) • Asking Questions (AQ)	20
Unrestricted Electives	**32**
Programme Requirements	
Faculty Requirements	**6**

ES1531 Critical Thinking and Writing	4
EG2401A Engineering Professionalism	2
ES1xxx English [1]	
ISE Foundation Requirements	**20**
MA1505 Mathematics I	4
MA1508E Linear Algebra	4
CS1010E Programming Methodology	4
Basket of Science Modules (PC1431/PC1432)	4
ST2334 Probability and Statistics	4
ISE Major Requirements	**74**
IE1111 Industrial & Systems Engineering Principles & Practice I	6
IE1112 Industrial & Systems Engineering Principles & Practice II	6
IE2100 Probability Models with Applications	4
IE2110 Operations Research I	4
IE2130 Quality Engineering I	4
IE2140 Engineering Economy	4
IE2150 Human Factors Engineering	4
IE3100M Systems Design Project	12
IE3101 Statistics for Engineering Applications	4
IE3110R Simulation	4
IE4100R BEng Dissertation	8
EG3612 Vacation Internship Programme [2]	6
ISE Electives (see Table 3.2.8e)	8
Pathway Requirements (*i*DCP)	**8**

Innovation & Enterprise Electives	8
Total	**160**

[1] Students who have not passed or been exempted from the Qualifying English Test at the time of admission to the Faculty will have to read ES1000 and/or ES1103. This will be decided by CELC.

[2] For BEng students who are from direct poly intake and in the following special programmes: DDPs, CDPs, GEP & CSP, internship/industrial-attachment is optional and the modular credits for the internship/industrial-attachment will become 'Free Electives' i.e., Unrestricted Electives (UE).

Innovation & Design Centric Pathway

- *i*DCP students will have to do a design project (EG3301R – 12MCs), FYP (EG4301 – 12MCs) and a 12-week internship (EG3612 – 6MCs).
- For mapping of *i*DCP modules to ISE modules and pathway requirements (8MCs), please refer to the *i*DCP website.

Table 3.2.8d: Basket of Modules for Research-focused Pathway Requirements

Modules
IE5108 Facility Layout and Location
IE5202 Applied Forecasting Systems
IE5203 Decision Analysis
IE5205 Healthcare Systems and Analytics
IE5213 Service Innovation and Management
IE5407 Flexibility in Engineering Systems Design
IE6001 Foundations of Optimization
IE6002 Advanced Engineering Statistics
IE6005 Stochastic Models and Optimization

Table 3.2.8e: List of ISE Electives

ISE TECHNICAL ELECTIVES
IE3105 Fundamentals of Systems Engineering and Architecture
IE3120 Manufacturing Logistics
IE4210 Operations Research II
IE4211 Modelling and Analytics
IE4220 Supply Chain Modelling
IE4221 Transportation Demand Modelling and Economics
IE4229 Selected Topics in Logistics
IE4230 Quality Engineering II
IE4239 Selected Topics in Quality Engineering
IE4240 Project Management
IE4241 Work, Technology and Organization
IE4242 Cost Analysis and Management
IE4243 Decision Modeling and Risk Analysis
IE4244 Energy: Security, Competitiveness and Sustainability
IE4249 Selected Topics in Engineering Management
IE4250 System Dynamics Modelling
IE4251 Process Analysis and Redesign
IE4259 Selected Topics in Systems Engineering
IE4299 Selected Topics in Industrial Engineering
IE5108 Facility Layout and Location
IE5121 Quality Planning and Management
IE5203 Decision Analysis

ISE TECHNICAL ELECTIVES
IE5213 Service Innovation and Management
IE5301 Human Factors in Engineering and Design
IE5307 Topics in Human Factor Engineering
MT4002 Technology Management Strategy
MT5002 Management of Industrial R&D

3.2.8.3 Recommended Semester Schedule

Please refer to the Department of Industrial Systems Engineering & Management website at www.isem.nus.edu.sg/beng_students/ for updated copy of the recommended semester schedule.

3.2.9 Bachelor of Engineering (Materials Science & Engineering)

3.2.9.1 Overview

At the undergraduate level, the Department of Materials Science & Engineering offers a four-year engineering curriculum leading to a Bachelor of Engineering degree in Materials Science and Engineering (MSE). This is a professional engineering programme, which prepares students for work as a Materials Engineer in different industries and for further study for postgraduate degrees.

This programme consists of many components – University Level Requirements, Unrestrictive Electives, Faculty Requirements and Major Requirements, in order to provide a broad education. The Faculty and Major Requirements are well-balanced in science, general engineering, and materials science and engineering. MSE graduates will have a solid science foundation, basic engineering background and sound knowledge in materials science and engineering. The Department offers two certified specialisations of Polymeric and Biomedical Materials and Nanostructured Materials/Nanotechnology.

3.2.9.2 Degree Requirements

The following are the requirements for the degree of BEng (Materials Science and Engineering):

- Students in the BEng (Materials Science and Engineering) Programme are required to complete a minimum of 162 MCs with a CAP ≥ 2.0 to graduate from the programme.
- 162 MCs will have to be earned by taking modules in accordance with Table 3.2.9a, 3.2.9b, and 3.2.9c for the research-focused, the professional practice and the design centric pathways, respectively.
- A student may obtain a specialisation certificate in Polymeric and Biomedical Materials or Nanostructured Materials/Nanotechnology by reading four modules from the respective group (Table 3.2.9d). The certificate will be issued by the Department.
- Satisfy all other requirements as prescribed by the Faculty of Engineering or the University.
- A student must also satisfy other additional requirements that may be prescribed by the Faculty of Engineering or the University.

Table 3.2.9a: Summary of MSE Module Requirements and Credits for Research-focused Pathway

Modular Requirements	**MCs**		
UNIVERSITY LEVEL REQUIREMENTS	**20**		
General Education Modules (GE) (5 Modules, each of 4 MCs) Human Cultures (HC) Quantitative Reasoning (QR) Thinking and Expression (T&E) Singapore Studies (SS) Asking Questions (AQ)	20	**UNRESTRICTED ELECTIVES**	**30**
		Faculty Requirements:	**6**
		EG2401A Engineering Professionalism	2
		ES1531 Critical Thinking & Writing	4
		English [1]	–
1st Year Requirements:	24		
MA1512 Differential Equations for Engineering	2		
MA1513 Linear Algebra with Differential Equations	2		
PC1432 Physics IIE [2]	4		
CM1501 Organic Chemistry for Engineers or CM1121 Organic Chemistry 1 [3]	4		

MLE1001 Materials Science and Engineering Principles & Practise I	6
MLE1002 Materials Science and Engineering Principles & Practise II	6
MSE Discipline Requirements:	
MSE Core Modules [4]	**26**
MLE2101 Introduction to Structure of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4
MLE2103 Phase Transformation and Kinetics	3
MLE2104 Mechanical Properties of Materials	4
MLE2105 Electronic Properties of Materials	4
MLE3101 Materials Characterization Laboratory	3
MLE3111 Materials Processing Laboratory	4
MSE Design and Final-Year Project Modules	**16**
MLE4102 Design Project	4
MLE4101 B.Eng. Dissertation [5]	12
MSE Technical Elective	**20**
MLE Level 2000/3000 Electives	12
MLE Level 4000 Electives	8
Pathway Requirements	**8**
MLE Level 5000 Electives	8
Internships Requirement	**10**
EG3611A Industrial Attachment Programme [6, 7]	10
TOTAL	**160**

1. Students who have not passed or been exempted from the Qualifying English Test at the time of admissions to the Faculty will have to read ES1000 and/or ES1103. This will be decided by CELC.
2. Bridging Module: Students without A-Level pass in Physics must read PC1221 Fundamentals of Physics I and PC1222 Fundamentals of Physics II as a prerequisite for PC1432.
3. Bridging Module: Students without A-level pass in Chemistry must read CM1417 Fundamentals of Chemistry as a prerequisite for CM1501.
4. The relevant departments reserve the right to decide the modules to be offered in any given semester.
5. Over two semesters.
6. For BEng students in the following special programmes: DDPs, CDPs, GEP & CSP, internship / industrial-attachment is optional and the modular credits for the internship/industrial-attachment will be become 'Free Electives' i.e., Unrestricted Electives (UE).
7. RfP students will have to carry out internship in Research Institutions or R&D Labs.

Requirements for Research-Focused Pathway

- RfP students will have to carry out internship in Research Institutions or R & D Labs.
- RfP students will have to work on research based FYP over two semesters.
- RfP student will have to work on a team Design project over one semester.
- RfP students will have to complete two Level-5000 modules as their pathway requirements (8MCs). Any MLE coded module at 5000 level can satisfy this requirement.

Table 3.2.9b: Summary of MSE Module Requirements and Credits for Professional Practice Pathway

Modular Requirements	**MCs**		
UNIVERSITY LEVEL REQUIREMENTS	**20**		
General Education Modules (GE) (5 Modules, each of 4 MCs) Human Cultures (HC) Quantitative Reasoning (QR) Thinking and Expression (T&E) Singapore Studies (SS) Asking Questions (AQ)	20	**UNRESTRICTED ELECTIVES**	**32**
		Faculty Requirements:	**6**
		EG2401A Engineering Professionalism	2
		ES1531 Critical Thinking & Writing	4
		English [1]	–
1st Year Requirements:	**24**		
MA1512 Differential Equations for Engineering	2		
MA1513 Linear Algebra with Differential Equations	2		
PC1432 Physics IIE [2]	4		

CM1501 Organic Chemistry for Engineers or CM1121 Organic Chemistry 1 [3]	4
MLE1001 Materials Science and Engineering Principles & Practise I	6
MLE1002 Materials Science and Engineering Principles & Practise II	6
MSE Discipline Requirements:	
MSE Core Modules [4]	**26**
MLE2101 Introduction to Structure of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4
MLE2103 Phase Transformation and Kinetics	3
MLE2104 Mechanical Properties of Materials	4
MLE2105 Electronic Properties of Materials	4
MLE3101 Materials Characterization Laboratory	3
MLE3111 Materials Processing Laboratory	4
MSE Design and Final-Year Project Modules	**14**
MLE4102A Design Project [5]	8
MLE4101A B.Eng. Dissertation	6
MSE Technical Elective	**20**
MLE Level 2000/3000 Electives	12
MLE Level 4000 Electives	8
Pathway Requirement	**8**
Professional Electives	8
Internships Requirement	**10**

EG3611A Industrial Attachment Programme [6, 7]	10	
TOTAL	**160**	

1. Students who have not passed or been exempted from the Qualifying English Test at the time of admissions to the Faculty will have to read ES1000 and/or ES1103. This will be decided by CELC.
2. Bridging Module: Students without A-Level pass in Physics must read PC1221 Fundamentals of Physics I and PC1222 Fundamentals of Physics II as a prerequisite for PC1432.
3. Bridging Module: Students without A-level pass in Chemistry must read CM1417 Fundamentals of Chemistry as a prerequisite for CM1501.
4. The relevant departments reserve the right to decide the modules to be offered in any given semester.
5. Over two semesters.
6. For BEng students in the following special programmes: DDPs, CDPs, GEP & CSP, internship / industrial-attachment is optional and the modular credits for the internship/industrial-attachment will be become 'Free Electives' i.e., Unrestricted Electives (UE).
7. PPP students will have to carry out internship in industrial companies.

Requirements for Professional Practice Pathway

- PPP students will have to carry out internship in industrial companies.
- RPP students will have to work on research based FYP over one semester.
- PPP student will have to work on a team Design project over two semesters.
- PPP students will have to take 8 MCs of professional development modules as their pathway requirements, one of which needs to be related to project management.

Table 3.2.9c: Summary of MSE Module Requirements and Credits for Design Centric Pathway

Modular Requirements	**MCs**		
UNIVERSITY LEVEL REQUIREMENTS	**20**		
General Education Modules (GE) (5 Modules, each of 4 MCs) Human Cultures (HC) Quantitative Reasoning (QR) Thinking and Expression (T&E) Singapore Studies (SS) Asking Questions (AQ)	20	**UNRESTRICTED ELECTIVES**	**28**
		Faculty Requirements:	**6**
		EG2401A Engineering Professionalism	2
		ES1531 Critical Thinking & Writing	4
		English [1]	–

1st Year Requirements:	24
MA1512 Differential Equations for Engineering	2
MA1513 Linear Algebra with Differential Equations	2
PC1432 Physics IIE [2]	4
CM1501 Organic Chemistry for Engineers or CM1121 Organic Chemistry 1 [3]	4
MLE1001 Materials Science and Engineering Principles & Practise I	6
MLE1002 Materials Science and Engineering Principles & Practise II	6
MSE Discipline Requirements:	
MSE Core Modules [4]	**26**
MLE2101 Introduction to Structure of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4
MLE2103 Phase Transformation and Kinetics	3
MLE2104 Mechanical Properties of Materials	4
MLE2105 Electronic Properties of Materials	4
MLE3101 Materials Characterization Laboratory	3
MLE3111 Materials Processing Laboratory	4
MSE Design and Final-Year Project Modules	**24**
EG3301R DCP Project [5]	12
EG4301 DCP B.Eng. Dissertation [5]	12
MLE Technical Elective	**20**
MLE Level 2000/3000 Electives	12

MLE Level 4000 Electives	8
Pathway Requirement Electives	**8**
Innovation & Enterprise Electives	8
Internships Requirement	**6**
EG3612 Vacation Internship Programme [6]	6
TOTAL	**162**

1. Students who have not passed or been exempted from the Qualifying English Test at the time of admissions to the Faculty will have to read ES1000 and/or ES1103. This will be decided by CELC.
2. Bridging Module: Students without A-Level pass in Physics must read PC1221 Fundamentals of Physics I and PC1222 Fundamentals of Physics II as a prerequisite for PC1432.
3. Bridging Module: Students without A-level pass in Chemistry must read CM1417 Fundamentals of Chemistry as a prerequisite for CM1501.
4. The relevant departments reserve the right to decide the modules to be offered in any given semester.
5. Over two semesters.
6. For BEng students in the following special programmes: DDPs, CDPs, GEP & CSP, internship / industrial-attachment is optional and the modular credits for the internship/industrial-attachment will be become 'Free Electives' i.e., Unrestricted Electives (UE).

Table 3.2.9d: MSE Elective Modules

MLE LEVEL 2000/3000 ELECTIVES

MLE2106 Metallic Materials and Processing
MLE2107 Ceramic Materials and Processing
MLE3102 Degradation and Failure of Materials
MLE3104 Polymeric and Composite Materials
MLE3105 Dielectric and Magnetic Materials
MLE3202 Materials for Biointerfaces

MSE LEVEL 4000 ELECTIVES

POLYMERIC AND BIOMEDICAL MATERIALS
(Two modules from this group are required for the specialisation)

MLE4201 Advanced Materials Characterisation
MLE4202 Selected advanced Topics on Polymers
MLE4203 Polymeric Biomedical Materials
ME4253 Biomaterials Engineering
BN4109 Special topics in Bioengineering

BN4301 Principles of Tissue Engineering
CM4266 Current Topics in Materials Chemistry
PC4268 Biophysical Instrumentation and Biomolecular Electronics

NANOSTRUCTURED MATERIALS & NANOTECHNOLOGY

(Two modules from this group are required for the specialisation)
MLE4201 Advanced Materials Characterisation
MLE4204 Synthesis and Growth of Nanostructures
MLE4205 Theory & Modelling of Material Properties
MLE4206 Current topics on Nanomaterials
MLE4208 Photovoltaic Materials
MLE4210 Materials for Energy Storage and Conversion
PC4253 Thin film Technology
CN4223R Microelectronic Thin Films

OTHER ELECTIVE MODULES

MLE4207 Growth Aspects of Semiconductor or EE4436 Semiconductor Process Technology
MLE4209 Magnetism and Magnetic Materials
EE4437 Photonics – Principles and Applications
CN4217R Processing of Microelectronic Materials
CN4203R Polymer Engineering
CN5251 Membrane Science and Technology
ME4283 Micro-fabrication Process
ME4293 Microelectronics Packing

3.2.9.3 Recommended Semester Schedule

Table 3.2.9e: Recommended Semester Schedule for Research-focused Pathway

Module	**MCs**	**Module**	**MCs**
Semester 1		**Semester 2**	
MLE1001 Materials Science and Engineering Principles & Practise I	6	MLE1002 Materials Science and Engineering Principles & Practise II	6
CM15101 Organic Chemistry for Engineers [1]	4	MA1512 Differential Equations for Engineering	2
		MA1513 Linear Algebra with Differential Equations	2
GE on QR or T&E	4	PC1432 Physics IIE [3]	4
GE on SS	4	GE/UE	4
ES1531 Critical Thinking & Writing	4	GE/UE	4
English [2]	–		
Sub-total	**22**	**Sub-total**	**22**
Semester 3		**Semester 4**	
MLE2101 Introduction to Structure of Materials	4	MLE2104 Mechanical Properties of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4	MLE2105 Electronic Properties of Materials	4
MLE2103 Phase Transformation and Kinetics	3	MLE3101 Materials Characterization Laboratory	3
GE/UE	4	GE/UE	4
GE on QR or T&E	4	GE/UE	4
		GE/UE	4
Sub-total	**19**	**Sub-total**	**23**
Semester 5 #		**Semester 6 #**	
MLE3111 Materials Processing Laboratory	4	EG3611A Industrial Attachment Programme	10
MLE Level 2000/3000 Elective	4	MLE Level 2000/3000 Elective	4
MLE Level 2000/3000 Elective	4		
GE/UE	4		

GE/UE	4		
Sub-total	**20**	**Sub-total**	**14**
Semester 7		**Semester 8**	
MLE4101 B.Eng. Dissertation	6	MLE4101 B.Eng. Dissertation	6
MLE4102 Design Project	4	EG2401A Engineering Professionalism	2
MLE Level 4000/5000 Electives	4	MLE Level 4000/5000 Electives	4
MLE Level 4000/5000 Electives	4	UE	4
MLE Level 4000/5000 Electives	4	UE	2
Sub-total	**22**	**Sub-total**	**18**
Total MCs			**160**

[1] Bridging Module: Students without A-level pass in Chemistry must read CM1417 Fundamentals of Chemistry as a prerequisite for CM1501.

[2] Students who score a Band 1 or Band 2 in Qualifying English Test (QET) have to read ES1103 and will be awarded with a 4 MCs upon successful completion of the module.

[3] Bridging Module: Students without A-Level pass in Physics must read PC1221 Fundamentals of Physics I and PC1222 Fundamentals of Physics II as a prerequisite for

Semesters 5 & 6 are interchangeable so that students can go on industrial attachment in either semester.

Table 3.2.9f: Recommended Semester Schedule for Professional Practice Pathway

Module	**MCs**	**Module**	**MCs**
Semester 1		**Semester 2**	
MLE1001 Materials Science and Engineering Principles & Practise I	6	MLE1002 Materials Science and Engineering Principles & Practise II	6
CM15101 Organic Chemistry for Engineers [1]	4	MA1512 Differential Equations for Engineering	2
		MA1513 Linear Algebra with Differential Equations	2
GE on QR or T&E	4	PC1432 Physics IIE [3]	4
GE on SS	4	GE/UE	4

ES1531 Critical Thinking & Writing	4	GE/UE	4
English [2]	–		
Sub-total	**22**	**Sub-total**	**22**
Semester 3		**Semester 4**	
MLE2101 Introduction to Structure of Materials	4	MLE2104 Mechanical Properties of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4	MLE2105 Electronic Properties of Materials	4
MLE2103 Phase Transformation and Kinetics	3	MLE3101 Materials Characterization Laboratory	3
GE/UE	4	GE/UE	4
GE on QR or T&E	4	GE/UE	4
		GE/UE	4
Sub-total	**19**	**Sub-total**	**23**
Semester 5 #		**Semester 6 #**	
MLE3111 Materials Processing Laboratory	4	EG3611A Industrial Attachment Programme	10
MLE Level 2000/3000 Elective	4	MLE Level 2000/3000 Elective	4
MLE Level 2000/3000 Elective	4		
GE/UE	4		
GE/UE	4		
Sub-total	**20**	**Sub-total**	**14**
Semester 7		**Semester 8**	
MLE4101A B.Eng. Dissertation	6	MLE4102A Design Project	4
MLE4102A Design Project	4	MLE Level 4000/Professional Electives	4
MLE Level 4000/Professional Electives	4	MLE Level 4000/Professional Electives	4
MLE Level 4000/Professional Electives	4	UE	4
		UE	4
		EG2401A Engineering Professionalism	2
Sub-total	**18**	**Sub-total**	**22**
Total MCs			**160**

[1] Bridging Module: Students without A-level pass in Chemistry must read CM1417 Fundamentals of Chemistry as a prerequisite for CM1501.

[2] Students who score a Band 1 or Band 2 in Qualifying English Test (QET) have to read ES1103 and will be awarded with a 4 MCs upon successful completion of the module.

[3] Bridging Module: Students without A-Level pass in Physics must read PC1221 Fundamentals of Physics I and PC1222 Fundamentals of Physics II as a prerequisite for

Semesters 5 & 6 are interchangeable so that students can go on industrial attachment in either semester.

Table 3.2.9g: Recommended Semester Schedule for Design Centric Pathway

Module	**MCs**	**Module**	**MCs**
Semester 1		**Semester 2**	
MLE1001 Materials Science and Engineering Principles & Practise I	6	MLE1002 Materials Science and Engineering Principles & Practise II	6
CM15101 Organic Chemistry for Engineers [1]	4	MA1512 Differential Equations for Engineering	2
		MA1513 Linear Algebra with Differential Equations	2
GE on QR or T&E	4	PC1432 Physics IIE [3]	4
GE on SS	4	GE/UE	4
ES1531 Critical Thinking & Writing	4	EG2201A Introduction to Design Thinking (UE)	4
English [2]	–		
Sub-total	**22**	**Sub-total**	**22**
Semester 3		**Semester 4**	
MLE2101 Introduction to Structure of Materials	4	MLE2104 Mechanical Properties of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4	MLE2105 Electronic Properties of Materials	4
MLE2103 Phase Transformation and Kinetics	3	MLE3101 Materials Characterization Laboratory	3
EG2301 Case Studies in Engineering (UE)	4	EG3301R DCP Project	6
GE on QR or T&E	4	GE/UE	4
Sub-total	**19**	**Sub-total**	**21**
Special Term			
EG3612 Vacation Internship Programme	6		

Sub-total	**6**		
Semester 5		**Semester 6**	
MLE3111 Materials Processing Laboratory	4	MLE Level 2000/3000 Elective	4
MLE Level 2000/3000 Elective	4	MLE Level 4000 Elective	4
MLE Level 2000/3000 Elective	4	GE/UE	4
EG3301R DCP Project	6	GE/UE	4
		GE/UE	4
Sub-total	**18**	**Sub-total**	**20**
Semester 7		**Semester 8**	
EG4301 DCP B.Eng. Dissertation	6	EG4301 DCP B.Eng. Dissertation	6
MLE Level 4000 Elective	4	Innovation & Enterprise Elective (UE)	4
Innovation & Enterprise Elective	4	UE	4
Innovation & Enterprise Elective	4	EG2401A Engineering Professionalism	2
Sub-total	**18**	**Sub-total**	**16**
Total MCs			**162**

[1] Bridging Module: Students without A-level pass in Chemistry must read CM1417 Fundamentals of Chemistry as a prerequisite for CM1501.

[2] Students who score a Band 1 or Band 2 in Qualifying English Test (QET) have to read ES1103 and will be awarded with a 4 MCs upon successful completion of the module.

[3] Bridging Module: Students without A-Level pass in Physics must read PC1221 Fundamentals of Physics I and PC1222 Fundamentals of Physics II as a prerequisite for PC1432.

3.2.10 Bachelor of Engineering (Mechanical Engineering)

3.2.10.1 Overview

The undergraduate mechanical engineering curriculum has evolved over the years to meet the challenges of technological development and industry. It emphasises the fundamentals of the engineering sciences as well as applications relevant to the prevailing industries. The students undergo a rigorous course of training in science and mathematics in their first year with the Faculty. In the four semesters following that, the students are given a strong foundation in all the principal areas of mechanical engineering sciences, namely: Applied Mechanics, Control, Electrical Engineering, Fluids Engineering, Manufacturing, Materials and Thermodynamics and Heat Transfer. Engineers exercise their creativity through the innovative products that they design. Design is hence an integral part of the mechanical engineering curriculum. In addition to the teaching of mechanical design principles, students are also taught computer-aided design and analysis (CAD/CAM) with the aid of state-of-the-art computer software and hardware. In the fifth and sixth semesters, students are given a design-and-build project on a group basis. The project provides learning opportunities for the students in integrative skills, and develops innovation, teamwork and communication skills. From the sixth semester onwards, the students are offered a wide-range of technical electives. They may choose a combination of elective modules to suit their individual interests or they may apply to the Department to enrol in one of the following specialisations:

- Aeronautical Engineering
- Energy and Sustainability
- Offshore Oil & Gas Technology

Enrolment in a specialisation is subjected to approval of the Head of Department. The students are also required to undertake a research-based project leading to a BEng Dissertation in the last two semesters. The project enhances the capacity of the students for critical thinking and self-motivated learning, and trains them in research methodology. The independent study elective modules provide further opportunities for interested students to be engaged on project and research-based work.

In addition to the aforementioned specialisations, which may be read as part of the BEng programme, students may also apply to read a minor in conjunction with the main degree. This will require the students to read additional modules as stipulated by the requirements of the minor programme. The available minor programmes are listed at https://www.eng.nus.edu.sg/undergraduatestudies/special-programmes/minors/.

The Mechanical Engineering Programme at NUS prepares its graduates well for challenging and rewarding careers in all phases of productive industrial activity extending from research to design, development and manufacturing. Our graduates are much sought after in a broad spectrum of industry covering:

- General Manufacturing

- Advanced Materials
- Aerospace
- Automation and Control
- Defence
- Precision Engineering
- Semiconductor Manufacturing and Testing
- Thermal and Power Engineering
- Design, Testing and Consulting services

The BEng (Mechanical Engineering) degree is accredited by the Engineering Accreditation Board (EAB) in Singapore. The BEng (Mechanical Engineering) degree is also internationally recognised for admission to graduate studies in all the major universities around the world.

3.2.10.2 Degree Requirements

Students in the BEng. (Mechanical Engineering) programme are required to satisfy the following requirements to graduate from the course:

- Complete a minimum of 160 MCs with a CAP ≥ 2.0.
- Pass the modules in accordance with Table 3.2.10a.
- Pass at least 8 MCs equivalent of technical elective modules as listed in Table 3.2.10b. Students may, subject to approval of the Head of Department, take up to two ME5-Level technical modules in lieu of two of the technical electives
- Subject to approval of the Head of Department, students may enrol in one of the following specialisations when they have completed a minimum of 100 MCs of the programme requirements:
- Aeronautical Engineering
- Energy and Sustainability
- Offshore Oil & Gas Technology
- To qualify for a specialisation, a student must pass at least four modules from the chosen area of specialisation and any other requirements as given in Table 3.2.10c. Students in a specialisation programme are required to do their final-year dissertation (8MCs) in an area related to the specialisation. For updated information on Specialisation programmes, please refer to http://me.nus.edu.sg/current-students/specialisations/

Students should not read more than 60 MCs of Level-1000 modules towards their degree requirements.

Table 3.2.10a: Summary of ME Modular Requirements and Credits (For student intakes from AY2017/18 onwards)

Students are advised to refer to Department of Mechanical Engineering website at me.nus.edu.sg for latest updated information on BEng (ME) Curriculum.

MODULAR REQUIREMENTS	MCS
University Requirements General Education Modules (GE) (5 Modules, each of 4MCs) • Human Cultures (GEH) • Quantitative Reasoning (GER) • Thinking and Expression (GET) • Singapore Studies (GES) • Asking Questions (GEQ)	**20**
Unrestricted Electives	**32**
Programme Requirements	

MODULAR REQUIREMENTS		MCS
Faculty Requirements		**6**
(ES1531 or equivalent) Critical Thinking & Writing[1]		4
EG2401	Engineering Professionalism	2
ES1xxx	English[2]	–
Foundation Requirements		**28**
MA1505	Mathematics I	4
MA1512	Mathematics II	2
MA1513	Mathematics III	2
PC1431	Physics IE	4
CS1010E	Programming Methodology	4
EG1111	Engineering Principles & Practice I	6
EG1112	Engineering Principles & Practice II	6
Mechanical Engineering Major Requirements		
ME Core Subjects		**36**
ME2112	Strength of Materials	4
ME2121	Engineering Thermodynamics	4
ME2134	Fluid Mechanics I	4
ME2142	Feedback Control Systems	4
ME2151	Principles of Mechanical Engineering Materials	4
ME3112	Mechanics of Machines	4
ME3162	Manufacturing Processes	4
Professional Development (Students in iRP pathway will read 2 Level-5000 modules)		8
ME Design and Project Modules		**20**

MODULAR REQUIREMENTS	MCS
ME2102 Engineering Innovation and Modelling	4
ME3103 Mechanical Systems Design	8
ME4101A BEng Dissertation (Over 2 semesters)	8
EG3611a Industrial Attachment[3]	**10**
ME Technical Electives (from Table 3.2.10b)	**8**
Total	**160**

[1] BEng students are required to read ES1531 Critical Thinking & Writing. Alternatively, students can read ES1501X Academic Expository Writing. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of ES1531.

[2] Students who have not passed or been exempted from the Qualifying English Test at the time of admission to the Faculty will have to read ES1000 and/or ES1103. This will be decided by CELC.

[3] For BEng students who are from direct poly intake and in the following special programmes: DDPs, CDPs, GEP & CSP, industrial attachment is optional and the modular credits for the industrial attachment will become 'Free Electives' i.e., Unrestricted Electives (UE).

Table 3.2.10b: ME Technical Electives Modules

Applied Mechanics

ME2114 Mechanics of Materials
ME3211 Mechanics of Solids
ME4212 Aircraft Structures
ME4213 Vibration Theory and Applications
ESP3206 Continuum Mechanics

Control and Mechatronics

ME2143 Sensors and Actuators
ME3241 Microprocessor Applications
ME3242 Automation
ME4241 Aircraft Performance and Stability
ME4245 Robot Mechanics and Control
ME4246 Modern Control System
ME5405◊ Machine Vision

Fluid Mechanics

ME2135 Fluid Mechanics II

ME2143 Sensor and Actuators

ME3232 Compressible Flow

ME3233 Unsteady Flow in Fluid Systems

ME4231 Aerodynamics and Propulsion

ME4233 Computational Methods in Fluid Mechanics

ME5304 ◊ Experimental Fluid Mechanics

ME5305◊ Fundamentals of Aeroelasticity

Manufacturing

ME3261 Computer aided Design and Manufacturing

ME3263 Design for Manufacturing and Assembly

ME4261 Tool Engineering

ME4262 Automation in Manufacturing

ME4263 Fundamentals of Product Development

Materials Science

ME3251 Materials for Engineers

ME4253 Biomaterials Engineering

ME4255 Materials Failure

ME4256 Functional Materials and Devices

Micro Systems Technology

ME3281 Microsystems Design and Applications

Thermodynamics

ME3122 Heat Transfer

ME3221 Sustainable Energy Conversion

ESP3401 Photovoltaic Devices & Systems

ME4223 Thermal Environmental Engineering

ME4225 Applied Heat Transfer

ME4226 Energy and Thermal Systems

ME4227 Internal Combustion Engine

ESP4401 Optimization of Energy Systems

Multidisciplinary

ME3291 Numerical Methods in Engineering

ME4291 Finite Elements Analysis

Table 3.2.10c: Technical Electives Modules for ME Specialisations

Students are advised to refer to Department of Mechanical Engineering website at http://me.nus.edu.sg/current-students/specialisations/ for latest updated information related to specialisations.

Aeronautical Engineering

Students taking the Aeronautical Engineering Specialisation must read ME2135 Fluid Mechanics II, select TWO modules from Group A and TWO modules from Group B and present their FYP in a poster session.

Compulsory

ME2135 Fluid Mechanics II

Group A

ME3232 Compressible Flow
ME4231 Aerodynamics and Propulsion
ME4241 Aircraft Performance and Stability
ME5305◊ Fundamentals of Aeroelasticity

Group B

ME4212 Aircraft Structures
ME4233 Computational Methods in Fluids Mechanics
ME4291 Finite Element Analysis
ME5304◊ Experimental Fluid Mechanics

Energy and Sustainability

Students taking the Energy and Sustainability specialisation must take at least FOUR modules from the list below and present their FYP in a poster session

ME3221 Sustainable Energy Conversion
ME4223 Thermal Environmental Engineering
ME4225 Applied Heat Transfer
ME4226 Energy and Thermal Systems
ME4227 Internal Combustion Engines
ME5205◊ Energy Engineering
ME5207◊ Solar Energy Systems
ME5516◊ Emerging Energy Conversion and Storage Technologies
ESP3401 Photovoltaic Devices & Systems
ESP4401 Optimization of Energy Systems

ESP4402 Transport Phenomena in Energy Systems

Offshore Oil and Gas Technology

Students taking the Offshore Oil and Gas Technology specialisation must take Group A modules and at least another TWO modules from Group B.

Group A

GE3244 Fundamentals in Petroleum Geoscience (Fulfil UEM requirements)
ME2135 Fluid Mechanics II
ME4105 Specialisation Study Module (Offshore Oil and Gas Technology)

Group B

ME3211 Mechanics of Solids
ME3233 Unsteady Flow in Fluid Systems
ME4213 Vibration Theory and Applications
ME4245 Robot Mechanics and Control
ME4261 Tool Engineering
ME5506◊ Corrosion of Materials

◊ Stage 4 status and a CAP of more than 3.5 are needed in order to read Level-5000 modules.

3.2.10.3 Sample Semester Schedule

Students may refer to Department of Mechanical Engineering website at *me.nus.edu.sg/current-students/program-overview/sample-schedules* for the updated copy of the sample semester schedule for their reference. The scheduling of the modules is a reference guide and may subject to changes without prior notice.

3.3 Minor Programmes

A minor programme is a coherent course of study which provides significant depth in a certain area outside the student's discipline. Due to limited places in each programme, each student is only allowed to read one minor programme.

The Modular Credit (MC) requirement for a minor programme should not be less than 24 MCs. Where there exists a substantial equivalence in the modules, departments may grant double counting of MCs from the major requirements (up to a maximum of 8 MCs) toward the MC requirement in the minor programme. A student may use up to 20 MCs to satisfy the Unrestricted Elective Module (UEM) requirement. If a student is unable to double count the minor modules toward his/her UEM, he/she will take the MCs on top of the 160 MC graduation requirement. The minor modules will be graded and the Cumulative Average Point (CAP) will be counted towards the degree classification. The minor programme will be reflected on the student's academic transcript. For more information on these programmes and other minor programmes, please refer to: nus.edu.sg/registrar/edu/UG/spugp-minor-progs.html

The following minor programmes are offered by the Faculty of Engineering:

3.3.1 Minor in Biomedical Engineering (hosted by the Department of Biomedical Engineering)

3.3.2 Minor in Engineering Materials

3.3.3 Minor in Systems Engineering

3.3.4 Minor in Management of Technology (hosted by the Division of Engineering & Technology Management)

3.3.5 Minor in Civil Infrastructure

3.3.1 Minor in Biomedical Engineering (hosted by the Department of Biomedical Engineering)

Biomedical Engineering is a discipline that advances knowledge in engineering, biology, and medicine. It improves human health through inter disciplinary integration of the engineering sciences with the biomedical sciences. Biomedical Engineering forms part of the Life Sciences, which is fast becoming a strategic area of economic development in Singapore. The aim of this minor is to enable students to understand how the principles and tools of traditional engineering fields, such as mechanical, materials, electrical, and chemical engineering, can be applied in biology and medicine. It will be suited to students who wish to pursue further career opportunities in hospitals and health care centres, medical devices, pharmaceutical, biotechnology and biomaterials industries. More details of the programme can be found at the Department of Biomedical Engineering website: www.bioeng.nus.edu.sg/edu/ugrad/minor.html

Only Stage 2 engineering students are eligible to apply for the Minor in Biomedical Engineering Programme. The intake for the programme is in January each year.

Requirements:

To satisfy the Minor in Biomedical Engineering, the students are required to fulfil at least 24 MCs and read at least ONE module from each of the following three options:

BIOMEDICAL ENGINEERING OPTION	LIFE SCIENCE OPTION[+]	ENGINEERING ELECTIVES OPTION
	LSM1102 Molecular Genetics	CE3143 Wastewater Microbiology
BN3401 Biomedical Electronics & Systems	LSM1104 General Physiology	CE4257 Linear Finite Element Analysis
BN3402 Bio Analytical Methods in Bioengineering	LSM1202[+] Human Anatomy	CN4208 Biochemical Engineering
BN4201 Musculoskeletal Biomechanics	LSM1401* Fundamentals of Biochemistry	CN4210 Membrane Science and Engineering

BIOMEDICAL ENGINEERING OPTION	LIFE SCIENCE OPTION[+]	ENGINEERING ELECTIVES OPTION
BN4202 Biofluid Dynamics	LSM2101 Metabolism and Regulation	CN4241R Engineering Principles for Drug Delivery
BN4203 Rehabilitation Engineering	LSM2102 Molecular Biology	EE3101 Digital Signal Processing
BN4301 Principles of Tissue Engineering	LSM2103 Cell Biology	EE3206 Intro to Computer Vision and Image Processing
BN4402 Electrophysiology	LSM2241 Introductory Bioinformatics	EE4605 Bio-Instrumentation and Signal Analysis
BN4403 Cellular Bioengineering	LSM2202A Experimental Molecular and Cell Biology	EE4601 Sensors for Biomedical Applications
BN4404 Biomicroelectromechanical Systems – BioMEMs	LSM3241 Bioinformatics and Biocomputing	EE4602 Bioelectronics
BN4406 Biophotonics and Bioimaging	PY1105 Physiology I	EE4603 Biomedical Imaging Systems
		ME4233 Computational Methods in Fluid Mechanics
		ME4253 Biomaterials Engineering
		ME4291 Finite Elements Analysis

* Students reading LSM1401 are NOT permitted to read LSM1101 and vice versa.

[+] No more than three Level-1000 modules should be read.

3.3.2 Minor in Engineering Materials

[Administered jointly by the Faculty of Engineering (Department of Materials Science & Engineering) and the Faculty of Science]

Engineering materials have played a key role in shaping the evolution of the industry in the past. All the more so, in recent times, materials played a catalytic role in influencing the technological advancement and economic growth of nations. It is not a coincidence that the most advanced nations of the world are also most advanced in the know-how of materials, which ranges from synthetic to biological materials. Rapid strides in advancement in cutting-edge technologies, whether related to life sciences such as in biomaterials, or engineering such as in thin films, are dependent on the further growth in the knowledge related to materials. Some of the materials-sensitive technologies include Bioengineering, Nanotechnology, Information Technology and Wafer Level Packaging. In order to align ourselves with most of the leading economies and universities of the world, it is imperative that we create a network of programmes that drive our students into the world of engineering materials.

The objectives of this multidisciplinary minor programme are as follows:

- To equip students with the fundamentals related to engineering materials, placing particular emphasis on advanced materials, design, manufacturing and processes,
- To enable students to be more aware of the behaviour of materials in engineering applications, and
- To enable students to select the materials for various engineering applications.

Requirements

To satisfy the Minor in Engineering Materials, a student must read materials related modules equivalent to at least 24 MCs, including the 8 MCs earned from the two core modules [((MLE1101 or ME2151) and MLE2101))], and at least two advanced elective modules (Level-3000 and Level-4000). In addition, the student has to select one of three tracks offered, namely, Biomedical and Polymeric Materials, Electronic Materials, and Structural Materials. Modules to be taken, other than the core modules, must be selected from the basket of modules listed under the appropriate track:

Biomedical and Polymeric Materials

BN3301 Introduction to Biomaterials
BN4301 Principles of Tissue Engineering
CN4203 Polymer Engineering
CM3264 Petroleum and Industrial Organics
CM4262 Advanced Materials Characterisation Techniques
CM4264 Speciality Polymers: Synthesis, Characterisation and Applications
CM4265 Polymer Blends and Composites
MLE3104 Polymeric and Composite Materials

MLE4202 Selected Advanced Topics on Polymers
MLE4203 Polymeric Biomedical Materials
ME4253 Biomaterials Engineering

Electronic Materials
CM3263 Chemistry of Semiconductors
CN4216 Electronic Materials Science
CN4217 Processing of Microelectronic Materials
CN4223 Microelectronic Thin Films
EE4411 Silicon Processing Technology
MLE2105 Electronic Properties of Materials
MLE3105 Dielectric and Magnetic Materials
MLE4207 Growth Aspects of Semiconductors
PC3235 Solid State Physics 1
PC3241 Solid State Devices
PC3242 Physics of Semiconductor Processing
PC4240 Solid State Physics 2
PC4253 Thin Film Technology
PC4259 Surface Physics
PC4264 Advanced Solid State Devices

Structural Materials
CE2164 Structural Design and Materials
CE3166 CE Materials and Structural Steel Systems
CE5604 Advanced Concrete Technology
ME3251 Materials for Engineers
ME4251 Thermal Engineering of Materials
ME4254 Materials in Engineering Design
ME4255 Materials Failure
MLE2102 Thermodynamics and Phase Diagrams
MLE2104 Mechanical Properties of Materials
MLE2106 Metallic Materials and Processing
MLE2107 Ceramic Materials and Processing
PC4259 Surface Physics

More details on the programme can be found at: www.eng.nus.edu.sg/minor/materials

3.3.3 Minor in Systems Engineering

This minor, offered by the Department of Industrial Systems Engineering and Management, will ground the engineering students with a solid foundation of systems engineering principles. It will also develop students with analytical mind set and techniques to tackle with trade-offs in order to optimise the performance of the systems within the relevant constraints to meet the requirements of the integrated global systems.

Eligibility

Students must meet the following criteria to be eligible to apply:

- Students can apply on admission or after they have completed first year of their study
- Must apply no later than the 5th semester of study
- Must have a CAP score of at least 3.5

Requirements

The minor in Systems Engineering will be awarded on satisfactory completion of the following 6 modules (24 MCs):

1. ST2334 Probability & Statistics
2. IE1113 Introduction to Systems Analytics
3. IE1114 Introduction to Systems Thinking
4. IE2110 Operations Research I
5. IE2150 Human Factors Engineering
6. IE3105 Fundamentals in Systems Engineering & Architecture

3.3.4 Minor in Management of Technology

Technology plays a key role in the growth of a business. The Minor in Management of Technology (MOT) aims to bridge the gap between engineering and business undergraduate education through a prescribed set of modules. The objective is to enable graduates to function effectively in a technical and interdisciplinary environment typical to technology-oriented business. Graduates would know business implications of technology and be able to appropriately use technology. They will understand market forces and the financial implications of technology investment.

This minor programme is open to students from the Faculty of Engineering, Faculty of Science and School of Computing. Students who are in the Minor in Business, Minor in Management or Minor in Technopreneurship programmes are not eligible to apply for the Minor in MOT Programme. More details of the programme can be found at: https://isem.nus.edu.sg/minorMOT/.

Requirements

To be awarded a Minor in Management of Technology, students must pass six modules, equivalent to 24 Modular Credits (MCs). These 24 MCs are divided into two sets of modules: Set 1 and Set 2. Students are to choose two modules from Set 1, and the remaining from Set 2. Students are recommended to take Set 1 modules first before taking Set 2 modules.

For students admitted prior to AY2014/2015, modules counted towards fulfilment of the Minor requirements must be letter graded. A module taken on Satisfactory/Unsatisfactory basis cannot be used to satisfy the Minor requirements.

For students admitted from AY2014/5 onwards, a minimum 16 MCs of the Minor requirements must be earned from modules read in NUS. 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 Minor programme.

(A) Set 1 Modules (Choose 2)
MNO1001 Management and Organisation
ACC1002 Financial Accounting
MKT1003 Principles of Marketing
BSP1004 Legal Environment and Business
DSC2006 Operations Management

Set 1 modules span important areas of management, marketing, legal, and quantitative aspects. Students interested to focus on management aspects are recommended to take MNO1001 and DSC2006.

(B) Set 2 Modules (Take 4)
Students are required to take three compulsory modules:
TR2202 Technological Innovation
MT4002 Technology Management Strategy
MT3001 Systems Thinking and Engineering

In addition, student will have to choose one of the following two modules:
EE3031 Innovation & Enterprise I (for ECE students only)
TR3001 New Product Development
MT4003 Engineering Product Development

3.3.5 Minor in Civil Infrastructure

This minor, is offered by Department of Civil and Environmental Engineering. In recent years, there has been an increasing diversification of focus and interest among engineering students, particularly in the field of Civil Infrastructure. This new Minor programme is designed especially to give students a grasp of essential Civil Engineering knowledge which will expand their career options and help Singapore to meet the high manpower demand in the infrastructure development, and the building and construction industry.

Environmental Engineering students who complete this Minor successfully, would be sufficiently proficient in core Civil Engineering disciplines. These will provide the necessary background and training to better prepare our Environmental Engineering graduates for a professional role in infrastructure development. Other discipline students, this Minor provides them the platform in understanding the core civil engineering knowledge, supplementing their Major degree.

Eligibility

The Minor programme is open to students from all departments in the Faculty of Engineering hence it is to be a Restricted Minor. To qualify, a students must

- obtain the minimum CAP of 3.5,
- completed CE1109/EG1109 Statics and Mechanics of Materials, CE2112 Soil Mechanics and CE2155 Structural Mechanics of Materials
- submit their entire study plan for the remaining semesters to us for approval before they can commence on their Minor in Civil Infrastructure, as a standard study plan cannot be formulated for these students.

Requirements

This Minor is a offered to students from Cohort AY2013/2014 onwards and requires a total of 36 MCs with at least a level 1000 module and all the other 8 modules. For students in the programme to be awarded a Minor in Civil Infrastructure, they are required to satisfy all their Major degree requirements, and read and pass the following Civil Engineering modules which provide key Civil Engineering foundation knowledge that follows:

Module Code/Title	Pre-requisite
CE1109/EG1109/EG1109FC/CE1109FC/CE1109X Statics and Mechanics of Materials	

CE2112 Soil Mechanics	EG1109/EG1109FC/CE1109/CE1109FC/CE1109X Statics and Mechanics of Materials
CE2155 Structural Mechanics and Materials	EG1109/EG1109FC/CE1109/CE1109FC/CE1109X Statics and Mechanics of Materials
CE3132 Water Resources Engineering	CE2134 Hydraulics
CE3115 Geotechnical Engineering	CE2112 Soil Mechanics
CE3116 Foundation Engineering	CE2112 Soil Mechanics
CE3155 Structural Analysis	EG1109/EG1109FC/CE1109/CE1109FC/CE1109X Statics and Mechanics of Materials
CE3165 Structural Concrete Design	CE2155 Structural Mechanics and Materials
CE3166 Structural Steel Design and System	CE2155 Structural Mechanics and Materials

3.4 Enhancement Programmes

Students are encouraged to participate in a variety of programmes and activities to enrich their undergraduate journey. At the Faculty level, programmes in engineering innovation, technopreneurship, and research are introduced to better support students in personalising their education experience. Students will generally receive modular credits via Unrestricted Electives upon successful completion of a particular enhancement programme.

3.4.1 EG3611 Industrial Attachment (12 MCs)

3.4.2 EG3612 Vacation Internship Programme (6 MCs)

3.4.3 EG1603/EG2603 Technopreneurship and Incubation Programme (2 MCs and 2 MCs)

3.4.4 EG2604 Innovation Programme (4 MCs)

3.4.5 EG2605 Undergraduate Research Opportunities Programme (4 MCs)

3.4.6 EG2606A/B Independent Work (2 MCs and 4 MCs)

3.4.2 Vacation Internship Programme

EG3612 Vacation Internship Programme is an internship module awarding 6MCs for 12 weeks of internship performed locally or overseas during the mid-year vacation period. This module has similar objectives as IAP, except that it is of a shorter duration. The scope of the internship shall be designed in variation according to the respective BEng programme of the student. Internships integrate knowledge and theoretical concepts learned from academic setting with practice application and personal and career skill development in a professional setting. Students can apply for internship positions preapproved by the Faculty or seek approval for self-sourced internships.

The module is largely offered as an additional option to students exempted from compulsory internship. These students may opt to intern for credits toward “free electives”.

3.4.3 Technopreneurship and Incubation Programme

The Technopreneurship and Incubation Programme (TIP) is a hands-on, competitive, experiential learning module that is ideal for students to gain insight, confidence, and basic capabilities about the theoretical and practical aspects of technopreneurship.

The overall learning objectives of TIP are:

- To enthuse and prepare students, by classroom and experiential learning, for a career in technology-based entrepreneurship.
- To educate students on how to start up and incubate companies.
- To provide the necessary resources for students to 'incubate' their ideas. To assist students to link up with companies/contacts that may be useful to their business ideas.
- The TIP comprises two parts, namely EG1603 and EG2603:

EG1603 TIP – Product & Business Plan Competition (2 MCs)

The first TIP module is setup as a competition to emulate the competitive nature of industry and intensify the learning. Students will engage in a two-day Technopreneur boot camp at the start of the course and will apply their newly acquired knowledge and skills to real-life problem statements by writing a business plan that includes a real (technical) solution with validated business models. Students will receive advice from mentors as they develop their solution and business models. They are expected to present their final business plan to a panel of judges at the end of the course.

EG2603 TIP Product & Business Plan Development (2 MCs)

In this second TIP module, selected teams will be allowed to participate in Part 2: EG2603 TIP Product & Business Plan Development in which the focus will be on prototyping the solutions and devising commercialisation strategies. The TIP – Product & Business Plan Competition is a hands-on, competitive, experiential learning module that is ideal for students to gain insight, confidence, and basic capabilities about the theoretical and practical aspects of technopreneurship. EG2603 follows on from EG1603 TIP Product & Business Plan Competition in which students devised (paper) solutions to real-life problems and presented their business plans to a panel of judges. Selected teams will be allowed to continue on to Part 2. EG2603 focuses on the prototyping and testing of the devised solutions and business models in the market. Students will receive advice from mentors as they develop their solution and business models. The final deliverable will be actual working prototypes that are demonstrated to a panel of judges, and validated business models to accompany the commercialisation strategy.

3.4.4 Innovation Programme

Students are engaged in a semester-long activity on a hands-on basis to create a novel outcome of practical significance. The students choose the subject of interest, under the guidance of a group of faculty members who also serve as mentors. Working sessions and seminars are organised throughout the duration of the programme. The topics of the seminars include problem definition and analysis, method of irritation, idea-generation methods and solutions, creativity and innovation, critical evaluation, intellectual property protection, and commercialisation of ideas and products with real-life case studies. Working sessions allow students to sell their ideas to the whole class and accept and/or defend critical evaluations.

Students propose a problem, the solution of which will improve our quality of life. They then proceed to analyse the problem and find solutions to it. In the working sessions, the students present their problems, ideas and solutions to peers and the group of mentors. The whole class is engaged in active discussion throughout the working sessions and students are continuously assessed during these sessions by the mentors. At the end of the programme, the students are expected to produce a prototype or a demonstrable system and to make a presentation to convince others of the value of the proposed idea, procedure or device. Peers will contribute to the evaluation of the success of the idea and product generated. The mentors will monitor the progress, and facilitate project development.

Students outside the Faculty of Engineering are encouraged to join to form multi-disciplinary teams in the class project. By taking part in the programme, the students are expected to learn that existing forms of schemes and procedures in practice can be challenged, but, at the same time, there are significant merits and strengths in existing schemes and procedures. Students will be able to create something meaningful to improve our quality of life. Assessment will be 100% continuous and there is no final examination.

3.4.5 Undergraduate Research Opportunities Programme

EG2605 Undergraduate Research Opportunities Programme (UROP) provides an opportunity for students to do research at an early stage in their candidature. They would be able to (a) acquire skills involved in the intellectual process of inquiry, (b) enhance their knowledge of the latest technology, and (c) interact with faculty members so as to foster closer ties. Students have to complete Stage 1 of their course to gain good fundamental engineering knowledge to handle the EG2605 programme on research and development work in the laboratory. Students are expected to work on the UROP project for at least 130 hours, which may be spread over two semesters. At the end of the project, UROP students have to submit a six- to eight-page paper to their supervisors. The assessment guidelines for satisfactory grading are based on students (i) having done a literature survey of the research area, (ii) having defined the problem clearly and proposing a hypothesis or a model for the problem, (iii) designing a solution procedure/experiment to study the hypothesis or analyse the problem, (iv) obtaining the data and evidences to support the hypothesis, and (v) drawing conclusions and making suggestions for future studies.

3.4.6 Independent Work

This programme aims to promote self-study, critical thinking and independent research ability. Possible independent work activities include systems development (e.g. hardware/software systems and mechanical systems) and participation in recognised national and international competitions. Students have to complete Stage 1 of their study to have sufficient basic engineering knowledge in order to propose a meaningful project and to work independently on the project with minimum supervision. Projects are initiated by students, individually or as a team of not more than four members by submitting a proposal to the Dean’s Office. The proposal will outline the background, nature and scope of the activity and should also include a statement of the learning objectives. In order to successfully complete the project and receive credit for EG2606A/B, students must achieve the learning objectives stated in the proposal and submit a short project report. Students can either register for the EG2606A Independent Work (2 MCs) for work totalling a minimum of 65 hours, or EG2606B Independent Work (4 MCs) for work totalling a minimum of 130 hours.

3.5 Special Programmes

3.5.1 University Scholars Programme

3.5.2 NUS Overseas Colleges (Beijing, Israel, Lausanne, Munich, New York, Shanghai, Silicon Valley, Singapore, and Stockholm)

3.5.3 NUS/Georgia Tech Special Term Programme

3.5.4 Double Degree Programmes

3.5.5 Double Major Programmes

3.5.6 Student Exchange Programme

3.5.1 University Scholars Programme

Students may apply to join the University Scholars Programme (USP) prior to enrolment into NUS. Students from the Faculty of Engineering are admitted into the Scholars Programme on the basis of their academic and co-curricular achievements, a written essay, and
an interview:

As much as possible, both USP students and their non-USP counterparts will graduate with similar, if not the same, number of modular credits. However, as the incorporation of the USP requirements at the Faculties/Schools is not perfect, USP students may require more modular credits to graduate as compared to their non-USP counterparts.

In general, USP students have to read a total of 48 MCs which fulfil the following USP requirement:

1. Foundation Tier modules (3 modules, 12 MCs)
   ▷ Writing and Critical Writing, UWC2101
   ▷ Quantitative Reasoning Foundation, UQF2101
   ▷ University Scholars Seminar, USS2015
2. Inquiry Tier modules (8 modules, 32 MCs)
   ▷ Interdisciplinary topic-based modules in two domains
   • Humanities and Social Sciences
   • Science and Technology
   ▷ At least one but no more than three ISMs; Faculty of Engineering-Independent Study Module ride-ons are not allowed
3. Reflection Tier module (1 module, 4 MCs)
   ▷ Senior Seminar

Students who complete the USP curriculum are deemed to have fulfilled:

▷ 20 MCs of University Level Requirement

▷ 7 MCs of Faculty Requirement: ES2331 (4 MCs) & HR2002 (3 MCs)

▷ 20 MCs of Major or Unrestricted Electives requirement

For more information, please refer to: www.eng.edu.sg/ugrad and usp.nus.edu.sg

3.5.2 NUS Overseas Colleges (Beijing, Israel, Lausanne, Munich, New York, Shanghai, Silicon Valley, Singapore, and Stockholm)

The NUS Overseas Colleges (NOC) programme provides students with the opportunity to work with innovative start-ups or high-growth companies and study at renowned partner universities at one of nine entrepreneurial hotspots across the globe. Students can choose to join the full-year programme or short programme. Under the full-year programme, students will join a company in either Silicon Valley (California), New York, Beijing, Shanghai, or Stockholm for a year. Under the short programme, students will participate in the company for either 6 or 7 months at either Israel, Beijing, Munich, Lausanne or Singapore.

During the internship, students will also get to attend courses at partner universities, namely Stanford University, NYU Polytechnic School of Engineering, Fudan University, Tsinghua University, Tel Aviv University, and Royal Institute of Technology (KTH), Technical University of Munich, and Ecole Polytechnique Federale de Lausanne. Course credits will count towards the students' NUS degree academic requirements. At the end of the programme, students will return to NUS to complete their degree.

The programme aims to cultivate and nurture students into enterprising, resourceful and independent self-starters, and eventually to blossom into successful entrepreneurs. Through this unique experience, students get the opportunity to immerse in the innovative and fast-paced start-up culture, acquire entrepreneurial skills, and establish business and personal networks.

For more information about NOC programme, please visit overseas.nus.edu.sg.

3.5.3 NUS/Georgia Tech Special Term Programme

This programme provides an opportunity for Industrial and Systems Engineering students to tap into the Georgia Institute of Technology's (Georgia Tech) educational programme. The modules conducted under this programme involve participation of faculty members and students from both NUS and Georgia Tech. Students will benefit from the exposure to a different kind of academic experience and also the cross-cultural exchanges that can take place through the interaction with the Georgia Tech students and faculty members. The 12-week programme is conducted from May to July, of which six weeks will be hosted in Singapore and the remaining six weeks in China. Students participate in several site visits and programme sponsored field trips. These are the possible NUS modules offered (subject to yearly review) where credits can be earned:

- IE4220 Supply Chain Modelling
- IE4299 Selected Topics in Industrial Engineering
- IE4249 Selected Topics to Engineering Management

For more details, visit: www.eng.nus.edu.sg/georgiatech

3.5.4 Double Degree Programmes

3.5.4.1 Double Degree Programme with French Grandes Écoles (FDDP)

In line with the objective of exposing our students to different academic environments and varied cultures, NUS also seeks to send students to non-English speaking universities in Europe. Students returning from these universities will have developed broader intellectual and social perspectives and a greater appreciation of other systems and cultures.

The Double Degree Programme (DDP) with French Grandes Écoles provides students the opportunity to learn from the best of both worlds, immersion in a foreign culture, networking with future industry and government leaders of the host country (as well as Singapore), and proficiency in a third language. Annually, up to eight NUS students may be admitted to each partner university to experience the best of the French education system in Engineering and Science, when they study for two years at the Grandes Écoles.

Students will have the opportunity to study at the following partner French Grandes Écoles under the DDP:

- Centrale Supélec (CS)
- Ecole Polytechnique (X)
- Ecole Nationale Supérieure des Mines de Paris (Mines ParisTech)
- Ecole Nationale Supérieure de Techniques Avancées (ENSTA)
- Ecole Nationale Supérieure des Télécommunications (Telecom ParisTech)
- Ecole Nationale des Ponts et Chaussées (Ponts ParisTech)

The selection of students for the programme is based on their academic merit and personal qualities. Students will spend the first two years in NUS, followed by two years in their Grande École in France, before returning to NUS to complete their Master's degree at NUS (see Table 3.5a).

Students will be conferred the Bachelor of Engineering degree with an appropriate class of honours after completing the first two years of undergraduate study in NUS and another two years of study in France. The Master of Engineering degree and the prestigious Diplôme d'Ingénieur will be conferred after completion of the graduate studies in NUS.

For more details, please visit: www.fddp.nus.edu.sg.

Table 3.5a: Double Degree Programme Structure with the French Grandes Écoles

YEAR	SCHEDULE
1	Faculty of Engineering at NUS • Year 1 Bachelor of Engineering studies at Faculty of Engineering, NUS (40 MCs) • French language classes at Centre for Language Studies, NUS (40 hours) • Four-week language and cultural immersion in France during vacation (100 hours) • Special Mathematics and Physics classes from second semester onwards (80 hours)
2	Faculty of Engineering at NUS • Year 2 Bachelor of Engineering studies at Faculty of Engineering, NUS (40 MCs) • French language classes at Centre for Language Studies, NUS (40 hours) • Four-week language immersion in France during vacation (100 hours) • Special Mathematics and Physics classes (180 hours) • Four-week language immersion in France before start of semester in France (100 hours)
3	Year 1 Diplôme d'Ingénieur studies at French Grandes Écoles
4	Year 2 Diplôme d'Ingénieur studies at French Grandes Écoles
5 – 6	Master of Engineering studies at Faculty of Engineering, NUS

3.5.4.2 Double Degree Programme in Business Administration and Engineering

Please refer to Double Degree in Engineering and Business Administration / Business Administration (Accountancy) section of the bulletin.

3.5.4.3 Double Degree Programme in Engineering and Economics

Please refer to Double Degree in Engineering and Economics section of the bulletin.

3.5.5 Double Major Programmes

3.5.5.1 Second Major in Systems Engineering Programme

3.5.5.1 Second Major in Systems Engineering Programme

The Department of Industrial Systems Engineering & Management (ISEM) offers the Major in Systems Engineering (Sys Eng Major), a Second Major as part of NUS Special Undergraduate Programmes, for students from all other faculties and schools.

The programme is offered from August 2008. Students may be admitted to the programme based on the following criteria:

- Students can apply on admission or after they have completed their first year of study;
- Must apply no later than the 5th semester of their study;
- Must have a CAP score of at least 3.5

Applications should be submitted to the ISEM Department Selection for admission will be on a competitive basis and subjected to the approval from ISEM Department as well as availability of quota.

To fulfil the requirements of the Second Major in Systems Engineering, students are required to complete 48 MCs.

Students may use up to a maximum of 16 MCs of their Second Major in Systems Engineering modules to double count towards other programmes.

In line with the NUS Centralised Online Registration System (CORS), students admitted into the Second Major in Systems Engineering programme will have to bid for their modules during CORS registration.

Once admitted to the Second Major in Systems Engineering programme, students do not need to maintain any minimum academic performance threshold in order to remain in the programme. They are strongly encouraged to plan their modules well in order to be able to complete the programme requirements.

Students who complete the 24 MCs of core modules* will be awarded a Minor in Systems Engineering if they do not wish to complete all the requirements for the Second Major in Systems Engineering.

Module Requirements for 2nd Major in SE AY2017/2018 Intake Onwards

MODULES	MCS
Seven Core Modules	**32**
ST2334 Probability and Statistics*	4
IE1113 Introduction to Systems Analytics*	4
IE1114 Introduction to Systems Thinking and Dynamics*	4
IE2110 Operations Research I*	4
IE2150 Human Factors Engineering*	4
IE3105 Fundamentals in Systems Engineering & Architecture*	4
IE3102 System Engineering Project	8
Two Electives Modules	**8**
Any two modules from the following:	
CS2113T Software Engineering	4
IE2130 Quality Engineering I	4
IE3101 Statistics for Engineering Applications	4
IE3110R Simulation	4
IE4240 Project Management (or equivalent)	4
IE4243 Decision Modeling & Risk Analysis	4

MODULES	MCS
Two Systems Modules	**8**
Any two modules from the following:	
Industrial Systems	
IE3120 Manufacturing Logistics	4
IE4220 Supply Chain Modeling	4
IE4221 Transport Demand Modeling & Economics	4
IE4244 Energy: Security, Competitiveness & Sustainability	4
Infrastructure Systems	
CE3101 Integrated Infrastructure Project	4
CE3102 Engineering of Socio-technical systems	4
CE3121 Transportation Engineering	4
CE3132 Water Resources Engineering	4
CE4221 Design of Land Transport Infrastructures	4
CE4282 Building Information Modeling for Project	4
ESE3101 Solid and Hazardous Waste Management	4
Computer Systems	
CS2102 Database Systems	4
CS4244 Knowledge Based Systems	4
CS4246 AI Planning & Decision Making	4
Electrical/ Electronic Systems	
EE3331C Feedback Control Systems	4
EE3505C Electrical Energy Systems	4
EE4214 Real Time Embedded Systems	4
EE4305 Introduction to Fuzzy/ Neural Systems	4
EE4307 Control Systems Design & Simulation	4
EE4308 Advances in Intelligent Systems & Robotics	4
EE4501 Power Systems Management & Protection	4
EE4511 Sustainable Energy Systems	4
Mechanical Systems	
ME4246 Modern Control Systems	4
ME4263 Fundamentals of Product Development	4
ME4266 Energy & Thermal Systems	4
Chemical Systems	
CN4122 Process Synthesis & Simulation	4
CN4201R Petroleum Refining	4
CN4238 Chemical & Biochemical Process Modelling	4
CN4245R Data Based Process Characterization	4
Biomedical Systems	
BN3101 Biomedical Engineering Design	4
BN4203 Rehabitation Engineering	4

MODULES	MCS
Total	48

For queries on the Second Major in Systems Engineering, please email us at isebox1@nullnus.edu.sg.

3.5.6 Student Exchange Programme

The Student Exchange Programme (SEP) provides an opportunity for students to study at more than 160 universities in 32 countries. These include premier institutions in North America, Europe, Asia and Australia. Please refer here for a list of partner universities available to Engineering students. SEP offers students exciting opportunities to get fresh perspectives on the subjects that they study, to experience foreign cultures and to forge friendships across borders. They gain maturity, confidence, independence and an ability to work with people of different cultures. Some students will also get a chance to develop new language skills that may serve them well in future careers.

Students are normally selected for SEP during Year 2 and embark on exchange for a semester during Year 3. Students design their own study plans by selecting modules offered by partner universities and mapping them to equivalent modules offered at NUS. The grades achieved while on SEP are not included in the CAP calculation.

For more information on the Student Exchange Programme, please visit here.

3.2.1.1 Overview

We are entering into an exciting time where we are seeing advances in the biomedical sciences that will transform the world. With the current plan of the Singapore government to establish this country as a biomedical hub and their continued support for the growth of the local biomedical industry, the demand for graduates well-trained in Biomedical Engineering will increase.

The undergraduate programme is designed to provide students with strong fundamental and broad based learning in engineering and life sciences while its approach is integrative with the students exposed to clinical applications as well. There is a strong emphasis in engineering design in our curriculum and we provide students with a unique educational experience through these design modules. A significant part of the curriculum is also set aside for non-engineering modules in areas such as management, organisation, critical thinking and other relevant areas. This is intended to equip our graduates with a broad-based knowledge enabling them to function effectively in tomorrow’s workplace.

Our Programme Educational Objectives are to prepare our graduates so that they are able to (a) apply the core concepts of biomedical engineering, its underlying sciences, and relevant technologies in their chosen profession; (b) utilise effective communication, learning, and teamwork skills to facilitate continued professional development; (c) possess a high standard of personal and professional integrity and ethical responsibility and (d) progress into positions of increasing leadership responsibilities.

Technical electives within the curriculum allow our students to explore areas of special interest which they do in their upper years. Students may choose to focus in one of the following areas, namely (a) biomaterials/tissue engineering, (b) biomechanics and (c) biomedical electronics and imaging. These focus areas represent technology areas that are of particular significance to the industry.

Students who want to major in Biomedical Engineering but do not have GCE ‘A’ Level Chemistry or their equivalent are required to read a bridging module CM1417 Fundamentals of Chemistry.

3.2.1.2 Degree Requirements

Students in the Bachelor of Engineering (Biomedical Engineering) Programme are required to fulfil the following requirements to graduate from the programme:

- Complete a minimum of 160 MCs with a CAP ≥ 2.0;
- Pass all modules in accordance with Table 3.2.1a;
- Pass at least four modules of technical electives and two pathway electives as listed in Table 3.2.1b;
- Satisfy all other requirements as prescribed by the Faculty of Engineering or the University

TABLE 3.2.1A: SUMMARY OF MODULAR REQUIREMENTS AND CREDITS

MODULAR REQUIREMENTS	MCS
University Level Requirements	**20**
General Education Modules (GE) (5 Modules, each of 4MCs) • Human and Cultures (H&C) • GER 1000 Quantitative Reasoning (QR), • Thinking and Expression (T&E) • Singapore Studies (SS) • Asking Questions (AQ)	20
Unrestricted Electives	**32**
Programme Requirements	
Faculty Requirements:	**6**
(ES1531 or equivalent) Critical Thinking & Writing[1]	4
EG2401 Engineering Professionalism	2
ES1102 English[2]	–
Foundation Requirements:	**26**
MA1511 Mathematics I	2
MA1512 Mathematics II	2
MA1513 Mathematics III	2
CS1010E Programming Methodology	4

MODULAR REQUIREMENTS	MCS
PC1432 Physics IIE	4
BN1111 Biomedical Engineering Principles and Practice I	6
BN1112 Biomedical Engineering Principles and Practice I I	6
Biomedical Engineering Major Requirements	
BME Core Subjects:	**28**
BN2102 Bioengineering Data Analysis	4
BN2201 Quantitative Physiology for Bioengineers	4
BN2202 Introduction to Biotransport	4
BN2204 Fundamentals of Biomechanics	4
BN2301 Fundamental Biochemistry and Biomaterials for Bioengineers	4
BN2403 Fundamentals of Biosignals Processing and Bioinstrumentation	4
CM1121* Basic Organic Chemistry[3] orCM1501* Organic Chemistry for Engineers[3]	4
BME Design and Project Modules:	**14**
BN3101 Biomedical Engineering Design	6
BN4101 BEng Dissertation	8
BME Electives:	
Technical Electives (from the modules in Table 3.2.1b)	**16**
Pathway Electives	**8**
EG3611 Industrial Attachment[4]	**10**
Total	**160**

3.2.1.3 Recommended Semester Schedule

TABLE 3.2.1C: RECOMMENDED SEMESTER SCHEDULE FOR BIOMEDICAL ENGINEERING STUDENTS

MODULES	MCS	MODULES	MCS
Semester 1		**Semester 2**	
CS1010E Programming Methodology	4	BN2103 Bioengineering Design Workshop*	2
CM1501 Organic Chemistry for Engineers	4	MA1506 Mathematics II	4
ES1531 Critical Thinking & Writing	4	PC1432 Physics IIE	4
MA1505 Mathematics I	4	GER 1000 Quantitative Reasoning (GE 1)	4
PC1431 Physics IE	4	GE 2	4
		GE 3	4
Sub-total	**20**	**Sub-total**	**22**
Semester 3		**Semester 4**	
BN2103 Bioengineering Design Workshop*	2	BN2102 Bioengineering Data Analysis	4
BN2201 Quantitative Physiology for Bioengineers	4	BN2204 Fundamentals of Biomechanics	4
BN2202 Introduction to Biotransport	4	BN2401 Biosignals Processing	4
BN2402 Fundamentals of Bioinstrumentation	4	BN3301 Introduction to Biomaterials	4
LSM1401 Fundamentals of Biochemistry	4	GE 4	4
ES2331 Communicating Engineering	4	GE 5	4
Sub-total	**22**	**Sub-total**	**24**
Semester 5 (First Half Cohort*)		**Semester 5 (Second Half Cohort*)**	

MODULES	MCS	MODULES	MCS
EG3611 Industrial Attachment	12	BN3101 Biomedical Engineering Design	6
UE 1	4	UE 1	4
EG2401 Engineering Professionalism	3	UE 2	4
		Technical Elective 1	4
		Technical Elective 2	4
Sub-total	**19**	**Sub-total**	**22**
Semester 6 (First Half of Cohort*)		**Semester 6 (Second Half of Cohort*)**	
BN3101 Biomedical Engineering Design	6	EG3611 Industrial Attachment	12
UE 2	4	UE 3	4
UE 3	4	EG2401 Engineering Professionalism	3
Technical Elective 1	4		
Technical Elective 2	4		
Sub-total	**22**	**Sub-total**	**19**
Semester 7		**Semester 8**	
BN4101 BEng Dissertation	4	BN4101 BEng Dissertation	4
Technical Elective 3	4	Technical Elective 6	4
Technical Elective 4	4	Technical Elective 7	3
Technical Elective 5	4	Technical Elective 8	4
UE 4	4		4
Sub-total	**20**	**Sub-total**	**16**

* Students without the GCE ‘A’ Level Chemistry or equivalent are strongly recommended to read CM1417 Fundamentals of Chemistry as their UE modules in their first year.

* **Half Cohort**

[+] Students are allowed to take up two modules in the evening, subject to approval.

Note: This schedule is correct as at time of printing and is subject to changes.

TABLE 3.2.1D: RECOMMENDED SEMESTER SCHEDULE FOR BIOMEDICAL ENGINEERING STUDENTS WITHOUT PHYSICS

Modules	MCs	Modules	MCs
Semester 1		**Semester 2**	
CS1010E Programming Methodology	4	BN2103 Bioengineering Design Workshop*	2
ES1531 Critical Thinking & Writing	4	GER1000 Quantitative Reasoning (GE 1)	4
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1221 Fundamentals of Physics I (UE 1)	4	PC1431 Physics IE	4
PC1221 Fundamentals of Physics I (UE 2)	4	PC1432 Physics IIE	4
		GE 2	4
Sub-total	**20**	**Sub-total**	**22**
Semester 3		**Semester 4**	
BN2103 Bioengineering Design Workshop*	2	BN2102 Bioengineering Data Analysis	4
BN2201 Quantitative Physiology for Bioengineers	4	BN2401 Biosignals Processing	4
BN2202 Introduction to Biotransport	4	BN2204 Fundamentals of Biomechanics	4
BN2402 Fundamentals of Bioinstrumentation	4	BN3301 Introduction to Biomaterials	4
LSM1401 Fundamentals of Biochemistry	4	GE 3	4
CM1501 Organic Chemistry for Engineers	4	GE 4	4
Sub-total	**22**	**Sub-total**	**24**

Semester 5 (First Half of Cohort*)		**Semester 5 (Second Half of Cohort*)**	
EG3611 Industrial Attachment	12	BN3101 Biomedical Engineering Design	6
UE 3	4	ES2331 Communicating Engineering	4
EG2401 Engineering Professionalism	3	Technical Elective 1	4
		Technical Elective 2	4
		GE 5	4
Sub-total	**19**	**Sub-total**	**22**
Semester 6 (First Half of Cohort*)		**Semester 6 (Second Half of Cohort*)**	
BN3101 Biomedical Engineering Design	6	EG3611 Industrial Attachment	12
ES2331 Communicating Engineering	4	UE 3	4
Technical Elective 1	4	EG2401 Engineering Professionalism	3
Technical Elective 2	4		
GE 5	4		
Sub-total	**22**	**Sub-total**	**19**
Semester 7		**Semester 8**	
BN4101 BEng Dissertation	4	BN4101 BEng Dissertation	4
Technical Elective 3	4	Technical Elective 6	4
Technical Elective 4	4	Technical Elective 7	4
Technical Elective 5	4	Technical Elective 8	4
UE 4	4		
Sub-total	**20**	**Sub-total**	**16**

* Students without the GCE ‘A’ Level Chemistry or equivalent are strongly recommended to read CM1417 Fundamentals of Chemistry as their UE modules in their first year.

* Half Cohort

[+] Students are allowed to take up two modules in the evening, subject to approval.

Note: This schedule is correct as at time of printing and is subject to changes.

3.4.2 Vacation Internship Programme

EG3612 Vacation Internship Programme is an internship module awarding 6MCs for 12 weeks of internship performed locally or overseas during the mid-year vacation period. This module has similar objectives as IAP, except that it is of a shorter duration. The scope of the internship shall be designed in variation according to the respective BEng programme of the student. Internships integrate knowledge and theoretical concepts learned from academic setting with practice application and personal and career skill development in a professional setting. Students can apply for internship positions preapproved by the Faculty or seek approval for self-sourced internships.

The module is largely offered as an additional option to students exempted from compulsory internship. These students may opt to intern for credits toward “free electives”.

3.4.4 Innovation Programme

Students are engaged in a semester-long activity on a hands-on basis to create a novel outcome of practical significance. The students choose the subject of interest, under the guidance of a group of faculty members who also serve as mentors. Working sessions and seminars are organised throughout the duration of the programme. The topics of the seminars include problem definition and analysis, method of irritation, idea-generation methods and solutions, creativity and innovation, critical evaluation, intellectual property protection, and commercialisation of ideas and products with real-life case studies. Working sessions allow students to sell their ideas to the whole class and accept and/or defend critical evaluations.

Students propose a problem, the solution of which will improve our quality of life. They then proceed to analyse the problem and find solutions to it. In the working sessions, the students present their problems, ideas and solutions to peers and the group of mentors. The whole class is engaged in active discussion throughout the working sessions and students are continuously assessed during these sessions by the mentors. At the end of the programme, the students are expected to produce a prototype or a demonstrable system and to make a presentation to convince others of the value of the proposed idea, procedure or device. Peers will contribute to the evaluation of the success of the idea and product generated. The mentors will monitor the progress, and facilitate project development.

Students outside the Faculty of Engineering are encouraged to join to form multi-disciplinary teams in the class project. By taking part in the programme, the students are expected to learn that existing forms of schemes and procedures in practice can be challenged, but, at the same time, there are significant merits and strengths in existing schemes and procedures. Students will be able to create something meaningful to improve our quality of life. Assessment will be 100% continuous and there is no final examination.

3.4.5 Undergraduate Research Opportunities Programme

EG2605 Undergraduate Research Opportunities Programme (UROP) provides an opportunity for students to do research at an early stage in their candidature. They would be able to (a) acquire skills involved in the intellectual process of inquiry, (b) enhance their knowledge of the latest technology, and (c) interact with faculty members so as to foster closer ties. Students have to complete Stage 1 of their course to gain good fundamental engineering knowledge to handle the EG2605 programme on research and development work in the laboratory. Students are expected to work on the UROP project for at least 130 hours, which may be spread over two semesters. At the end of the project, UROP students have to submit a six- to eight-page paper to their supervisors. The assessment guidelines for satisfactory grading are based on students (i) having done a literature survey of the research area, (ii) having defined the problem clearly and proposing a hypothesis or a model for the problem, (iii) designing a solution procedure/experiment to study the hypothesis or analyse the problem, (iv) obtaining the data and evidences to support the hypothesis, and (v) drawing conclusions and making suggestions for future studies.

3.4.6 Independent Work

This programme aims to promote self-study, critical thinking and independent research ability. Possible independent work activities include systems development (e.g. hardware/software systems and mechanical systems) and participation in recognised national and international competitions. Students have to complete Stage 1 of their study to have sufficient basic engineering knowledge in order to propose a meaningful project and to work independently on the project with minimum supervision. Projects are initiated by students, individually or as a team of not more than four members by submitting a proposal to the Dean’s Office. The proposal will outline the background, nature and scope of the activity and should also include a statement of the learning objectives. In order to successfully complete the project and receive credit for EG2606A/B, students must achieve the learning objectives stated in the proposal and submit a short project report. Students can either register for the EG2606A Independent Work (2 MCs) for work totalling a minimum of 65 hours, or EG2606B Independent Work (4 MCs) for work totalling a minimum of 130 hours.

4 Graduate Education

The NUS Faculty of Engineering has about 300 distinguished faculty members and a graduate student enrolment of some 2,500. We are committed to the pursuit of academic excellence in a vibrant research community actively engaged at the forefront of ideas and innovation. The graduate experience helps students realise their full potential and prepare them for an increasingly borderless and innovation-driven global economy.

We believe it is just as important to infuse our students with a spirit of enterprise and the mind-set needed to thrive in an ever-changing global landscape. Our scholars have opportunities to learn from the best minds, not just in Singapore but beyond, because of our strong global partnerships with renowned universities. Their names are synonymous with the best in their field, including US Naval Postgraduate School (NPS), Monterey; French Grandes Écoles; Technische Universiteit Eindhoven (TU/e) and selected Indian Institute of Technology (IIT).

Apart from benefiting from an international exchange of ideas with a vibrant community of international faculty and students, prospective graduate students will discover a mosaic of graduate programmes — both coursework-based and research-based — covering various engineering disciplines to meet their areas of interests and needs.

4.1 Research Programmes

4.1.1 Doctor of Philosophy (PhD) and Master of Engineering (MEng)

4.1.2 NUS-IIT Joint Doctor of Philosophy (PhD) Programme

4.1.3 NUS-SUTD Joint Doctor of Philosophy (PhD) Programme

4.1.4 NUS-Supelec Joint Doctor of Philosophy (PhD) Programme

4.1.5 NUS-TU/e Joint Doctor of Philosophy (PhD) Programme

4.1.1 Doctor of Philosophy (PhD) and Master of Engineering (MEng)

4.1.1.1 Overview

The Faculty has built a comprehensive research infrastructure with top-notch facilities for carrying out cutting-edge research and strives to provide graduate students with facilities and an environment that are conducive for the pursuit of creative research.

Graduate students have the opportunity to work closely with faculty members on a wide variety of exciting research projects. Excellent opportunities are available for students to be immersed in a vibrant research intensive environment in the following departments/ programmes:

- Biomedical Engineering
- Chemical & Biomolecular Engineering
- Civil & Environmental Engineering
- Electrical & Computer Engineering
- Industrial Systems Engineering & Management
- Materials Science & Engineering
- Mechanical Engineering

Alternatively, students may choose to be attached to one of the Research Institutes/Centres:

NUS Research Institutes/Centres:

- Interactive & Digital Media Institute (IDMI)
- NUS Nanoscience and Nanotechnology Initiative (NUSNNI)
- Solar Energy Research Institute of Singapore (SERIS)
- Temasek Laboratories (TL@NUS)
- The Logistics Institute – Asia Pacific (TLI-Asia Pacific)
- Tropical Marine Science Institute (TMSI)

A*STAR Research Institutes/Centres:

- Bioprocessing Technology Institute (BTI)
- Data Storage Institute (DSI)
- Institute for Chemical & Engineering Sciences (ICES)
- Institute for Infocomm Research (I2R)
- Institute of Bioengineering and Nanotechnology (IBN)
- Institute of High Performance Computing (IHPC)
- Institute of Materials Research and Engineering (IMRE)
- Institute of Microelectronics (IME)
- Singapore Institute of Manufacturing Technology (SIMTech)

4.1.1.2 Degree Requirements

Coursework element**

The research degree programme includes an element of coursework in the same or related fields. This provides a graduate-level foundation and prepares the student for research. The coursework component comprises not less than 24 MCs (typically six graduate modules) for PhD students and 16 MCs (typically four graduate modules) for MEng students. Students of some departments may be required to read additional modules. For example, PhD students in the Industrial & Systems Engineering programme are required to take two additional modules as approved by the Department.

All coursework modules and English language requirements (for international students) are to be taken and passed at an expected level of proficiency.

**Specific coursework requirements for research programmes in Department of Electrical & Computer Engineering only

PhD coursework requirements :

- EE6990 Research Attachment
- 2 EE5xxx modules
- 2 EE6xxx modules
- 2 “unrestricted” modules from any of the following: (i) EE5xxx/ EE6xxx; (ii) EE5666 IA module; (iii) Level 5xxx/6xxx module from other Departments/Faculties; or (iv) EE4xxx module (subject to approval by Department on a case by case basis).
- EE6999 Doctoral Seminars

MEng coursework requirements :

- 2 EE5xxx modules
- 1 EE6xxx module
- 1 “unrestricted” module from any of the following: (i) EE5xxx/ EE6xxx; (ii) EE5666 IA module; (iii) Level 5xxx/6xxx module from other Departments/Faculties; or (iv) EE4xxx module (subject to approval by Department on a case by case basis).
- EE5999 Graduate Seminars

Compulsory ES5101 Technical Communication for Engineers for both PhD and MEng programmes.

Graduate Seminar

To cultivate a strong research culture among graduate students, the required coursework includes a “graduate/doctoral seminar” in which faculty members, graduate students and visitors present current research. All research students are also expected to obtain a satisfactory grade for the Graduate Seminar module.

Research Methodology & Ethics module

This module is relevant for engineering research students. it provides an insight into good practices of research methods abiding by scientific ethics. It aims to inculcate students with the knowledge to practice conducting good research methodology, bearing in mind ethical issues. Doctoral students are expected to obtain a satisfactory grade for this module.

PhD Qualifying Examination

A doctoral candidate must complete a prescribed set of modules before proceeding to the PhD Qualifying examination (QE). The QE comprises a comprehensive examination and a presentation of the PhD thesis proposal. The comprehensive examination tests the general competence of the candidate in his/her discipline(s), while the presentation ensures that the candidate is prepared to embark on his/her thesis research. The QE should usually be taken 12 to 24 months from the start of the PhD candidature.

Doctoral students are expected to pass both the comprehensive examination and the oral defence.

Thesis component

The Master's programme requires the completion of a thesis not exceeding 30,000 words and the PhD programme requires a 40,000 word thesis. In both instances, the thesis is not measured by MCs. The thesis will be examined by internal/external examiners.

Oral Defence Examination

Doctoral candidates are required to undergo and pass an oral examination before a panel chaired by the candidates' Head of Department and two examiners of the PhD thesis. Doctoral students are required to pass their oral defence thesis examination before they are conferred their doctoral degree.

4.1.2 NUS-IIT Joint Doctor of Philosophy (PhD) Programme

4.1.2.1 Overview

The Joint Doctoral programme is offered by NUS and the selected Indian Institute of Technology (IIT). The programme has all the academic requirements of the normal PhD degree of both NUS and the IIT. Faculty members from both universities will participate in the joint supervision of research projects in Singapore, in India and via teleconferencing.

4.1.2.2 Degree Requirements

Coursework element

The prevailing requirements for coursework/education plan for each student of each university shall apply. Candidates would spend at least 2 semesters of their candidature each at NUS and their respective IIT, either reading modules and/or undertaken research. Candidates would spend their final semester of study at their home university.

Joint Supervision

Candidates will be jointly supervised by faculty members from NUS and the IIT.

Oral Defence Examination

The Oral Defence of the thesis would be conducted at the home university with a possible teleconferencing link to the examiner(s) at the partner university. The Oral Defence examiners will comprise examiners of the thesis, mutually agreed by both the home and the partner universities.

Conferment

Conferment of the joint degree will be by the candidate’s home university. Only one certificate is awarded jointly by both universities. The degree awarded to all successful candidates is identical except that a candidate may use the title of either PhD (NUS-IIT) or PhD (IIT-NUS) with his/her home university mentioned first.

4.1.3 NUS-SUTD Joint Doctor of Philosophy (PhD) Programme

4.1.3.1 Overview

The joint Doctoral programme is offered by NUS and SUTD. The programme has the same academic requirements as the regular single-degree PhD of both NUS and SUTD. Faculty members from both universities will participate in the joint supervision of each candidate’s research in Singapore.

4.1.3.2 Degree Requirements

Coursework element

The prevailing requirements for coursework/education plan of the home university shall apply. Candidates will spend at least 2 semesters of their candidature in the partner university, either reading modules and/or performing research. Candidates will spend their final semester of study at their home university.

Joint Supervision

Every candidate will be jointly supervised by faculty members from NUS and SUTD.

Oral Defence/Examination

The Oral Defence of the thesis will be conducted at the home university. The Oral Defence examiners will be jointly selected by the home and the partner universities.

Conferment

Conferment of the joint degree will be by the candidate’s home university. Only one certificate is awarded jointly by both universities. The degrees awarded to all successful candidates are identical except that a candidate shall use the title of PhD (NUS-SUTD) if NUS is the home university, or PhD (SUTD-NUS) if SUTD is the home university.

4.1.4 NUS-CentraleSupelec Joint Doctor of Philosophy (PhD) Programme

4.1.4.1 Overview

A joint PhD degree programme between NUS and CentraleSupelec was launched in August 2004. CentraleSupelec is one of France’s prestigious Grandes Écoles.

Seven key research areas have been identified for this joint Doctoral programme, namely :

- Communications & Networks;
- Control, Intelligent Systems & Robotics;
- Integrated Circuits & Embedded Systems;
- Microeletronics Technologies & Devices;
- Microwave & Radio Frequency;
- Power & Energy Systems; and
- Signal Analysis & Machine Intelligence

The programme aims to attract high-calibre students to engage in research in these key areas and to prepare candidates for leadership roles in R & D.

CentraleSupelec is one of the partners in the French NUS Double Degree Programme in Science, Engineering and Computing with the French Grandes Écoles. The Joint doctoral programme is an extension of the Master’s level double degree programme which provides students with the opportunities to learn from the best of both worlds – exposure to foreign culture, networking with Singaporeans and overseas counterparts, and proficiency in a third language. The joint doctoral programme brings the collaboration to a higher plane given the excellent rapport between faculty of both institutions and their complementary expertise and strengths.

Candidates are admitted according to each university’s prevailing admission criteria. Students who have completed their Bachelor’s degree (with at least a Second Class Upper Honours) and students upgrading from Master’s level research programmes will also be considered. For CentraleSupelec, students who have completed their Master’s degree will be considered.

The students will spend at least two semesters/terms at each partner university.

4.1.4.2 Degree Requirements

The prevailing requirements for PhD students of each university shall apply (see section 4.1.1.2).

4.1.5 NUS-TU/e Joint Doctor of Philosophy (PhD) Programme

4.1.5.1 Overview

This complementary joint degree is a synergy of two excellent study programmes. The qualities that the students develop by taking on such an in-depth inter-cultural experience lead to a new definition of the engineer, well prepared to confront the international challenges of modern society.

4.1.5.2 Degree Requirements

Research Areas

Candidates will conduct research his/her area of interest and which are of mutual interest to both universities.

Coursework element

The prevailing requirements for coursework/education plan for each student of each university shall apply. However, all students will be encouraged to read some approved modules at the partner university. And modules taken at the partner university will be accredited as partial fulfilment of their PhD degree. Candidates would spend at least two years of their candidature in TU/e and 18 months of their candidature in NUS, either reading modules and/or undertaking research.

Joint Supervision

Candidates will be jointly supervised by faculty members from NUS and TU/e.

Oral Defence Examination

Towards the end of the research project, each student undergoes two oral defences, one at each university.

Conferment

Conferment of the joint degree will be by the student’s home university. Both universities will award the same degree certificate to their successful students. Successful TU/e students will be awarded with their degrees at the end of the public defence session as currently practiced at TU/e.

4.2 Coursework Programmes

Aimed at working professionals, our coursework (taught) programmes are designed for university graduates who wish to advance their knowledge and careers in their chosen fields of specialisation.

Coursework programmes leading to the Master of Science (MSc) are normally conducted in the evenings and are awarded once the candidates pass the relevant examinations in a prescribed number of subjects. Students may enrol in any of these programmes on a part-time or full-time basis.

Admission for a Master of Science programme requires a good bachelor's degree with at least a Second Class Honours or its equivalent from institutions of recognised standing. Candidates should preferably have had a period of relevant work experience after obtaining their first degree. Candidates with other qualifications and achievements deemed to be suitably prepared for the programme of study may also be considered.

The maximum candidature for full-time MSc programme is two years and for part-time study is four years. Our full-time students typically are able to complete their degree requirements between one to one-and-a-half-years while the part-time students take about two-and-half-years.

Coursework programmes of study, well chosen, enhance future career prospects and have been a vital part of many of our students' career plans.

4.2.1 Master of Science (Chemical Engineering)

4.2.2 Master of Science (Civil Engineering)

4.2.3 Master of Science (Electrical Engineering)

4.2.4 Master of Science (Environmental Engineering)

4.2.5 Master of Science (Geotechnical Engineering)

4.2.6 Master of Science (Hydraulic Engineering and Water Resources Management)

4.2.7 Master of Science (Industrial & Systems Engineering)

4.2.8 Master of Science (Intellectual Property Management)

4.2.9 Master of Science (Management of Technology)

4.2.10 Master of Science (Materials Science and Engineering)

4.2.11 Master of Science (Mechanical Engineering)

4.2.12 Master of Science (Offshore Technology)

4.2.13 Master of Science (Safety, Health and Environmental Technology)

4.2.14 Master of Science (Supply Chain Management)

4.2.15 Master of Science (Systems Design & Management)

4.2.16 Master of Science (Transportation Systems and Management)

4.2.1 Master of Science (Chemical Engineering)

4.2.1.1 Overview

During the past few decades, there has been rapid industrial development in Singapore and the Asia Pacific region. To maintain the competitiveness of the industry, there will be an increasing dependence on people with advanced scientific and technological knowledge. Moreover, with engineering work expected to become more interdisciplinary, collaborative and global in nature, the engineer should be adaptable, flexible as well as technically proficient. The Master of Science Programme in Chemical Engineering is designed to provide the candidate with a firm grounding in the broad fundamentals of chemical engineering and familiarity with several specialised areas. This approach fosters versatility and leads to more professional options for the graduates of this programme.

4.2.1.2 Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.00 (equivalent to an average of Grade B-) for the best 40 MCs, inclusive of core modules, where required. Of the 40 MCs, at least 30 MCs must be at graduate level within the subject or in a related discipline, the remaining credits may be from other levels in the same or other disciplines as approved by the Department.

Students of the MSc (ChemEng) must successfully complete a programme of study consisting of at least four core modules, at least three electives from Group 1 and the remaining modules from Group 2. Modules in Group 1 are in several specialised areas of chemical engineering while those in Group 2 consist of selected modules from the Master of Science programmes in Environmental Engineering and Safety, Health and Environmental Technology approved by the Department.

Core Modules
CN5010 Mathematical Methods in Chemical & Environmental Engineering
CN5020 Advanced Reaction Engineering
CN5030 Advanced Chemical Engineering Thermodynamics
CN5040 Advanced Transport Phenomena
CN5050 Advanced Separation Processes

Elective Modules
Group 1*
CN5111 Optimisation of Chemical Processes
CN5131 Colloids and Surfaces
CN5161 Polymer Processing Engineering
CN5162 Advanced Polymeric Materials
CN5172 Biochemical Engineering
CN5173 Downstream Processing of Biochemical & Pharmaceutical Products
CN5181 Computer Aided Chemical Engineering
CN5191 Project Engineering
CN5192 Future Fuel Options: Prospects and Technologies
CN5193 Instrumental Methods of Analysis
CN5222 Pharmaceuticals and Fine Chemicals
CN5251 Membrane Science and Technology
CN5252 Metabolic Engineering
CN5371 Special Topics in Biochemical Engineering and Bioseparations
CN5391 Selected Topics in Advanced Chemical Engineering – I
CN5392 Selected Topics in Advanced Chemical Engineering – II
CN5401 Contemporary Topics in Advanced Chemical Engineering

CN5555 Chemical Engineering Project

Group 2

ESE5202 Air Pollution Control Technology
ESE5602 Environmental Management Systems
SH5004 Fundamentals in Industrial Hygiene
SH5201 Hazard Identification and Evaluation
SH5202 Quantified Risk Analysis
SH5204 Safety Engineering

*All modules listed are worth 4 MCs each except for CN5401 Contemporary Topics in Advanced Chemical Engineering which is 2 MCs and CN5555 Chemical Engineering Project which is 8 MCs.
Not all modules listed above are necessarily available in any one year, and new modules may be made available from time to time.

4.2.2 Master of Science (Civil Engineering)

4.2.2.1 Overview

The MSc (Civil Engineering) is designed for professionals who are working in the civil engineering and related industries. The programme accepts both full-time and part-time students. The specialisations available are:

- Structural Engineering
- Geotechnical Engineering
- Infrastructure Project Management

Students will be able to acquire more advanced and in-depth knowledge and at the same time achieve intellectual broadening across the disciplines of Civil Engineering. The programme provides flexibility for students in the choice of modules to suit their ability, interests, and career advancement.

4.2.2.2 Degree Requirements

To qualify for the MSc (Civil Engineering) degree with or without specialisation, a candidate must successfully complete a programme of study consisting of at least 40 Modular Credits (MCs). At least 30 MCs must be taken from 5000 and 6000 level modules. In addition, a student must obtain a minimum CAP of 3.00 (equivalent to an average of grade of B-) for the best modules equivalent to 40 MCs (inclusive of compulsory modules, where required).

Students who wish to graduate with a specialisation, they must also meet the requirements for that specialisation.

Specialisation in Structural Engineering

Candidates who wish to obtain the MSc (Civil Engineering) with specialisation in Structural Engineering must pass at least five of the following distinct modules, each with a grade point of at least 2.0 (Grade C):

CE5509 Advanced Structural Steel Design
CE5510 Advanced Structural Concrete Design
CE5513 Plastic Analysis of Structures
CE5514 Plate and Shell Structures
CE5604 Advanced Concrete Technology
CE5610 Assessment and Retrofit of Concrete Structures
CE5611 Precast Concrete Technology
CE6006 Advanced Finite Element Analysis
CE6705 Analysis and Design of Buildings Against Hazards

Should a student have sufficient reason to replace any of the above modules by another appropriate module, approval must be sought from the Head, Department of Civil and Environmental Engineering or his nominee.

The remaining five modules (20 MCs) to satisfy the degree requirements may be selected from level 5000 and 6000 modules offered by the Department of Civil and Environmental Engineering. For modules outside the Department of Civil and Environmental Engineering, prior approval must be sought from the Head, Department of Civil and Environmental Engineering or his nominee.

Specialisation in Geotechnical Engineering

Candidates who wish to obtain the MSc (Civil Engineering) with specialisation in Geotechnical Engineering must pass five (20 MCs) of the following distinct modules, each with a grade point of at least 2.0 (Grade C):

CE5101 Seepage & Consolidation of Soils

CE5104 Underground Space
CE5105 Analytical & Numerical Methods in Foundation Engineering
CE5106 Ground Improvement
CE5107 Pile Foundation
CE5108 Earth Retaining Structures

Should a student have sufficient reasons to replace any of the above modules by another appropriate module, approval must be sought from the Head, Department of Civil and Environmental Engineering or his nominee.

The remaining five modules (20 MCs) to satisfy the degree requirements may be selected from level 5000 and 6000 modules offered by the Department of Civil and Environmental Engineering. For modules outside the Department of Civil and Environmental Engineering, prior approval must be sought from the Head, Department of Civil and Environmental Engineering or his nominee.

Specialisation in Infrastructure Project Management

For this specialisation, students must pass at least five of the following distinct modules, each with a grade point of at least 2.0 (Grade C):

CE5603 Engineering Economics and Project Evaluation
CE5804 Global Infrastructure Project Management
CE5805 Construction Equipment & Methods
CE5806 Construction Project and Site Control
PM5103 Contract Management
PM5109 Project Management Law

Should a student have sufficient reason to replace any of the above modules by another appropriate module, approval must be sought from the Head, Department of Civil and Environmental Engineering or his nominee. In addition, he/she must complete at least three (12 MCs) of the following modules:

CE5207 Pavement Network Management Systems
CE5604 Advanced Concrete Technology
CE5610 Assessment and Retrofit of Concrete Structures
CE5611 Precast Concrete Technology
CE5880 Topics in Project Management Engineering
CE6001 Operations and Management of Infrastructure Systems
PM5104 Development Management
PM5105 Development Finance
IE5122 Statistical Quality Control
IE5208 Systems Approach to Project Management
IE5404 Large Scale Systems Engineering
CN5191 Project engineering
SH5201 Hazard Identification and Evaluation Techniques
SH5401 SHE and Quality Management Systems

The remaining two modules (8 MCs) to satisfy the degree requirements may be selected from level 5000 and 6000 modules offered by the Department of Civil and Environmental Engineering, which also include the above mentioned modules. For modules offered outside the Department of Civil and Environmental Engineering (except those listed above), prior approval must be sought from the Head, Department of

Civil and Environmental Engineering or his nominee.

Finally, students must ensure that at least five (20 MCs) of the ten modules to be counted for this specialisation must be those offered by the Department of Civil and Environmental Engineering (i.e. with the CE prefix in the module code).

Note: Not all electives listed are necessarily available in any one year. All modules listed are of 4 MCs each.

For more details on the modules offered, please refer to the website at www.eng.nus.edu.sg/civil/programmes/MSc_ce.html

4.2.3 Master of Science (Electrical Engineering)

4.2.3.1 Overview

The MSc (Electrical Engineering) programme provides an excellent opportunity for practising engineers to upgrade their knowledge and core capabilities in various exciting areas of engineering involving nano-science and nano-technology, biomedical systems, computer/ multimedia systems, communications and networks, intelligent control systems, electronic and optoelectronic materials and devices, silicon integrated circuits, microwaves and electromagnetics, and power & energy systems. It is structured around lectures (conducted in the evening) and end-of-semester examinations.

A candidate may read for MSc (Electrical Engineering) with or without a specialisation. The specialisations available are:

- Automation and Control Engineering
- Communications Engineering
- Computer Engineering
- Nanoelectronics
- Power and Energy Systems

Whether or not a specialisation is taken, a candidate may offer projects in lieu of graduate modules. Two types of projects are available: (1) independent study module (equivalent to one graduate module), (2) technical project (equivalent to two graduate modules).

4.2.3.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.00 (equivalent to an average of Grade B-) for the best 40 modular credits (MCs), inclusive of core modules, where required. Of the 40 MCs, at least 30 MCs must be from Electrical Engineering (EE) graduate modules or equivalent modules as identified by the Department. The remaining credits may be from other levels in the same or other disciplines as approved by the Department.

Students who opt to read MSc (Electrical Engineering) with a specialisation will be required to fulfil the following requirements:

Specialisation in Automation and Control Engineering

Compulsory Modules
EE5101 Linear Systems
EE5103 Computer Control Systems

Elective Modules for Specialisation (at least 3 modules)
EE4302 Advanced Control Systems
EE4308 Advances in Intelligent Systems and Robotics
EE5102 Multivariable Control Systems
EE5104 Adaptive Control Systems
EE5106 Advanced Robotics
EE5107 Optimal Control Systems
EE5108 Instrumentation and Sensors
EE5109 Applications of Mechatronics
EE5110 Special Topics in Automation and Control
EE5201 Control in Data Storage Systems
EE6102 Multivariable Control Systems (Advanced)
EE6104 Adaptive Control Systems (Advanced)
EE6105 Non-linear Dynamics and Control
EE6107 Optimal Control Systems (Advanced)
EE6110 Special Topics in Automation and Control (Advanced)

Specialisation in Communications Engineering

Compulsory Modules
EE5135 Digital Communications
EE5310 Communication Networking Fundamentals

Elective Modules for Specialisation (at least 3 modules)

EE5132 Wireless and Sensor Networks
EE5133 Statistical Signal Processing Techniques
EE5134 Optical Communications and Networks
EE5137 Stochastic Processes
EE5138 Optimization for Communication Systems
EE5139 Information Theory for Communication Systems
EE5401 Cellular Mobile Communications
EE5404 Satellite Communications
EE6130 Classical & Modern Channel Coding
EE6131 Wireless Communications (Advanced)

Specialisation in Computer Engineering

Compulsory Modules
EE5902 Multiprocessor Systems
EE5903 Real-Time Systems

Elective Modules for Specialisation (at least 3 modules)
EE4212 Computer Vision
EE4213 Image Processing
EE4218 Embedded Hardware System Design
EE5904 Neural Networks
EE5907 Pattern Recognition
EE6231 Reconfigurable Computing
EE6701 Evolutionary Computation
CS5222* Advanced Computer Architecture
CS5229* Advanced Computer Networks
CS5241* Speech Processing
CS5248* Systems Support for Continuous Media
CS5272* Embedded Software Design
CS5342* Multimedia Computing and Applications
CS5343* Advanced Computer Animation

* Conditions apply to MSc students registered from August 2011 onwards. A maximum two (2) of the above listed CS modules can be taken and be counted towards fulfilling the elective requirements of the specialisation in Computer Engineering. In the event that a student opts out from this specialisation, any CS modules that had been taken from this list would no longer be considered as equivalent EE graduate modules and if necessary, the student would then have to take additional modules to meet the requirements of the MSc(EE) degree, or MSc(EE) with specialisation in areas other than Computer Engineering.

Specialisation in Nanoelectronics

Compulsory Modules

EE5508 Semiconductor Fundamentals

EE5434 Microelectronic Processes and Integration

Elective Modules for Specialisation (at least 3 modules)

EE4415 Integrated Digital Design

EE4437 Photonics – Principles and Applications

EE5439 Micro/Nano Electromechanical Systems

EE5440 Magnetic Data Storage for Big Data

EE5502 MOS Devices

EE5507 Analog Integrated Circuit Design

EE5517 Optical Engineering

EE5518 VLSI Digital Circuit Design

PC5203 Advanced Solid State Physics

Specialisation in Power and Energy Systems

Compulsory Modules

EE5703 Industrial Drives

EE5711 Power Electronic Systems

Elective Modules for Specialisation (at least 3 modules)

EE4510 Solar Photovoltaic Energy Systems

EE4511 Sustainable Energy Systems

EE5701 High-Voltage Testing and Switchgear

EE5702 Advanced Power System Analysis

EE5704 High-Frequency Power Converters

EE6531 Selected Topics in Smart Grid Technologies

4.2.4 Master of Science (Environmental Engineering)

4.2.4.1 Overview

The Master of Science in Environmental Engineering programme is targeted at graduates who are either working or considering a career in environmental engineering and wish to be part of the global effort to incorporate environmental considerations in all human activities. The curriculum is sufficiently flexible to accommodate students from science and technology backgrounds as well as provide practising engineers an opportunity to enhance their technical competence. This programme is also suitable for graduates who wish to build on their prior educational background and professional experience in the field of environmental science and technology, and to acquire new skills for solving advanced environmental engineering problems, thus enabling them to contribute in greater measure to Singapore's push to develop its environmental technology industry. The programme will prepare students to contribute to the environmental protection efforts spearheaded by countries in the region. In addition, this broad-based educational programme would be of relevant interest to professionals in the government's regulatory and statutory bodies, as well as institutes of higher learning.

The Master of Science (MSc) in Environmental Engineering is structured around lectures, continual assessments and end-of-semester examinations. Candidates may opt for part-time or full-time study.

Part-time students will normally read two graduate modules equivalent to 8 MCs per semester and attend lectures two evenings per week.

Full-time students will normally read three to four graduate modules equivalent to 12 to 16 MCs per semester and attend lectures three to four evenings per week.

A candidate needs to complete a programme of study consisting of one core module and at least nine elective modules. Some modules may have prerequisites. It is the candidate's responsibility to ensure that the prerequisite requirements, if any, are met. Candidates should also note that the final composition of graduate modules proposed by themselves is subject to approval by the Department of Civil & Environmental Engineering. Candidates may, as part of the ten-module requirement for the MSc and subject to approval by the Department of Civil & Environmental Engineering, take up to two modules not exceeding 10 MCs that are from other departments/faculties.

4.2.4.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.00 (equivalent to an average of Grade B-) for the best 40 Modular Credits (MCs), inclusive of core modules. Of the 40 MCs, all must be at graduate level and at least 30 MCs must be within the subject or in a related discipline, the remaining credits may be from other disciplines as approved by the Department of Civil & Environmental Engineering. Students are not allowed to take a module which they have previously taken and counted towards a different degree programme without prior permission from the Head of Department.

Core Modules
ESE5001 Environmental Engineering Principles

At least 7 Elective Modules
ESE5002 Physical and Process Principles
ESE5003 Environmental Chemical Principles
ESE5201 Combustion Pollution Control
ESE5202 Air Pollution Control Technology
ESE5203 Aerosol Science and Technology
ESE5204 Toxic & Hazardous Waste Management
ESE5205 Sludge and Solid Waste Management
ESE5301 Environmental Biological Principles
ESE5401 Water Quality Management
ESE5402 Industrial Wastewater Control
ESE5403 Water Reclamation & Reuse
ESE5404 Biological Treatment Processes
ESE5405 Water Treatment Processes
ESE5406 Membrane Treatment Processes and Modelling
ESE5407 Membrane Technology for Water Management
ESE5601 Environmental Risk Assessment
ESE5602 Environmental Management Systems
ESE5607 Green Catalysis
ESE5608 Heavy Metals in the Environment
ESE5901 Environmental Technology
ESE6001 Environmental Fate of Organic Contaminants
ESE6301 Topics in Environmental Biotechnology
ESE6401 Advanced Biological Treatment Processes

ESE6403 Topics in Membrane Purification

Note that all required modules can be from Environmental Engineering Programme but a maximum of two modules of the ten required modules may be from other Department/Faculties, including the following modules (subject to approval of Department of Civil and Environmental Engineering):

DE5107 Environmental Planning
GE6211 Spatial Data Processing
LX5103 Environmental Law
PP5227 Environmental Policy and Nature Resource Management
SH5101 Industrial Toxicology
SH5104 Occupational Health

Note: Not all modules listed are necessarily available in any one year. All modules listed are of 4 MCs each.

For more details on the modules offered, please refer to the website at
www.eng.nus.edu.sg/cee/programmes/TimeTable.html

4.2.5 Master of Science (Geotechnical Engineering)

4.2.5.1 Overview

The primary objective of the MSc (Geotechnical Engineering) is to produce engineers who can plan, design and supervise construction of temporary earth retaining structures and other geotechnical problems that are more complex than standard foundations in a competent and professional manner. The secondary objective is to provide continuing education to engineers who wish to be trained solely in the highly specialised area of geotechnical engineering.

4.2.5.2 Degree Requirements

The MSc (Geotechnical Engineering) programme consists of seven compulsory core modules (total of 28 MCs) and eight elective modules. The core modules are formulated specifically to address the primary objective, while the elective modules are formulated to address the secondary objective. Each module carries 4 MCs.

To satisfy graduation requirements, a candidate must obtain a minimum Cumulative Average Point (CAP) of 3.00 (equivalent to an average of Grade B-) for the best 40 MCs, inclusive of seven core modules and three elective modules. In addition, the grade point for each of the seven core modules must be at least 2.5 (Grade C+). A student is allowed one re-take for at most two core modules if the grade point obtained is less than 2.5 (Grade C+).

Core Modules

CE4257 Linear Finite Element Methods
CE5108 Earth Retaining Structures
CE5111 Underground Construction Design Project[1]
CE5112 Structural Support Systems for Excavation
CE5113 Geotechnical Investigation and Monitoring
CE6101 Geotechnical Constitutive Modelling
CE6102 Geotechnical Analysis[2]

Elective Modules

CE5101 Seepage and Consolidation of Soils
CE5104 Underground Space
CE5105 Analytical and Numerical Methods in Foundation Engineering
CE5106 Ground Improvement
CE5107 Pile Foundation
CE5881 Topics in Geotechnical Engineering
CE6002 Analysis of Civil Engineering Experiments
CE6003 Numerical Methods in Engineering Mechanics

Note: Not all elective modules listed are necessarily available in any one year. All modules listed are of 4 MCs each.

[1] Students are expected to complete CE5111 in one semester. Request for extension will be approved on a case-by-case basis and only with valid reasons (which exclude heavy work commitment). Extension, if granted, is limited to one semester, and students who fail to complete CE5111 in two semesters will be given a grade F and will have to repeat the module.

[2] CE6102 requires two pre-requisites/co-requisites, namely CE4257 and CE6101. In other words, students need to have taken CE4257 and CE6101 in a previous semester or are taking them in the same semester as CE6102. Otherwise, the system will not register him/her for CE6102. In terms of contents, CE6102 will draw heavily from CE4257 and CE6101. For this reason, students are advised to take CE4257 and CE6101 as early as possible in their study.

For more details on the modules offered, please refer to the web site at www.eng.nus.edu.sg/cee/programmes/MSc_ge.html

4.2.6 Master of Science (Hydraulic Engineering and Water Resources Management)

4.2.6.1 Overview

Singapore government through the Environment and Water Industry Development Council (EWI) intends to establish Singapore as a global hydrohub. Among the EWI's goals is to encourage the growth and development of cutting-edge water technology in Singapore and to export the products and services that arise from the developed technology. To be able to achieve this goal there must exist a manpower base within Singapore that is able to support this aim.

Therefore, the objectives of the MSc (Hydraulic Engineering and Water Resources Management) programme are as follows:

1. Develop the manpower base that processes the necessary expertise to support Singapore as a global hydrohub.
2. Provide the students with opportunity to undertake innovative research projects within the framework of an Master of Science.

4.2.6.2 Degree Requirements

To qualify for the MSc (HEWRM) degree, a candidate must successfully complete a programme of study consisting of at least 40 Modular Credits (MCs). At least 30 MCs must be at graduate level within the subject or in related disciplines.

The core requirements in total are worth 28 MCs, of which 20 MCs are in the form of core modules, while the remaining 8 MCs are in the form of an MSc project for which students will work on innovative research in the HEWRM field. The remaining 12 MCs will be obtained from elective modules.

In addition, a student must obtain a minimum Cumulative Point Average (CAP) of 3.00 (equivalent to an average of Grade B-) for the best modules equivalent to 40 MCs (inclusive of core modules, where required). Furthermore, the grade point obtained for each of the 6 core modules must be at least 2.5 (equivalent to Grade C+). If this is not met, a student is allowed to re-take once, up to 2 core modules within the given programme time frame. The better grade will be used to compute the CAP.

Core Modules
CE5307 Wave Hydrodynamics and Physical Oceanography
CE5308 Coastal Processes and Sediment Transport
CE5310 Hydroinformatics
CE5311 Environmental Modelling with Computers
CE5312 River Mechanics
CE5314 HEWRM Project

Elective Modules

CE5313 Groundwater Hydrology
CE5603 Engineering Economics and Project Evaluation
CE5883A Topics in Hydraulic & Water Resources – Environmental Hydraulics
OT5203 Design of Floating Structures
OT5204 Offshore Moorings and Risers
ESE5601 Environmental Risk Assessment
ESE5602 Environmental Management Systems
ESE5405 Water Treatment Processes
ESE5901 Environmental Technology
IE5203 Decision Analysis
PP5257 Water Policy and Governance
PP5294 Dynamic Modelling of Public Policy Systems

4.2.7 Master of Science (Industrial & Systems Engineering)

4.2.7.1 Overview

The Master of Science (Industrial & Systems Engineering) programme is designed to provide graduate level education to prepare individuals for a life-long career addressing critical engineering and managerial decision making in the manufacturing and service sectors.
It is conducted on both part-time and full-time basis.
Candidates may opt for either a general programme of study, or a programme with specialisation in either one of the three areas:
1) Operations Research
2) Project Management
3) Service Systems.

4.2.7.2 Degree Requirements

The general requirements include at least 40 MCs, of which at least 30 MCs must be at graduate level within the subject or in related disciplines and the remaining credits may be from other levels in the same or other disciplines subject to the approval of the department.

To graduate with the MSc (Ind & Sys Eng) degree, a student must complete a minimum of 40 MCs in coursework with a minimum CAP of 3.00 for the best modules equivalent of 40 MCs (inclusive of foundation/core modules, where required). These must include the four ISE graduate foundation modules IE5001, IE5002, IE5003 and IE5004 (16 MCs), and at least 16 MCs of ISE graduate elective modules. Subject to the department's approval, up to 8 MCs may be from outside the department.

The graduate modules currently offered in the programme are listed in Table 4.2.7.2a. All modules are of 4 MCs. Some modules are offered in selected years only. See Modules Listings under Industrial and Systems Engineering at the Faculty of Engineering website for details.

Table 4.2.7.2a: Modules in Master of Science (Industrial & Systems Engineering)

Foundation Modules

IE5001 Operations Planning and Control I
IE5002 Applied Engineering Statistics
IE5003 Cost Analysis and Engineering Economy
IE5004 Engineering Probability and Simulation

Systems Engineering and Methodologies

IE5105 Introduction to Supply Chain Systems
IE5107 Material Flow Systems
IE5108 Facility Layout and Location
IE5202 Applied Forecasting Methods
IE5203 Decision Analysis
IE5205 Healthcare Systems and Analytics
IE5206 Energy and Sustainability: A Systems Approach
IE5402 Introduction to Systems Engineering and Architecture
IE5404 Large Scale Systems Engineering
IE5407 Flexibility In Engineering Systems Design
IE5409 Topics in Systems Engineering
IE5504 Systems Modelling and Advanced Simulation
IE5506 Computer Based Decision Systems
IE5508 Applied Systems Optimization
IE5880 Topics in Supply Chain Systems

Quality and Reliability Engineering

IE5121 Quality Planning and Management
IE5122 Statistical Quality Control
IE5123 Reliability Engineering
IE5124 Quality and Reliability by Design
IE5125 Software Quality Engineering
IE5129 Topics in Quality and Reliability Engineering

Engineering Management
IE5208 Systems Approach to Project Management
IE5211 New Product Management
IE5212 Management of Technological Innovation
IE5213 Service Innovation and Management
IE5214 Infocomm Systems Project Management
IE5291 Topics in Engineering Management

Human Engineering
IE5301 Human Factors in Engineering and Design
IE5302 Ergonomics and Workplace Design
IE5307 Topics in Human Factors Engineering

Advanced Modules
IE6001 Foundations Of Optimization
IE6002 Advanced Engineering Statistics
IE6004 Advanced Engineering Probability
IE6005 Stochastic Models and Optimization
IE6099 ISE Research Methodology
IE6107 Advanced Material Flow Systems
IE6108 Advanced Facility Layout and Location
IE6123 Advanced Reliability Engineering
IE6125 Advanced Software Quality Engineering
IE6126 Advanced Industrial Data Modelling and Analysis
IE6127 Six Sigma Methodologies
IE6199 Advanced Topics in Quality Engineering
IE6203 Advanced Decision Analysis
IE6211 Advanced New Product Management
IE6299 Advanced Topics in Engineering Management
IE6302 Advanced Ergonomics and Workplace Design
IE6399 Advanced Topics in Human Factors Engineering
IE6401 Advanced Topics in Industrial Logistics
IE6499 Advanced Topics in Systems Engineering

IE6503 Advanced Operations Research
IE6504 Advanced Systems Modelling and Simulation
IE6506 Advanced Computer Based Decision Systems
IE6511 Surrogate and Metaheuristic Global Optimization

Areas of Specialisation

Students may opt for one of the following optional areas of specialisation. Not all modules will necessarily be offered in one academic year:

Operations Research – *from January 2016 and onwards*

To be considered for the award of this specialisation, a student must complete a minimum of 40 MCs with a graduating CAP = 3.50 as follows:

- The four ISE graduate foundation modules: IE5001, IE5002, IE5003 and IE5004
- At least five of the following elective modules for specialisation:

IE5006 Learning from Data
IE5105 Modelling for Supply Chain Systems
IE5107 Material Flow Systems
IE5108 Facility Layout and Location
IE5123 Reliability Engineering
IE5203 Decision Analysis
IE5504 Systems Modelling and Advanced Simulation
IE5506 Computer Based Decision Systems
IE5508 Applied Systems Optimization
IE5907 Independent Study in Operations Research
IE5908A Research Project in Operations Research I
IE5908B Research Project in Operations Research II

- The remaining MCs in elective modules within or outside the Department subject to general degree requirements and Department's approval.
- A candidate may offer projects in lieu of graduate modules regardless whether he has selected the area of specialisation. If a candidate opts for a project, he/she has to propose a suitable project and find an appropriate supervisor. The Department does not have a list of projects. The candidate's experience and expertise in his/her workplace should help to identify a suitable project.
- Not more than 2 modules can be taken by a student for the project and independent study modules.

Project Management – *from August 2015 and onwards*

To be considered for the award of this specialisation, a student must complete a minimum of 40 MCs with a graduating CAP = 3.50 as follows:

- The four ISE graduate foundation modules: IE5001, IE5002, IE5003 and IE5004

- The compulsory module : IE5208 **or** IE5214.
- At least four of the following elective modules for specialisation:

IE5121 Quality Planning and Management
IE5125 Software Quality Engineering
IE5202 Applied Forecasting Methods
IE5211 New Product Management **or** MT5006 Strategic and New Product Management
IE5212 Management of Technological Innovation **or** MT5007 Management of Technological Innovation
IE5291 Topics in Engineering Management
IE5301 Human Factors in Engineering and Design
IE5404 Large Scale Systems Engineering
IE5407 Flexibility in Engineering Systems Design
IE5903 Independent Study in Project Management
IE5904A Research Project in Project Management I
IE5904B Research Project in Project Management II

- The remaining MCs in elective modules within or outside the Department subject to general degree requirements and Department's approval.
- A candidate may offer projects in lieu of graduate modules regardless whether he has selected the area of specialisation. If a candidate opts for a project, he/she has to propose a suitable project and find an appropriate supervisor. The Department does not have a list of projects. The candidate's experience and expertise in his/her workplace should help to identify a suitable project.
- Not more than 2 modules can be taken by a student for the project and independent study modules.

Service Systems – *from August 2015 and onwards*

To be considered for the award of this specialisation, a student must complete a minimum of 40 MCs with a graduating CAP = 3.50 as follows:

- The four ISE graduate foundation modules: IE5001, IE5002, IE5003 and IE5004
- At least five of the following elective modules for specialisation:

IE5122 Statistical Quality Control
IE5201 Service Operations Analysis and Design
IE5205 Healthcare System and Analytics
IE5206 Energy and Sustainability: A Systems Approach
IE5213 Service Innovation and Management
IE5302 Ergonomics and Workplace Design
IE5404 Large Scale Systems Engineering
IE5409 Topics in Systems Engineering
IE5504 Systems Modelling and Advanced Simulation
IE5905 Independent Study in Service Systems
IE5906A Research Project in Service Systems I

- The remaining MCs in elective modules within or outside the department subject to general degree requirements and Department’s approval
- A candidate may offer projects in lieu of graduate modules regardless whether he has selected the area of specialisation. If a candidate opts for a project, he/she has to propose a suitable project and find an appropriate supervisor. The Department does not have a list of projects. The candidate’s experience and expertise in his/her workplace should help to identify a suitable project.
- Not more than 2 modules can be taken by a student for the project and independent study modules.

4.2.8 Master of Science (Intellectual Property Management)

4.2.8.1 Overview

In today’s knowledge economy, intellectual assets (such as technological information) are business assets that must be effectively managed in order to unlock their commercial potential for the sustained growth of technology-related businesses.

The MSc (IP Management) is a comprehensive interdisciplinary post-graduate programme in Intellectual Property which bridges law, technology, science, engineering and management. It is jointly offered by the Faculties of Engineering and Law, National University of Singapore, and jointly administered by the IP Academy, Singapore together with the Department of Industrial Systems Engineering & Management from the Faculty of Engineering.

The programme is the first of its kind in Singapore to target mid-to senior management professionals with a background in science, technology or engineering who wish to specialise in the management of IP in a technology-related business.

4.2.8.2 Degree Requirements

A full-time or part-time candidate for the degree of MSc (IP Management) must successfully complete a programme of study consisting of the following two key components:

Part 1 – Graduate Certificate of Intellectual Property Law (GCIP) Programme: (IP Law)
Part 2 – Management of Technology (MOT) Programme, 20 MCs

For graduation:

1. Must successfully complete the GCIP programme with a minimum satisfactory performance level
2. For the MOT programme, must obtain a minimum CAP of 3.00 (B-) for the best modules equivalent to 20 MCs

Students may be allowed to take more than 20 MCs only if at the point of request to take more modules, the student has less than 20 MCs or his CAP is less than 3.00. In general, all students are expected to graduate after obtaining 20 MCs and achieving a CAP of at least 3.00.

Modules

Part 1 – IP Law: GCIP programme

Candidates have to take all the modules in this list, which will be equivalent to 20 MCs. All these modules provide detailed coverage of the relevant laws of Singapore. However, all these matters are placed in their international context and reference is made, as appropriate, to the comparable laws, in particular of the United States and the European Union and, selectively and where appropriate, with other countries if visiting speakers are available.

- Introduction to Law
- The Law of Trade Marks and Unfair Competition
- The Law of Copyright and Design
- The Law of Patents and Trade Secrets
- Special Topics

Part 2 – MOT modules

Students will have to complete a programme of study consisting of 20 MCs, selected from the following MOT modules (4 MCs each unless otherwise stated).

MT5001	IP Management
MT5002	Management of Industrial R&D
MT5003	Creativity and Innovation
MT5006	Strategic and New Product Development; (or IE5211 New Product Management)
MT5007/BMA5115	Management of Technological Innovation
MT5008/BMA5404	Corporate Entrepreneurship
MT5009	Analyzing Hi-Technology Opportunities
MT5010	Technology Intelligence & IP Strategy

MT5011	Finance for Engineering & Technology Management
MT5012	Marketing of High-Tech Products & Innovations
MT5016	Business Models for Hi-Tech Products
MT5018	Managing and Organizing Open Innovation
MT6001	Research in Technology and Innovation Management
SDM5003	Knowledge Management
SDM5004	Systems Engineering Project Management; (or IE5208 Systems Approach to Project Management)
MT5900	MOT Project (8 MCs)

Subject to the approval of the Programme Manager for MSc (IP Management), students may be allowed to take up 4 MCs outside this list.

4.2.9 Master of Science (Management of Technology)

4.2.9.1 Overview

Research and Development (R&D) have the ultimate aim of creating and applying technology to improve our quality of life. The resources needed for R&D are considerable, so how R&D should be best managed to yield attractive returns on investment? The new Master of Science in Management of Technology (MOT) degree programme specifically addresses this question. It is designed to provide scientists, engineers or technology professionals with business and technology management education, thus equipping them with the "science" of business innovation. The programme facilitates the synergistic integration of business management to engineering to effectively bring high-technology products and services to the marketplace with attractive returns on investments.

The need for training at the postgraduate level in Management of Technology (MOT) has been recognised by top universities in the world. In Japan, a 2003 report highlighted the need for MOT training given Japan's higher concentration of manufacturing sector compared to US, and has estimated a demand of 10,000 MOT specialists annually for the next five years. As Singapore accelerates more into knowledge-based industry development, the need for well-trained technology managers at all levels are needed to ensure successful innovation, resulting in economic development.

MOT is a multidisciplinary field which interconnects the science, engineering and business management fields. It is called by different titles in different universities such as technology management, engineering management, engineering and technology management, management and systems, etc. The major areas covered are Strategic Aspects of Technology Management, Organisational Aspects of Technology Management, Manufacturing Management, Innovation Policy and Strategy, New Product Development, Management of R&D, and Knowledge Management and Intellectual Property (IP). The Management of R&D and IP Management are important areas unique to the MSc (MOT) programme.

A student may choose to graduate with ONE of the following:

- MSc (Management of Technology) ; or
- MSc (Management of Technology) with specialization in Innovation & Entrepreneurship (offered from Semester 1, AY2014/2015)

4.2.9.2 Degree Requirements

To qualify for the degree of MSc (Management of Technology), a full-time or part-time candidate must successfully complete a programme of study of at least 40 MCs, which consists of the following:

(a) At least 16 MCs from the list of core modules

(b) The remaining MCs can be obtained from both the lists of core and/or elective modules, to make up a total of 40 MCs. *Subject to the approval of the Programme Manager for MSc (MOT), students may be allowed to take up to 8 MCs outside the prescribed curriculum, in lieu of the required modules to complete the MSc degree.*

In addition, a student must obtain a minimum CAP of 3.00 (B-) for the best modules equivalent to 40 MCs.

Core Modules

All the following core modules are 4 MCs each.

MT5001	IP Management
MT5002	Management of Industrial R&D
MT5003	Creativity and Innovation
MT5007/BMA5115	Management of Technological Innovation
MT5011	Finance for Engineering & Technology Management[#]
MT5012	Marketing of High-Technology Products and Innovations
IE5003	Cost Analysis and Engineering Economy[#]
IE5208	Systems Approach to Project Management^
SDM5004	Systems Engineering Project Management^

Elective Modules

Unless otherwise indicated, the elective modules below span different relevant areas and are 4 MCs each.

MT5005	IP Law for Engineers and Scientists
MT5006	Strategic & New Product Development*
MT5008/BMA5404	Corporate Entrepreneurship
MT5009	Analyzing Hi-Technology Opportunities
MT5010	Technology Intelligence & IP Strategy
MT5016	Business Models for Hi-Tech Products
MT5017	Integrative Design Thinking Workshop
MT5018	Managing and Organizing Open Innovation
MT5900	MOT Research Project (8MCs) [+]
MT5901	Management Practicum (2 MCs) [+]

MT5902	Management Extended Practicum [+]
MT5900	MOT Research Project (8 MCs)
MT5911	Venture Funding
MT5912	Frugal Innovation
MT5913	TechLaunch – Experiential Entrepreneurship
MT5920	Enterprise Development
MT5921	Market Gaps – A Search for Innovation Opportunities
MT5966	Overseas Internship Project and Attachment (12 MCs) [+]
MT6001	Research in Tech & Innovation Management[@]
BMA5004A	Management & Organization (2 MCs)
BMA5010A	Managing Operations (2 MCs)
BMA5108	Technopreneurship
IE5121	Quality Planning and Management*
IE5203	Decision Analysis
IE5211	New Product Management
IE5401	Industrial Logistics
SDM5001	Systems Architecture
SDM5002	Systems Engineering
SDM5003	Knowledge Management
PP5220	National Science & Technology Policy
PP5293	Ruling the Net: IT and Policy Making

* # ^ Modules with the same symbol are mutually exclusive.

[+] Students are not allowed to take more than 8 MCs worth of project/practicum modules. Students who are on the overseas internship project and attachment will not be allowed to take any of the project/practicum modules.

@ Module is meant for students who are interested to do research and want to contribute to the knowledge of Technology & Innovation Management.

MSc (Management of Technology) with specialisation in Innovation & Entrepreneurship

To be eligible for the specialisation, students must successfully complete a programme of study of at least 40 MCs and achieve a minimum CAP of 3.00, which consists of the following:

6 Compulsory Core Modules

MT5001	IP Management
MT5003	Creativity and Innovation
MT5007/BMA5115	Management of Technological Innovation
MT5011	Finance for Engineering & Technology Management
MT5008/BMA5404	Corporate Entrepreneurship

MT5913	TechLaunch – Experiential Entrepreneurship

Set 1 Electives (Choose any 2)

MT5902	Management Extended Practicum
MT5912	Frugal Innovation
MT5920	Enterprise Development
MT5921	Market Gaps – A Search for Innovation Opportunities

Set 2 Electives (Choose any 2)

MT5002	Management of Industrial R&D
MT5010	Technology Intelligence & IP Strategy
MT5911	Venture Funding

Note: Please note that not all modules listed are necessarily available in any one semester or year. A good GRE/GMAT score is needed to take the BMA electives from NUS Business School.

4.2.10 Master of Science (Materials Science and Engineering)

4.2.10.1 Overview

The programme equips students with advanced knowledge in materials science and engineering, and is committed to the highest quality in teaching and learning by professors from various disciplines in Science and Engineering. The MSc (Materials Science and Engineering) programme aims to create leaders and provide expertise in the fast-growing field of materials engineering by offering foundation courses, as well as up-to-date advanced courses in areas ranging from metallic, organic, and inorganic materials to state of the art semiconductor materials. Students of the MSc (Materials Science and Engineering) programme are trained to be spirited, self-reliant, open and egalitarian.

4.2.10.2 Degree Requirement

To graduate, a student needs to accumulate a total of no less than 40 MCs and obtain a minimum Cumulative Average Point (CAP) of 3.00 (equivalent to an average of Grade B-) for the best modules equivalent of 40 MCs, inclusive of the two core modules. Of the 40 MCs, at least 30 MCs must be from the approved list of core and elective graduate level modules, the remaining credits may be from other levels in the same or other disciplines subject to the approval of the Department.

The following modules are offered for the MSc (Materials Science and Engineering):

Core Modules

MST5001 Structures and Properties of Materials

MST5002 Materials Characterisation

Elective Modules

MLE5102 Mechanical Behaviours of Materials
MLE5104 Physical Properties of Materials
MLE5210 Modelling and Simulation of Materials
MLE6101 Thermodynamics and Kinetics of Materials
MLE6103 Structures of Materials
MLE6205 Magnetic Materials and Applications
MLE6206 Nanomaterials: Science and Engineering
BN5201 Advanced Biomaterials
CE5604 Advanced Concrete Technology
CM5212 Crystal Engineering
CM5237 Advanced Optical Spectroscopy and Imaging
CM5262 Contemporary Materials Chemistry
CM5268 Advanced Organic Materials
CN5161 Polymer Processing Engineering
CN5162 Advanced Polymeric Materials
CN5251 Membrane Science and Technology
CN6163 Inorganic Nanomaterials for Sustainability
EE5431R Fundamentals of Nanoelectronics
EE5434 CMOS Processes and Integration
EE5502 MOS Devices
EE5508 Semiconductor Fundamentals
EE5517 Optical Engineering
ME5161 Optical Techniques in Experimental Stress Analysis
ME5506 Corrosion of Materials
ME5513 Fracture and Fatigue of Materials
ME5516 Emerging Energy Conversion and Storage Technologies
ME5611 Sustainable Product Design & Manufacturing
ME6303 Advanced Fluid Dynamics
ME6504 Defects and Dislocations in Solids
ME6505 Engineering Materials in Medicine
ME6604 Modelling of Machining Processes
MT5002 Management of Industrial R&D

MT5007 Management of Technological Innovation
PC5204 Special Topics in Physics
PC5205 Topics in Surface Physics
PC5212 Physics of Nanostructures

All modules are of 4 MCs each.

Not all modules listed are necessarily available in any one year and the curriculum is subject to changes.

4.2.11 Master of Science (Mechanical Engineering)

4.2.11.1 Overview

The programme is intended to provide students with an advanced knowledge and understanding of the ‘state-of-the-art’ in one or more of the many areas of mechanical engineering. Its unique balance of rigorous fundamentals and engaging real-world applications in the MSc (Mechanical Engineering) programme trains the students to be analytical thinkers who will successfully integrate and synthesise theory and new knowledge. The combination of expertise in research and in engineering consultancy in the Mechanical Engineering Department helps to give this MSc (Mechanical Engineering) course its unique features. The success of this MSc (Mechanical Engineering) course can be measured by the large proportion of its graduates who find appropriate and challenging posts in industry at home and abroad.

A candidate may read for the MSc (Mechanical Engineering) with or without a major or area of specialisation. The specialisations available are:

- Computation and Modelling
- Advanced Manufacturing

4.2.11.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.00 (equivalent to an average of Grade B-) for the best modules equivalent of 40 MCs. Each graduate module of 39 lecture hours is usually assigned 4 MCs. Hence, in general, a student needs to complete 10 modules chosen from the list of modules. A maximum of 2 approved external modules are usually allowed.

Students must complete at least 5 modules from the core module list for the specialisation in order to graduate with the specialisation.

List for the Specialisation in Computation and Modelling:

Students can only choose either ME4291 or CE4257, which is pre-requisite for CE6006.

ME4291	Finite Element Analysis
CE4257	Linear Finite Element Analysis
ME5300A	Special Project in Computation and Modelling I
ME5300B	Special Project in Computation and Modelling II
ME5301	Flow Systems Analysis
ME5302	Computational Fluid Mechanics
ME5361	Advanced Computational Fluid Dynamics
ME5401/EE5101R	Linear Systems
ME5404/EE5404R	Neural Networks
ME6105	Continuum Mechanics
ME6303	Advanced Fluid Dynamics
ME6604	Modelling of Machining Processes
CE6003	Numerical Methods in Engineering Mechanics
CE6006	Advanced Finite Element Analysis

List for the Specialisation in Advanced Manufacturing:

The 5 modules must include ME5608 and either ME5612 or ME6505.

ME5608	Additive and Non-Conventional Manufacturing Processes
ME5612	Computer Aided Product Development
ME6505	Engineering Materials in Medicine
ME5402/EE5106R	Advanced Robotics
ME5513	Fracture and Fatigue of Materials
ME5600A	Project in Advanced Manufacturing I
ME5600B	Project in Advanced Manufacturing II
ME5611	Sustainable Product Design & Manufacturing
ME6604	Modelling of Machining Processes
MLE5102	Mechanical Behaviours of Materials
MLE5204	Advanced Processing of Metallic Materials
MST5001	Structure and Properties of Materials
MST5002	Materials Characterization
PR5211	Pharmaceutical Analysis IV
PR5216	Advances in Drug Delivery
ID5951B	Topics in Industrial Design: Interaction Design
ID5951C	Topics in Industrial Design: Healthcare Design

4.2.12 Master of Science (Offshore Technology)

4.2.12.1 Overview

The Master of Science (Offshore Technology) is jointly hosted by the Department of Civil & Environmental Engineering and the Department of Mechanical Engineering, and is administered by the Department of Civil & Environmental Engineering. It offers a comprehensive coverage of topics in Offshore Technology and Subsea Engineering that are of great relevance to the offshore oil and gas industry which span the design of facilities in shallow waters to challenges that are faced by engineers in developments in deep waters and in arctic conditions.

A student may choose to graduate with ONLY one of the following:

- MSc (Offshore Technology)
- MSc (Offshore Technology) with specialisation in Subsea Engineering

4.2.12.2 Degree Requirements

Programme Information

The Master of Science (Offshore Technology) programme, or MSc (OT) in short, is jointly hosted by the Department of Civil and Environmental Engineering and the Department of Mechanical Engineering, and is administered by the Department of Civil and Environmental Engineering.

It offers a comprehensive coverage of topics in Offshore Engineering, Subsea Engineering and Petroleum Engineering that are of great relevance to the offshore oil and gas industry which span the design of facilities in shallow waters to challenges that are faced by engineers in developments in deep waters and in arctic conditions, and technologies related to drilling, downhole measurements and characterization in the exploration and production of petroleum reservoirs.

A student can choose to graduate with ONLY one of the following:

MSc (Offshore Technology)
MSc (Offshore Technology) with Specialization in Subsea Engineering
MSc (Offshore Technology) with Specialization in Petroleum Engineering

Students of MSc (Offshore Technology) now have an option to participate in an exchange programme with either Delft University of Technology (TUD) or Norwegian University of Science & Technology (NTNU).

Modules for MSc (Offshore) programme

The programme's modules are presented in the following three groups:

(i) **Modules in Offshore Technology**
All modules below are 4 MCs each with the exception of OT5001 Independent Study Module which is 8 MCs.

OT5001 Independent Study Module (8MC)
OT5101 Exploration and Production of Petroleum
OT5102 Oil & Gas Technology
OT5201 Marine Statics & Dynamics
OT5202 Analysis & Design of Offshore Structure
OT5203 Design of Floating Structures

OT5204 Moorings & Risers
OT5205 Offshore Pipelines
OT5206 Offshore Foundations
OT5207 Arctic Engineering
OT5301 Subsea Systems Engineering
OT5303 Subsea Control
OT5304 Subsea Construction & Operations Support
OT5305 Pressure Surges in Oil & Gas Flow Systems
OT5401 Geoscience for Petroleum Exploration
OT5402 Seismic Acquisition and Processing
OT5403 Petrophysics and Downhole Measurements
OT5404 Reservoir Characterization and Rock Physics
OT5881 Topics in Offshore Technology Engineering
OT5882 Topics in Subsea Engineering
OT5883 Topics in Petroleum Engineering
ME5301 Flow Systems Analysis
CE5307 Wave Hydrodynamics and Physical Oceanography
ME5506 Corrosion of Materials
ME5513 Fracture and Fatigue of Materials

(ii) **Modules for Specialization in Subsea Engineering**

All modules below are 4 MCs each with the exception of OT5001A Independent Study Module: Subsea Engineering which is 8 MCs.

OT5102 Oil & Gas Technology (Compulsory)
OT5301 Subsea Systems Engineering. [Compulsory unless the student has taken this module for his/her B.Eng.(Mechanical Engineering) programme]
OT5205 Offshore Pipelines
OT5302 Flow Assurance
OT5303 Subsea Control
OT5304 Subsea Construction & Operations Support
OT5305 Pressure Surges in Oil & Gas Flow Systems
OT5882 Topics in Subsea Engineering
OT5001A Independent Study Module: Subsea Engineering

(iii) **Modules for Specialization in Petroleum Engineering**

All modules below are 4 MCs each with the exception of OT5001B Independent Study Module: Petroleum Engineering which is 8 MCs.

OT5401 Geoscience for Petroleum Exploration
OT5402 Seismic Acquisition and Processing
OT5403 Petrophysics and Downhole Measurements
OT5404 Reservoir Characterization and Rock Physics
OT5883 Topics in Petroleum Engineering
OT5001B Independent Study Module: Petroleum Engineering
[Note: Other modules related to Petroleum Engineering are being planned and may include Reservoir Engineering and Simulation, and Enhanced Oil Recovery]

(iv) **Elective modules**
All modules below are 4 MCs each.
CE4257 Linear Finite Element Analysis,
CE4258 Structural Stability and Dynamics
CE5105 Analytical & Numerical Methods in Foundation Engineering
CE5308 Coastal Engineering and Sediment Transport
CE5509 Advanced Structural Steel Design
CE5514 Plate and Shell Structures
CE5603 Engineering Economics and Project Evaluation
CE5702 CE Reliability Analysis & Design
CE5804 Global Infrastructure Project Management
CE6003 Numerical Methods in Engineering Mechanics
CE6006 Advanced Finite Element Analysis
CE6101 Geotechnical Constitutive Modelling
ME5105 Shock and Vibration Control
ME5201 Thermal Systems Design
ME5362 Advanced Fluid Transients Computation and Modelling
ME5402 Advanced Robotics
SH5204 Safety Engineering

Programme Structure

MSc (Offshore Technology)
Students reading the programme without specialising in Subsea Engineering or Petroleum Engineering,

must successfully complete a programme with at least 40 MCs and achieve a minimum CAP of 3.00 which consist of:

1. at least 28 MCs (7 modules) from modules listed in part (i); &
2. the remaining up to 12 MCs (3 modules) from modules listed in part (iv) However, subject to prior approval from the Department's Programme Management Committee, up to two (2) modules may be taken from outside the prescribed programme's curriculum.

MSc(Offshore Technology) with Specialisation in Subsea Engineering

To be eligible for the specialization, students must successfully complete a programme at least 40 MCs and achieve a minimum CAP of 3.00 which consist of:

1. at least 20 MCs (5 modules) from modules listed in part (ii); &
2. at least 28 MCs less the number of MCs taken in (a) from modules listed in part (i); &
3. the remaining up to 12 MCs (3 modules) from modules listed in part (iv). However, subject to prior approval from the Department's Programme Management Committee, up to two (2) modules may be taken from outside the prescribed programme's curriculum.

MSc (Offshore Technology) with Specialization in Petroleum Engineering

To be eligible for the specialization, students must successfully complete a programme at least 40 MCs and achieve a minimum CAP of 3.00 which consist of:

1. at least 20 MCs (5 modules) from modules listed in part (iii); &
2. at least 28 MCs less the number of MCs taken in (a) from modules listed in part (i); &
3. the remaining up to 12 MCs (3 modules) from modules listed in part (iv). However, subject to prior approval from the Department's Programme Management Committee, up to two (2) modules may be taken from outside the prescribed programme's curriculum.

MSc (Offshore Technology) students are not allowed to do a module which they have previously taken and counted towards a different degree programme without prior permission from the Head of Department.

4.2.13 Master of Science (Safety, Health and Environmental Technology)

4.2.13.1 Overview

Industry is increasingly recognising the common philosophy and approaches in the promotion of safety, industrial hygiene and environment protection. Regulatory authorities are requesting the implementation of safety management based on the system-safety approach and risk management methodology to minimise the risk of accidents, health effects and environment damages in the different stages of the product or project life cycle, from business conception, design, building/construction, use/operation to dismantling/decommissioning.

In order for the prevention of accidents, diseases and environment damage to be effective, the hazards have to be identified and assessed and the associated risk evaluated and treated. The programmes must be documented, resourced, planned, monitored and audited. It is a line function to implement management system programmes but such programmes have to be coordinated under the stewardship of appropriate knowledgeable specialists and advisors.

To make full use of the synergy between safety, industrial hygiene and environmental management systems, these advisory specialists require the appropriate level of knowledge in all three areas. They are then equipped to take up the challenge of integrating their management. This is considered to be the most cost-effective way of minimising production loss, preventing accidents and diseases, avoiding damage to property and safeguarding the environment.

The course is designed to provide the candidate with a good understanding of philosophy and approaches in managing safety, industrial hygiene and environmental knowledge so as to optimise globally, rather than locally, on these important topics in order to advise line management on the most productive and appropriate business path forward.

The objective of the course is to develop experts to advise senior management in industry on Safety, Health and Environment (SHE) matters. The MSc holder will be a credible professional in the identification and assessment of hazards as well as risk evaluation and treatment in the management of any SHE programme. The course is conducted by faculty members drawn from the Chemical and Biomolecular Engineering Department and invited lecturers from industries and government ministries.

4.2.13.2 Degree Requirements

The Master of Science (Safety, Health and Environmental Technology) course, or MSc (SHE), is hosted by the Department of Chemical and Biomolecular Engineering. The programme accepts both full time and part time students. To qualify for the MSc (SHE) degree with or without an area of specialization, a candidate must successfully complete a programme of study consisting of at least 40 Modular Credits (MCs). In addition, a student must obtain a minimum CAP of 3.00 (Grade B-) for the best modules equivalent to 40 MCs (inclusive of compulsory modules, where required). A student may choose to graduate with one of the following:

- MSc (SHE)
- MSc (SHE) with specialisation in Industrial Hygiene
- MSc (SHE) with specialisation in Process Safety

Programme course modules are presented in the following four groups

Foundation Modules

SH5002 Fundamentals in Industrial Safety
SH5003 Fundamentals in Environmental Protection
SH5101 Industrial Toxicology
SH5108 Chemical Hazard Management

Core Modules in Industrial Hygiene

SH5102 Occupational Ergonomics
SH5104 Occupational Health
SH5105 Noise and Other Physical Agents
SH5106 Radiation
SH5107 Industrial Ventilation
SH5109 Biostatistics and Epidemiology
SH5110 Chemical Hazard Evaluation

Core Modules in Process Safety

SH5201 Hazard Identification and Evaluation
SH5202 Quantified Risk Analysis
SH5203 Emergency Planning
SH5204 Safety Engineering
SH5205 Incident Management
SH5206 Human Factors in Process Safety
SH5401 SHE and Quality Management Systems OR

ESE5602 Environmental Management Systems

Elective Modules

SH5402 Advanced SHE Management
SH5403 Independent Study
SH5404 Safety Health and Environmental Project
ESE5202 Air Pollution Control Technology
ESE5204 Toxic and Hazardous Waste Management
ESE5205 Sludge and Solid Waste Management
ESE5402 Industrial Wastewater Control
ESE5403 Water Reclamation & Reuse
ESE5603 Pollution Minimization and Prevention
SH5880 Topics in Industrial Hygiene
SH5881 Topics in Process Safety
SH5882 Topics in Environment Protection

All modules are worth 4 MCs each except SH5404 Safety Health & Environmental Project which is worth 8 MCs.

Not all modules are necessarily available in any one year.

To be awarded with a specialisation, the student must also meet the requirements for that specialisation as stipulated below.

MSc (SHE) without specialisation

A candidate (full-time and part-time) must successfully complete a programme of study consisting of:
a) the 4 foundation modules listed in part (i) Foundation Modules, and
b) any 6 modules from part (ii) Core Modules in Industrial Hygiene, (iii) Core Modules in Process Safety, (iv) Elective Modules and/or any other 2 modules subjected to the approval of the Department..

Depending on the background of the candidate, the Department may allow the waiver of foundation modules on a case-by-case basis. In such instances, the candidate must make up for these modules from part (ii) Core Modules in Industrial Hygiene, (iii) Core Modules in Process Safety, (iv) Elective Modules and/or other modules subjected to the approval of the Department.

MSc (SHE) with specialisation in Industrial Hygiene

A candidate (full-time and part-time) must successfully complete a programme of study consisting of:

a) the 4 foundation modules listed in part (i) Foundation Modules,
b) any 5 modules from part (ii) Core Modules in Industrial Hygiene, and
c) any 1 module from part (ii) Core Modules in Industrial Hygiene, (iii) Core Modules in Process Safety, or (iv) Elective Modules , or any other module subjected to the approval of the Department. .

Depending on the background of the candidate, the Department may allow the waiver of foundation modules on a case-by-case basis. In such instances, the candidate must make up for these modules from part (ii) Core Modules in Industrial Hygiene, (iii) Core Modules in Process Safety, (iv) Elective Modules and/or other modules subjected to the approval of the Department.

MSc (SHE) with specialisation in Process Safety

A candidate (full-time and part-time) must successfully complete a programme of study consisting of:
a) the 4 foundation modules listed in part (i) Foundation Modules,
b) any 5 modules from part (iii) Core Modules in Process Safety, and
c) any 1 module from part (ii) Core Modules in Industrial Hygiene, (iii) Core Modules in Process Safety, or (iv) Elective Modules or any other module subjected to the approval of the Department.

Depending on the background of the candidate, the Department may allow the waiver of foundation modules on a case-by-case basis. In such instances, the candidate must make up for these modules from part (ii) Core Modules in Industrial Hygiene, (iii) Core Modules in Process Safety, (iv) Elective Modules and/or other modules subjected to the approval of the Department.

4.2.14 Master of Science (Supply Chain Management)

4.2.14.1 Overview

Master of Science (Supply Chain Management) is hosted by the Department of Industrial and Systems Engineering, Faculty of Engineering jointly with The Logistics Institute- Asia Pacific and Department of Decision Sciences from NUS Business School. It is a well-structured integrated multi-disciplinary programme which combines topics from business and engineering and is ideal for mid-career professionals who are keen to advance their career in supply chain management. The programme will be complemented by site visits to logistics and manufacturing companies, and the country's ports. Expert industry speakers in supply chain management and logistics will be invited to share their best practices.

The programme comprises a comprehensive skill-set for planning and operating modern supply chains in Asia with a global context so that graduates from this programme will be able to assume positions as logistics executives, supply chain analysts and manufacturing planners.
Expected learning outcomes include
(a) a comprehensive understanding of supply chain management that covers planning, design and operations
(b) exposure to current issues in the wider context of supply chain management and developments in Asia
(c) in-depth application of theory to solve real-world problems with business analytics methodologies such as optimisation, simulation, data analysis, economic analysis and information technology.
The programme is offered on both part-time and full-time bases.

4.2.14.2 Degree Requirements

To graduate with an MSc (SCM) degree, a student is required to pass the examinations for 9 modules equivalent to 40 modular credits (MCs). There are 4 core modules and 5 elective modules (selected from a list of 12 elective modules). For full-time course of study, a student must achieve a minimum Cumulative Average Point (CAP) of 3.00 for all the 40 MCs (inclusive of the core modules, where required) within a specified maximum period of his/her candidature of 2 years. The 4 core modules must include DSC 5211A (4MCs), IE5105 (4MCs), LI 5001 (8MCs) and LI 5101 (4MCs). The remaining 20 MCs would come from any 5 elective modules listed in the MSc (SCM) programme structure. To strive for a good balance between industrial relevance and methodological competency, students will be required to study at least one elective module from each of the two elective groups under ISE and Decision Sciences respectively.

The graduate modules offered in the MSc (SCM) programme are listed below. Not all elective modules listed are necessarily available in any one year. Unless indicated otherwise, all listed modules are 4MCs each.

For more details on modules offered, please visit: www.ise.nus.edu.sg/scm_modules

Modules in Master of Science (Supply Chain Management)

Core Modules (4):
DSC 5211A Supply Chain Coordination and Risk Management
IE5105 Introduction to Supply Chain Systems
LI 5001 Research Project (8MCs)
LI 5101 Supply Chain Management Thinking and Practice

Elective Modules (Choose 5):
Set 1 – ISE (Choose at least 1 module)
IE5001 Operations Planning and Control I*
IE5004 Engineering Probability and Simulation
IE5107 Material Flow Systems
IE5108 Facility Layout and Location
IE5205 Healthcare System and Analytics
IE5504 Systems Modelling and Advanced Simulation

Set 2 – Decision Sciences (Choose at least 1 module)
BDC5101 Deterministic Operations Research Models*
DSC4215 Supply Chain Visualization & Actionable Intelligence
DSC5211B Analytical Tools for Consulting

DSC5211C Quantitative Risk Management

Set 3 – Others

LI5201 Special Topics in Logistics

LI5202 Supply Chain Management Strategies and Case Studies

*IE5001 and BDC5101 are mutually exclusive.

4.2.15 Master of Science (Systems Design & Management)

4.2.15.1 Overview

Engineering systems is an important new field of study focusing on the complex engineering systems in a broad human, societal and industrial context. It takes an integrative holistic view of large-scale, complex, technologically enabled systems which have significant enterprise level interactions and socio-technical interfaces. The establishment of this new field has been a significant step toward evolving the holistic engineering management science needed to address the complex systems challenges of this century.

The Faculty of Engineering launched the Engineering Systems Initiative (ESI) in January 2005. A major objective of this initiative is to ensure that the knowledge and expertise in engineering and architecting large-scale systems are crystallised into a discipline which can be ported, taught and adapted for the ongoing challenges, and improved by further systematic research. The expertise to understand, analyse and build large-scale systems calls upon the highest level of integration of core engineering competencies with social, economic and policy considerations. The ESI task force proposed a strategic plan to develop a system for training and improving the expertise needed within Singapore to build complex engineering systems. This proposal for a graduate education programme in ‘Systems Design and Management’ is one of the key elements of that plan.

4.2.15.2 Degree Requirements

The modules in the programme are divided between core and foundation areas (of which there are currently two). The modules in the core area represent the fundamental knowledge of concepts and methodology that distinguish the Systems Design & Management (SDM) programme from other programmes. The modules in the foundation areas have been selected from existing graduate modules to provide essential and supporting knowledge from management science and engineering.

A full-time or part-time candidate for the degree of MSc (SDM) must successfully complete a Programme of study consisting of 40 MCs:

1. All four core modules (16 MCs);
2. The remaining 24 MCs can be obtained from the list of elective modules, divided into two foundation areas; a minimum of 8 MCs is to be obtained from each foundation area.

For graduation, a student:

1. Must obtain a minimum CAP of 3.00 (B-) for the best modules equivalent to 40 MCs; and
2. Must obtain at least 40 MCs of which at least 30 MCs must be at a graduate level within the subject or in related disciplines and the remaining credits may be from other levels in the same or other disciplines subject to the approval of the Programme Manager.

Modules

The proposed programme consists of four core modules (total of 16 MCs) and a list of electives drawn from existing modules taught by the Faculty of Engineering (with the exception of two elective modules from the NUS Business School). Three of the core modules cover the fundamental concepts and methods in designing and managing engineering systems, and have been specially created for the programme. The current electives have been divided into two areas to provide foundation knowledge in two areas: (a) system methodology and management; and (b) system application.

Core Modules
The following are core modules and are 4 MCs each. Candidates have to take all the modules in this list.
SDM5001 Systems Architecture
SDM5002 Systems Engineering
SDM5003 Knowledge Management
SDM5004 Systems Engineering Project Management

Electives
The electives are organised into two different foundation areas. All the modules are 4 MCs unless otherwise stated. Candidates have to take at least two modules from the list in each foundation area.

Systems methodology and management

SDM5010 Model-Based Systems Engineering
BMA5004A Management & Organisation (2 MCs)
MT5007 Management of Technological Innovation
MT5009 Analyzing Hi-Technology Opportunities
MT5011/ Finance for Engineering & Technology Management; (or
IE5003 Cost Analysis and Engineering Economy); (or
CE5603 Engineering Economics and Project Evaluation)
MT5012 Marketing of Hi-Tech Products and Innovation
MT5013 Global Innovation Management
MT6001 Research in Technology & Innovation Management
IE5202 Applied Forecasting Methods
IE5203 Decision Analysis
IE5404 Large Scale Systems Engineering
IE5409 Topics in Systems Engineering
PP5240 Applied Policy Analysis

Systems application

BMA5010A Managing Operations (2 MCs)
TP5026 Transportation Management & Policy
TP5028 Intermodal Transportation Operations
CE5804 Global Infrastructure Project Management
ME5602 Manufacturing Systems Engineering
ME5205 Energy Engineering
MT5002 Management of Industrial R&D
MT5003 Creativity and Innovation
MT5004 User centred Engineering and Product Development
MT5006 Strategic and New Product Development; (or
IE5211 New Product Management)
MT5016 Business Models for Hi-Tech Products
IE5401 Industrial Logistics
CN5191 Project Engineering
EE5702R Advanced Power Systems Analysis
ESE5102 Sludge & Solid Waste Management
TD5101 Specification of Complex Hardware/ Software Systems
SDM5990 SDM Research Project (8 MCs)

4.2.16 Master of Science (Transportation Systems and Management)

4.2.16.1 Overview

This is a multidisciplinary programme designed for professionals who are working in transportation and related industry. The programme involves graduate level modules taught by academic faculty members from the Faculty of Engineering, Faculty of Arts and Social Sciences, and the Business School. Students come from a variety of backgrounds, including undergraduate degrees in engineering, science, social sciences and business management. The programme accepts both full-time and part-time students.

4.2.16.2 Degree Requirement

To qualify for the MSc (Transportation Systems and Management) degree with or without specialisation, a candidate must successfully complete a programme of study consisting of at least 32 Modular Credits (MCs) from modules in Lists A and B below. The remaining two modules (8 MCs) to satisfy the degree requirements may be selected from relevant level 5000 and level 6000 modules offered by the Department of Civil and Environmental Engineering or other graduate programmes of Faculty of Engineering, subject to the approval of MSc (TSM) Programme Management, which also include the modules in aforementioned Lists A and B. In addition, a student must obtain a minimum CAP of 3.00 (Grade B-) for the best modules equivalent to 40 MCs (inclusive of compulsory modules, where required).
A Student may choose to graduate with the following degrees:

- MSc (Transportation Systems and Management), or
- MSc (Transportation Systems and Management) with specialisation in Logistics and Distribution Management

Specialisation in Logistics and Distribution Management

In addition to the above requirements, to graduate with MSc (TSM) with specialisation in Logistics and Distribution Management, the student must also obtain at least 20 MCs from List A:

List A – Distinct modules: (minimum choose any 5 modules)
CE5203 Traffic Flow & Control
CE5205 Transportation Planning
CE5207 Pavement Network Management Systems
TP5025 Intelligent Transportation Systems
TP5027 Transport & Freight Terminal Management
TP5028 Intermodal Transportation Operations

Another 16 MCs can be obtained from List B:

List B – Electives modules (minimum choose any 4 modules)
BMA5004A Management and Organisation (2MCs)
BMA5101 Industry and Competitive Analysis
CE5204 Pavement Design and Rehabilitation
CE5603 Engineering Economics and Project Evaluation
CE5705 Transportation and Construction Safety Management
CE5804 Global Infrastructure Project Management
CE6001 Operations & Management of Infrastructure Systems
CE6002 Analysis of Civil Engineering Experiments
IE5001 Operations Planning and Control I
IE5107 Material Flow Systems

IE5121 Quality Planning and Management
IE5202 Applied Forecasting Methods
IE5203 Decision Analysis
IE5401 Industrial Logistics
IE5404 Large Scale Systems Engineering
TP5026 Transportation Management and Policy

Modules taken outside the Department of Civil and Environmental Engineering are subject to the general guidelines and Department's approval.

For more details about the modules offered, please refer to the web site at
www.eng.nus.edu.sg/civil/programmes/MSc_tsm.html

4.4 Financial Assistance and Awards

Lee Kong Chian Graduate Scholarships

The Lee Kong Chian Graduate Scholarships were established from donations received from the Lee Foundation and they are NUS' most prestigious scholarship awards for graduate students.

The bond-free Scholarships are open to all nationalities who will be admitted as a candidate for a doctoral programme at NUS. Shortlisted candidates will be notified for an interview either in Singapore or their home country. Award of the Scholarship is based on competition among eligible candidates and performance at the Scholarship interview.

Up to five new awards will be given each year. Each award covers a monthly stipend of S$3,300, tuition, miscellaneous student fees at NUS, an annual book allowance of S$500, a one-off air travel allowance of two return tickets of up to S$4,000 (only for overseas students) and a one-off laptop allowance of S$1,500.

Further details are available at:
nus.edu.sg/admissions/graduate-studies/scholarships-financial-aid-and-fees/scholarships-awards/lee-kong-chian-graduate-scholarship.html

NUS President's Graduate Fellowships (PGF)

The bond-free PGFs are awarded to candidates who show exceptional promise or accomplishment in research.

It is available to full-time doctoral candidates of any nationality (incoming or existing) on a competitive basis.

Each award covers a monthly stipend of $3,000 to $3,300 (depending on citizenship) throughout the period of award. It also provides for tuition fees, a one-off air travel allowance for 1 one-way ticket of up to $750 (only for overseas students) and a one-off settling allowance of $1,000 (only for overseas students).

Further details are available at:
nus.edu.sg/admissions/graduate-studies/scholarships-financial-aid-and-fees/scholarships-awards/president's-graduate-fellowship.html

NUS Research Scholarship

(Applicable for PhD and MEng programmes)
Full-time research graduate students are eligible to apply for the NUS Research Scholarship. This scholarship is tenable for one year in the first instance and, subject to the research scholar's satisfactory progress, renewable annually up to a maximum of two years for Master's candidates and four years for PhD candidates.

Research scholars will be given a monthly stipend and a full tuition fee subsidy.

For research scholars in a Masters, the monthly stipend is S$2,500 (for Singapore Citizens*) / S$1,500 (for International and Singapore Residents). For Research Scholars in a PhD programme, monthly stipends for Singapore citizens*, Singapore Permanent Residents and foreigners are currently S$2,700, S$2,200 and S$2,000 respectively. For student intakes prior to AY2010, the monthly stipend for Singapore citizen is S$2,300. There is no bond for this scholarship.

* with effect from 1 August 2015, Central Provident Fund (CPF) contributions shall be provided at a rate pegged to the prevailing employer's contribution rate by CPF, on top of the monthly stipend received.

Research scholars may also be eligible for an additional stipend of up to $500 per month upon passing the PhD qualifying examination, which is normally held 12 to 18 months after registration of candidature. The top-up is renewable annually subject to good performance.

Further details are available at:
nus.edu.sg/admissions/graduate-studies/scholarships-financial-aid-and-fees/scholarships-awards/nus-research-scholarship.html

Singapore International Graduate Award (SINGA)

The bond-free Scholarship is open to all international students with excellent academic results and with a passion for research, who will be admitted as a candidate for a doctoral programme (in key research areas identified by A*STAR) at NUS. Each award carries a stipend, tuition fees, airfare and settling-in allowance.

Further details are available at:
a-star.edu.sg/singa-award

Student Employment

Full-time graduate students may apply to work on a part-time basis during the period of candidature as a Graduate Student Tutor or Researcher under the Registrar's Office Part-time Appointments Scheme. In addition, the Office of Student Affairs posts offers of jobs for students on their Career Service website.

These jobs may be performed during semester or vacation periods. In all instances, international students will first need the approval of the Office of Student Affairs before taking up any form of employment.

4.3 Special and Collaborative Programmes

4.3.1 Double Degree Programmes

4.3.1.1 Double Degree Programme with French Grande Ecoles

4.3.2 Joint Degree Programmes

4.3.2.1 NUS-CentraleSupélec Joint PhD

(CentraleSupélec, France)

4.3.2.2 NUS-IIT Joint PhD

Indian Institute of Technology, Bombay
Indian Institute of Technology, Kanpur
Indian Institute of Technology, Madras

4.3.2.3 NUS-SUTD Joint PhD

Singapore University of Technology and Design, Singapore

4.3.2.4 NUS-TU/e Joint PhD

Eindhoven University of Technology, Netherlands

4.3.2 Collaborative Programme

NUS-SUSTech Collaborative Ph.D. Programme

Partner: Southern University of Science and Technology

This is a collaborative programme with Southern University of Science and Technology, China (SUSTech). Students are required to spend 2 years of studies/ research in NUS, followed by another 2 years in SUSTech.

To apply, click here.

4.3.3 Student Exchange

For Incoming Students:Click here to apply :
http://www.nus.edu.sg/registrar/education-at-nus/non-graduating-programme.html

For Outgoing Students:Existing MSc students* and M.Eng./Ph.D. students may apply to spend 1 semester, taking a few coursework modules and/or doing research/projects, at partner university. For more information, please approach your Department.* *only for selected MSc programmes, eg. MSc (Hydraulic Eng & Water Res Mgt), MSc (Mgt of Tech), MSc (Offshore Tech)*

- University Level Exchange
- Faculty Level Exchange:
- Institut Mines-Télécom
- Norwegian University of Science and Technology
- Department Level Exchange: *(Please refer to Departments for more details)*