Faculty of Engineering

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2.1 Deanery

Title & Name	*Designation/Responsibility*	*Telephone 6516 xxxx*	*Email xxxx@nus.edu.sg*
Prof Chan Eng Soon	Dean	2142	engdean
Prof LIM Seh Chun	Deputy Dean	4123	englimsc
Prof Quek Ser Tong	Vice-Dean (Graduate Studies)	6283	engqst
Prof Victor SHIM	Vice-Dean (External Relations)	2166	engspw
Assoc Prof TEO Kie Leong	Vice-Dean (Research)	6063	engvdr
Assoc Prof ANG Kok Keng	Vice-Dean (Student Life)	2570	engangkk
Assoc Prof ASHRAF Kassim	Vice-Dean (Undergraduate Studies)	5048	eleashra
Assoc Prof Christopher YAP	Assistant Dean (Undergraduate Studies)	2271	engcyap
Assoc Prof TAN Kay Chen	Assistant Dean (Undergraduate Studies)	2127	eletankc

2.2 Heads and Deputy Heads of Departments (Academic)/Directors of Programmes

Title & Name	*Designation/Responsibility*	*Telephone 6516 xxxx*	*Email xxxx@nus.edu.sg*
Prof GOH Cho Hong, James	Head, Department of Bioengineering	5259	biehead

Prof LEE Jim Yang	Head, Department of Chemical & Biomolecular Engineering	2186	chehead
Prof CHEONG Hin Fatt	Head, Department of Civil & Environmental Engineering	2148	ceehead
Prof CHUA Kee Chaing	Head, Department of Electrical & Computer Engineering	2108	elehead
Prof WANG Chien Ming	Director, Engineering Science Programme	2157	ceewcm
Prof HANG Chang Chieh	Head, Department of Engineering & Technology Management	8501	etmhead
Prof TANG Loon Ching	Head, Department of Industrial & Systems Engineering	2203	isehead
Prof CHOW Gan Moog	Head, Department of Materials Science & Engineering	3325	msehead
Prof TAY Tong Earn	Head, Department of Mechanical Engineering	2210	mpehead
Prof POO Aun Neow	Director, Office of Bachelor of Technology	7995	engpooan
Assoc Prof TOH Siew Lok	Deputy Head, Department of Bioengineering	2920	bietohsl
Prof G. P. RANGAIAH	Deputy Head, Department of Chemical & Biomolecular Engineering	2187	chegpr
Prof Somsak Swaddiwudhipong	Deputy Head, Department of Civil and Environmental Engineering	2173	ceesomsa
Assoc Prof LOH Ai Poh	Deputy Head, Department of Electrical & Computer Engineering	2451	elelohap
Assoc Prof Anjam KHURSHEED	Deputy Director, Engineering Science Programme	2295	eleka
Assoc Prof CHAI Kah Hin	Deputy Head, Division of Engineering & Technology Management	7615	etmckh
Assoc Prof NG Szu Hui	Deputy Head, Department of Industrial & Systems Engineering	3095	isensh
Assoc Prof Daniel John BLACKWOOD	Deputy Head, Department of Materials Science & Engineering	6289	msedjb
Assoc Prof Teo Chee Leong	Deputy Head, Department of Mechanical Engineering	2259	mpeteocl

2.3 Academic Advisors for undergraduate programmes

Title & Name	***Designation/Responsibility***	***Telephone 6516 xxxx***	***Email xxxx@nus.edu.sg***

A. Department of Bioengineering			
Assoc Prof TOH Siew Lok	Level-1000 and Level-4000 Advisor	2920	bietohsl
Dr Kim SangHo	Level 2000 Advisor	6713	bieks
Dr Evelyn Yim	Level 3000 Advisor	7322	bieykfe
B. Department of Chemical & Biomolecular Engineering			
Assoc Prof HONG Liang	Level-1000 Advisor	5029	chehongl
Dr Photinon, Kanokorn	Level-2000 Advisor	8609	chepk
Assoc Prof FENG Si-Shen	Level-3000 Advisor	3835	chefss
Assoc Prof HIDAJAT Kus	Level-4000 Advisor	2191	chehidak
Dr LU Xianmao	Level-4000 Advisor	1071	chelxm
C. Department of Civil & Environmental Engineering			
Prof FWA Tien Fang	Level-1000 Advisor	2276	ceefwatf
Prof BALENDRA T	Level-2000 Advisor	2159	ceebalen
Dr QIAN Xudong	Level-3000 Advisor	6827	ceeqx
Assoc Prof MENG Qiang	Level-4000 Advisor	5494	ceemq
Assoc Prof Rajasekhar BALASUBRAMANIAN	EVE Program Director	5135	ceerbala
Dr. LIN Yi-Pin	Year 1 Advisor	4729	ceelinyp
Assoc Prof CHEN Jia-Ping, Paul	Year 2 Advisor	8092	ceecjp
Assoc Prof YU Liya E	Year 3 Advisor	6474	ceeley
Assoc Prof Rajasekhar BALASUBRAMANIAN	Year 4 Advisor	5135	ceerbala
D. Department of Electrical & Computer Engineering			
Assoc Prof TAN Woei Wan	EE Program Director	8323	eletanww
Dr MOUTHAAN, Koenraad	Level-1000 & Level-2000 Advisor	7871	elemk
Assoc Prof MANSOOR Bin Abdul Jalil	Level-3000 Advisor	2125	elembaj
Assoc Prof HO Weng Khuen	Level-4000 Advisor	6286	elehowk
Assoc Prof TAY Teng Tiow	CEG Program Director	2126	eletaytt
Assoc Prof CHEONG Loong Fah	CEG Advisor (all levels)	2290	eleclf
E. Engineering Science Programme			

Assoc Prof Anjam KHURSHEED	Advisor (all levels)	2295	eleka
F. Department of Industrial & Systems Engineering			
Assoc Prof NG Szu Hui	Advisor (all levels)	3095	isensh
G. Department of Materials Science & Engineering			
Dr XUE Jun Min	Level-1000 Advisor	4655	msexuejm
Dr CHEN Jingsheng	Level-2000 Advisor	7574	msecj
Dr CHIU Cheng Hsin	Level-3000 Advisor	4502	msecch
Assoc Prof GONG Hao	Level-4000 Advisor	4632	msegongh
H. Department of Mechanical Engineering			
Assoc Prof LEE Thong See	Level-1000 Advisor	2156	mpeleets
Dr SHAH Dilip A	Level-2000 Advisor	2121	mpedilip
Prof NG Kim Choon	Level-3000 Advisor	2214	mpengkc
Assoc Prof TAY Cho Jui	Level-4000 Advisor	2557	mpetaycj
I. Office of Bachelor of Technology			
Assoc Prof LAKSHMINARAYANAN Samavedham	Coordinator, B.Tech. (Chemical Engineering)	8484	chels
Dr TI Hwei Chen	Coordinator, B.Tech. (Chemical Engineering)	2188	chetihc
Assoc Prof Ganesh SAMUDRA	Coordinator, B.Tech. (Electronics Engineering)	2293	eleshanr
Assoc Prof POH Kim Leng	Coordinator, B.Tech. (Industrial & Management Engineering)	2193	isepohkl
Assoc Prof A.Senthil KUMAR	Coordinator, B.Tech. (Mechanical/Manufacturing Engineering)	6800	mpeask
Assoc Prof Christopher YAP	Coordinator, B.Tech. (Mechanical/Manufacturing Engineering)	2271	mpecyap
Assoc Prof HO Juay Choy	Advisor	2552	mpehojc

2.4 Programme Coordinators for graduate programmes

Title & Name	*Programme*	*Telephone*	*Email*

		6516 xxxx	*xxxx@nus.edu.sg*
Prof KANG En-Tang	M.Sc. (Chemical Engineering)	2189	cheket
Prof TAN Kiang Hwee	M.Sc. (Civil Engineering) and M.Sc. (Geotechnical Engineering)	2260	ceetankh
Assoc Prof Adekunle Olusola Adeyeye	M.Eng. and Ph.D. (Electrical and Computer Engineering)	5071	eleaao
Assoc Prof ZHU Chun Xiang	M.Sc. (Electrical Engineering)	8930	elezhucx
Assoc Prof HE Jianzhong	M.Sc. (Environmental Engineering)	3385	ceehj
Assoc Prof NG Kien Ming	M.Sc. (Industrial & Systems Engineering)	5541	isenkm
Assoc Prof Marcelo H ANG Jr	M.Sc. (Intellectual Property Management) and M.Sc. (Management of Technology)	2555	mpeangh
Dr CHEN Jingsheng	M.Sc. (Materials Science & Engineering)	7574	msecj
Assoc Prof KUMAR A Senthil	M.Sc. (Mechanical Engineering)	6800	mpeask
Assoc Prof LIM Siak Piang	M.Sc. (Mechatronics)	2235/6479	mpelimsp
Dr BAI Wei	M.Sc. (Offshore Technology)	2288	ceebaiw
Assoc Prof FOO Swee Cheng	M.Sc. (Safety, Health and Environmental Technology)	8721	chefoosc
Assoc Prof LEE Loo Hay	M.Sc.(Supply Chain Management)	2895	iseleelh
Assoc Prof CHAN Weng Tat	M.Sc. (Systems Design and Management)	2576	ceecwt
Assoc Prof LEE Der-Horng	M.Sc. (Transportation Systems and Management) and Grad. Dip. In Aviation Management	2131	ceeleedh
Assoc Prof CHIA Eng Seng Aaron	Executive Master in Systems Engineering and Management	6431	iseces
Prof Raj RAJAGOPALAN	NUS-UIUC Joint Ph.D. Programme (Chemical Engineering)	4679	cherajr
Assoc Prof Madapusi P SRINIVASAN	M.Eng. and Ph.D. (Chemical & Biomolecular Engineering)	2171	chesmp
Dr Martin BUIST Lindsay	M.Eng. and Ph.D. (Bioengineering)	5929	biebml
Prof LEUNG Chun Fai	M.Eng. and Ph.D. (Civil Engineering) & M.Eng. and Ph.D. (Environmental Science & Engineering)	2281	ceelcf
Assoc Prof CHAI Kah	M.Eng. and Ph.D. (Engineering &	7615	etmckh

Hin	Technology Management)		
Assoc Prof LEE Loo Hay	M.Eng. and Ph.D. (Industrial & Systems Engineering)	2895	iseleelh
Assoc Prof Daniel John BLACKWOOD	M.Eng. and Ph.D. (Materials Science & Engineering)	6289	msedjb
Assoc Prof KUMAR A Senthil	M.Eng. and Ph.D. (Mechanical Engineering)	6800	mpeask
Assoc Prof Christopher YAP	University Scholars Programme	2271	engcyap
Dr John Arthur BAULY	NUS Overseas Colleges (in Silicon Valley and Bio Valley)	6657	engjb
Assoc Prof CHEW Ek Peng	NUS/Georgia Tech Special Term Programme	6554	isecep
Assoc Prof Christopher YAP	Double Degree Programme with French Grandes Écoles	2271	engcyap
Assoc Prof Vladan BABOVIC	Double Degree Programme with Delft University of Technology	4929	ceebv
Assoc Prof HIDAJAT Kus	Industrial Attachment Programme and Vacation Internship Programme	2191	chehidak
Dr John Arthur BAULY	Technopreneurship and Incubation Programme	6657	engjb
Assoc Prof Marcelo H ANG Jr	Innovation Programme	2555	mpeangh
Assoc Prof ABDULLAH Al Mamun	Undergraduate Research Opportunities Programme	2251	eleaam
Assoc Prof ONG Sim Heng	Independent Work Programme	2245	eleongsh

2.5 Departments/Administrative Coordinators

Title & Name	***Designation/Responsibility***	***Telephone 6516 xxxx***	***Email xxxx@nus.edu.sg***
A. Office of Undergraduate Programmes			
Ms Lesley POONG	Senior Manager for Admissions-related matter, Transfer of courses, Double Degree Programmes, University Scholars Programme, Polytechnic Accreditation, Commencement, Curriculum, UCEP/BUS matters, Secretariat for EUPAC	1339	engpge
Mr Ivan YEW	Assistant Manager for Examinations, Prizes & Medals, Scholarships, Student appeals (exams/dismissal), Streaming, Leave of Absence/Withdrawals	2269	engivan

Ms Davina THAM	Assistant Manager for Student Exchange Programme, NUS Overseas Colleges, French Double Degree Programme, NUS/Georgia Tech Special Term, Global Village Programme, International Summer Programmes	1659	engdtwn
Ms Lisa Moo	Executive for Enhancement Programmes (Local Industrial Attachment, Vacation Internship, Technopreneurship, UROP, Innovation Programme, Independent Work Programme), NUS Bulletin, Secretariat for Faculty Teaching Excellence Committee, Outstanding Undergraduate Researcher Prize	6217	engmrc
Ms Nuraini Nazeha Bte S S Mohd Habeeb	Executive for CORS, Class Scheduling, Minors and Majors, Engineering Colours Awards	5503	engnnss
B. Office of Bachelor of Technology			
Ms LEE Yee Ling Adeline	Manager for Admissions	2486	englyl
Ms Patricia LEE Eng Joo	Assistant Manager for Student Matters (Mechanical/Manufacturing Engineering and Industrial & Management Engineering)	4492	engplej
Mrs CHIA-CHEW Lay Har	Senior Executive for Student Matters (Chemical Engineering and Electronics Engineering)	6816	engclh
C. Graduate Studies Office			
Ms CHIN Ai Wei Ivy	Senior Manager for Graduate Research Programmes	5015	engcaw
Ms CHENG Sew Chin	Manager for Graduate Coursework Programmes	8301	engcsc
D. Department of Bioengineering			
Ms Teo Mun Mun Jacqueline	Executive for Undergraduate and Graduate Programmes	1611	bietmmj
Ms Loo Shi Yun Melinda	MAO for Undergraduate and Graduate Programmes	3553	bieloosy
E. Department of Chemical & Biomolecular Engineering			
Ms NG Ai Mei	Assistant Manager for Undergraduate Programme	4568	chengam
Ms LUM Mei Peng Sharon	Assistant Manager for Graduate Coursework Programmes	3103	chelums
Ms TAN Hui Ting	Executive for Graduate Research Programmes	5031	chetanht
F. Department of Civil and Environmental Engineering			

Ms Peggy LEONG	Associate Director for MSc Programmes	5831	ceelp
Ms LIM Chi Cheng Christina	Senior Executive for Undergraduate Programmes	4270	ceelccc
Ms Cecilia SHANTI DEWI	Assistant Manager for Double Degree Programme with Delft University of Technology	5942	ceesdc
Ms Charulatha D/O VENGADISWARAN	Executive for MEng and PhD Programmes	4513	ceecv
Ms Sarimah Bte Mustafa	MAO for Undergraduate Programmes	4656	ceesm
Ms Lynn WONG	MAO for MSc (CE), MSc (EVE) and MSc (GEO) Programmes	5837	ceewsl
Ms NORELA Bte Buang	LT for MSc (OT) and MSc (TSM) Programmes	4314	ceenb
G. Department of Electrical & Computer Engineering			
Ms YIP Lai Yeng Elyn	Assistant Manager for EE Undergraduate Programmes: Years 1 and 2	5983	eleylye
Ms YAP Siew Choo	Manager for EE Undergraduate Programmes: Years 3 and 4	1353	eleysc
Ms WONG Yoke Cheng Eunice	Manager for Graduate Programmes	3809	elewyc
Ms CHUA Wei Nee Winnie	Assistant Manager ~~Executive~~ for CEG Undergraduate Programmes	4186	elecwn
H. Engineering Science Programme			
Ms Tay Tang Lim Violet	Assistant Manager for Undergraduate Programme	3354	espttlv
Miss Shanmuga Priya D/O Subramaniam	MAO for Undergraduate Programme	8664	espsps
I. Division of Engineering & Technology Management			
Ms CHIN Yuen Yee Mavis	Assistant Manager for all programmes	8502	etmcyy
J. Department of Industrial & Systems Engineering			
Mr CHIANG Tee Hwa, Steven	Manager for Undergraduate Programme	4499	isecth
Ms CHEN Weiting	MAO for Undergraduate Programmes	8726	isecwt
Mr TANG Kang Wei	Executive for M.Sc. Programme	5497	isetkw
Ms OW Lai Chun	MAO for M.Eng. and Ph.D. Programmes	2206	iseowlc
K. Department of Materials Science & Engineering			
Ms HO Sen Lin	Assistant Manager for Undergraduate	4672	msehslk

	Programme		
Dr KONG Hui Zi	Executive for Graduate Programme	7508	msekhz
Mr CHOO Shi Guang Eugene	Assistant for Graduate Programme	1301	msecsge
L. Department of Mechanical Engineering			
Ms Eileen LIM	Assistant Manager for Undergraduate Programme	4494	mpeelwl
Ms LEE Meng Kiow	Senior Executive for Graduate Programmes	7610	mpelmk

MAO – Management Assistant Officer

LT – Laboratory Technologist

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Undergraduate Education (Full-time Programme)

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3.1 Bachelor of Engineering Programme

The Faculty of Engineering offers the following full-time four-year undergraduate programmes leading to Bachelor of Engineering (Honours) degrees [i.e., B.Eng. (Hons.) degree]:

B.Eng. (Bioengineering)
B.Eng. (Chemical Engineering)
B.Eng. (Civil Engineering)
B.Eng. (Computer Engineering)
B.Eng. (Electrical Engineering)
B.Eng. (Engineering Science)
B.Eng. (Environmental Engineering)
B.Eng. (Industrial & Systems Engineering)
B.Eng. (Materials Science & Engineering)
B.Eng. (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 B.Eng. (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 (section 3.3) and a host of enhancement programmes (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 also available via *http://btech.eng.nus.edu.sg*

3.1.1 Overview of the Engineering Curriculum

Table 3.1.1: Engineering Undergraduate Curriculum[1] (except for the Engineering Science Programme)

University Level Requirements (Ulr)	Programme Requirements	
		Foundational Requirement Mathematics I & II, Progra

General Education Modules (GEMs) (8 MCs) 1 Singapore Studies (SS) module (4 MCs) Breadth Modules (outside student's Faculty) (8 MCs)	Faculty Requirements: Critical Thinking & Writing Human Capital in Organizations Engineering Professionalism	Methodology and others Discipline-specific modules for various programmes (Bioengineering, Chemical Civil Engineering, Compute Electrical Engineering, Env Engineering, Industrial & S Engineering, Materials Sci Engineering and Mechanic
Sub-total = 20 MCs (12.5%)	Sub-total = 10 MCs (6.25%)	Sub-total = 110 MCs (68.75%)
Minimum required for graduation = 160 MCs		

[1]All students admitted in AY2012/2013 are required to read an additional requirement, ES2331 Communicating Engineering, on a graded basis as Breadth (module type code U9) OR as Unrestricted Elective (module type code 27).

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

University Level Requirements (ULR)	20 MCs
Programme Requirements*	120 MCs
Unrestricted Elective Modules (UEMs)	20 MCs
Total	160 MCs

* Note that the programme requirements could be more for some engineering programmes.

University Level Requirements (ULR)

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), Breadth Modules 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:

Two General Education Modules (GEMs)
One Singapore Studies (SS) Module
Two Breadth Modules (outside student's Faculty)

General Education Modules

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 http://www.nus.edu.sg/gem/ for further details concerning GEMs.

GEMs offered by the Faculty of Engineering are as follows:

GEK1500 Inside Your Personal Computer

GEK1501	Information Technology and Us
GEK1513	Wireless Communications — Past, Present and Future
GEK1522	Global Environmental Issues
GEK1523	Innovativeness in Engineering Design
GEK1524	Living with Fluids
GEK1546	Harnessing patterns of light
GEK2505	Introductory Biomedical Engineering
GEM1505A	Engineering by Design — Innovations in Conservation Devices & Systems
GEM1505B	Engineering by Design — Innovations in Electrical & Electronic Systems
GEM1505C	Engineering by Design — Natural Forms & Conceptual Design of Structures
GEM1505D	Engineering by Design — Biomimetic Principles in Engineering Design
GEM2501	Electric Energy — Powering the New Millennium

Engineering students must read at least one GEM from Group B (the Humanities & Social Sciences group) and are encouraged to read a Design GEM Offered by the Faculty of Engineering.

Design GEMS offered by FOE

Engineering is about the innovative and creative application of mathematical and scientific principles to the creation of products, technology and services for the good of mankind. Engineering design essentially involves an engineering methodology for solving problems, and the final solution depends on a number of issues or constraints including cost and user requirements. The purpose of these introductory modules on Engineering Design is to introduce first year students to the exciting world of engineering by a combination of lectures, laboratory and “design-and-build” project work. Learning will be accomplished by providing opportunity for students to apply principles of design and integrate fundamentals of engineering and science for novel or improved solutions of problems. Students will be working in small groups, interacting with faculty and research staff in an active laboratory where they will be required to think critically and implement solutions to a given “grand challenge” design problem in an integrated way. First-year engineering undergraduates are encouraged to read one of the following Design GEMs:

GEM1505A	Engineering by Design — Innovations in Conservation Devices & Systems
GEM1505B	Engineering by Design — Innovations in Electrical & Electronic Systems
GEM1505C	Engineering by Design — Natural Forms & Conceptual Design of Structures
GEM1505D	Engineering by Design — Biomimetic Principles in Engineering Design

Singapore Studies Modules

Students are required to take one module from a list of Singapore Studies (SS) Modules. SS modules heighten awareness and knowledge in history, politics, economics, law and urban environment of Singapore and Southeast Asia.

Breadth Modules (outside Student’s Faculty)

The Breadth Modules under ULR enable students to pursue topics beyond their field of specialization by reading subjects outside their faculty. Students are strongly encouraged to consider Breadth modules which will prepare them for their future roles as engineer – leaders such as one or more from the list of business and management modules in Table 3.1.1b. Students also should refer to their respective Departments for recommended breadth modules. Such modules from other Faculties can also be read as unrestricted electives.

Engineering students admitted from AY2012 are required to read a new compulsory communications modules offered by the Centre for English Language Communication (CELC) on a graded basis as a breadth or unrestricted elective.

Students should seek guidance from the departmental academic advisors on their elective choices. As these modules can be used to satisfy Minor and Second Major requirements, students are advised to carefully plan the use of the Breadth Requirement.

Table 3.1.1b: Complementary Breadth Modules

Module	Prerequisites	Preclusions
ACC1002X Financial Accounting	None	None
BSP1004X Legal Environment of Business	None	None
BSP1005 Managerial Economics	None	EC1301, IE2140
EC1301 Principles of Economics	None	BSP1005, IE2140 & etc.
MKT1003X Marketing	None	TR2201
MNO1001X Management and Organisation	None	None
DSC2006 Operations Management	None	None

Students should refer to their specific programmes for recommended Breadth modules from other Faculties.

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 the following: EG1531 Critical Thinking and Writing, HR2002 Human Capital in Organizations and EG2401 Engineering Professionalism, ***and***
> Foundational Requirements: MA1505 Mathematics I, MA1506 Mathematics II, CS1010E Programming Methodology (or IT1005/CE2409) and others as defined by the student's engineering discipline (details in section 3.2) ***and***
> Discipline Specific Modules: core/essential, technical electives, project modules and independent study modules as defined by the student's engineering discipline (details in section 3.2).

Unrestricted Elective Modules (UEMs)

Unrestricted Elective Modules (UEMs) enable students to pursue their interests without any restrictions. Students may use UEMs to partially or wholly satisfy exciting academic programmes such as the Enhancement Programmes (see Section 3.4), Minor Programmes (see Section 3.3) and Second Major Programmes. To achieve a greater depth in their engineering major, students may also take technical electives to satisfy UE requirements. Engineering modules including technical electives/modules taken as UE must be taken on a graded basis.

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 the Second Major in Systems Engineering offered by the Department of Industrial & Systems Engineering.

Table 3.1.1c: Possible Unrestricted Elective Modules (UEMs)

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 UEM and ULR-Breadth Modules

Students should carefully plan the use of UEM and ULR Breadth modules which can be used to satisfy the requirements of a number of exciting programmes such as the FoE Enhancement, Double degree, Second Major and Minor programmes. Students are strongly urged to take modules towards UEM in later semesters and to take note of the 60 MC limit on Level-1000 modules (see section 3.1.3)

The Industrial Attachment (EG3601) and Vacation Internship (EG3602) programmes, which are part of the FoE Enhancement programmes, provide students with the invaluable opportunity to bring their proficiencies from the classroom to a real industrial environment and to acquire the ability to translate theoretical knowledge into practical applications. Through these programmes, students not only attain the practical work experience by working alongside with experienced professionals in multinational corporations and research centres, they may also get a taste of working with diverse cultures, and develop a global outlook when doing the internship overseas. With this, interns could also get opportunities for employment by companies upon graduation. Students are therefore strongly encouraged to plan carefully to incorporate Industrial Attachments or Vacation Internships into their study plans. For more information on these Enhancement Programmes, please refer to Section 3.4.

Critical Thinking, Writing & Communications.

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 and 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 and oral skills. The compulsory ES1513 Critical Thinking & Writing module is designed to prepare engineering students to think, speak, and write critically and effectively. While oral communication skills are emphasized throughout the engineering curriculum, a compulsory oral communications module ES2331 Communicating Engineering (to be taken as Breadth/UE) 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 in the USP and University Town programmes will undergo a separate set of writing and communications modules in place of ES1513/ES2331.

3.1.2 General Degree Requirements

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

i. Satisfy the Modular Credit (MCs) requirements of their specific B.Eng. degree programme,
ii. Obtain a cumulative average point (CAP) of 2.00 or higher,
iii. 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*
iv. 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 at the Faculty of Engineering's website at: http://www.eng.nus.edu.sg/ugrad/ and in the websites of the student's respective departments.

The class of honours awarded to a candidate who completes the Bachelor of Engineering degree requirements will be based on the cumulative average point (CAP – see section 3.1.3) of all modules completed at all levels as given in Table 3.1.2.Table 3.1.2: Relationship between CAP and Honours Classification

Table 3.1.2: Relationship between CAP and Honours Classification

Class of Honours	CAP Cut Offs
First Class	4.5 and above, plus at least an 'A minus' in the Final Year Project
Second Class Upper	4.0 to 4.49
Second Class Lower	3.5 to 3.99
Third Class	3.2 to 3.49
Pass	2.0 to 3.19
Fail	Below 2.0

Please carefully read the information on "Undergraduate Continuation and Graduation Requirements" at the general information section of the NUS Bulletin (http://www.nus.edu.sg/registrar/nusbulletin/GI/index.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

Minimum MCs to be graded and factored into CAP for BEng students:

A minimum 65% of Programme/Major credits must be graded and factored into the CAP. The other 35% of credits may be earned through credit transfers, advanced placement, exemptions and CS-graded modules.

Exemption Policy for Polytechnic Graduates

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

a) Up to 8 MCs from University Level Requirements (ULR): one General Education Module from Group B (Humanities & Social Sciences) and one Breadth module
b) Up to 12 MCs from Unrestricted Elective Modules (UEMs)
c) 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).

Math Bridging Module for Polytechnic Graduates

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

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

GCE 'A' Level students without H2 or H1 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 ES1102 English for Academic Purposes (Engineering) must be taken by students who have not passed or been exempted from the Qualifying English Test (QET) at the time of admission to the Faculty. There are no MCs assigned to this module, but a pass is required for the award of the degree. Students are strongly urged to complete ES1102 in the first semester so that they can proceed to read EG1531 Critical Thinking and Writing in the second semester of the first year of study.

3.1.4 Common Engineering

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

- MA1505 Mathematics I
- MA1506 Mathematics II
- CS1010E Programming Methodology (will be mapped to IT1005/CE2409 for students who enter Civil/Chemical Engineering)
- At least one physics module (either PC1431 Physics IE or PC1432 Physics IIE) and
- At least two engineering modules from MLE1101 Introductory Materials Science and Engineering, EG1108 Electrical Engineering and EG1109 Statics and Mechanics of Materials.

First-year common engineering students will also be encouraged to read EG1531 Critical Thinking and Writing in the first year of study subject to meeting its prerequisites.

Table 3.1.4 shows the Physics and Engineering modules that common engineering students are required to read to qualify to apply for entry into the various engineering disciplines. Students with H2 Chemistry who plan to apply for Chemical Engineering should read CM1502 and CN1111, while those who plan to apply for Environmental Engineering should read CM1502 only. Students should carefully choose a combination of Physics and Engineering modules which would qualify them to apply for entry into at least three engineering disciplines. 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 and Engineering modules for the various engineering disciplines

Engineering Programme	Physics Modules	Engineering Modules
Bioengineering	PC1431, PC1432	EG1108, EG1109
Chemical	-	MLE1101*
Civil	PC1431	EG1108, EG1109, MLE1101*
Electrical	-	EG1108 (*will be mapped to EE1002*)
Computer	PC1432	EG1108 (*will be mapped to CG1108*)
Environmental	PC1431	EG1109, MLE1101*
Industrial & Systems	-	EG1108, EG1109
Mechanical	PC1431	EG1108, EG1109
Material Science	PC1431, PC1432	EG1108, EG1109

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 (B.Eng.) 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 advance 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. Students can participate in the NUS Overseas Colleges (NOC) programme to nurture their entrepreneurial spirit and acquire associated skills.

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

3.1.6 Design-Centric Curricuium

The Design-Centric Curriculum (DCC) is a flexible and self-exploratory alternative learning pathway for engineering students uniquely offered by the NUS Faculty of Engineering. It complements the many options available to NUS engineering students. DCC aims to produce engineering graduates with a global perspective yet who are sensitive to local cultural subtleties, and who have the ability to identify and solve complex challenges of societal importance.

A key feature of the DCC is the multi-year, multi-disciplinary projects which address complex and coupled problems within the three broad themes of Engineering in Medicine, Future Transportation Systems and Smart and Sustainable Cities. DCC students will spend 3 to 3.5 years (depending on the nature of the projects undertaken) working together on these projects in teams comprising students from different engineering disciplines. They will be guided by teams of mentors with diverse backgrounds.

The other features of the DCC include generic DCC modules, a learning environment that encourages creativity, team learning and collaboration/cooperation across disciplinary boundaries, and a Design Summer Programme during which DCC students will have the opportunity to work with students coming from different parts of the world to solve problems with societal importance.

DCC students begin their learning journey in their second semester with the identification and formulation of problems through the full cycle of empathy, definition, ideation, prototyping, and testing (the Design Thinking Cycle), leading to a clear roadmap for their respective projects. Employing engineering principles they have learned, DCC students work on these problems starting at the component level and moving with increasing complexity till an integrated engineering solution is obtained. This process will take up to 7 semesters or 3.5 years to complete. For those who prefer to work in a more directed fashion, they could opt to tackle problems within certain topical engineering grand challenges. They will still go through the Design Thinking Cycle but will ideate within the predefined challenges to offer engineering solutions. For the latter group, the DCC learning journey will start one semester later and will take up to 6 semesters or 3 years to complete.

Website: http://www.eng.nus.edu.sg/ugrad/dcc/index.html.

3.2 Bachelor of Engineering Degree Programmes

3.2.1 Bachelor of Engineering (Bioengineering)

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 Bioengineering 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 bioengineering, 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 tomajor in Bioengineering 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 (Bioengineering) Programme are required to fulfil the following requirements to graduate from the programme:

- Complete a minimum of 161 MCs with a CAP ≥ 2.0;
- Pass all modules in accordance with Table 3.2.1a;
- Pass at least four modules of technical electives as listed in Table 3.2.1b;
- To qualify for an area of focus, a student must pass at least 16 MCs and do a Final Year Project in the chosen area;
- 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 (GEM) (at least one from Group B: Humanities and Social Sciences)	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives	18
Programme Requirements	
Faculty Requirements:	10
EG1531 Critical Thinking and Writing	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English[#]	-
Foundation Requirements:	27
MA1505 Mathematics I	4

MA1506 Mathematics II	4
EG1108 Electrical Engineering	3
EG1109 Statics and Mechanics of Materials	4
PC1431 Physics IE	4
PC1432 Physics IIE	4
CS1010E Programming Methodology	4
Bioengineering Major Requirements	
BIE Core Subjects:	48
BN2101 Principles of Bioengineering	4
BN2102 Bioengineering Data Analysis	4
BN2201 Quantitative Physiology for Bioengineers	4
BN2202 Introduction to Biotransport	4
BN3201 Introduction to Biomechanics	4
BN3301 Introduction to Biomaterials	4
BN3401 Biomedical Electronics and Systems	4
BN3501 Equilibrium and Kinetic Bioprocesses	4
CM1121* Basic Organic Chemistry or CM1501* Organic Chemistry for Engineers	4
BN2401 Biosignals Processing	4
LSM1401+ Fundamentals of Biochemistry or LSM1101+ Biochemistry of Biomolecules	4
LSM2103 Cell Biology	4
BIE Design and Project Modules:	22
BN2203 Introduction to Bioengineering Design	4
BN3101 Biomedical Engineering Design	6
BN4101R B.Eng. Dissertation (over 2 semesters)	12
BIE Electives:	
Technical Electives (from the modules in Table 3.2.1b)	16
Total	161

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

* Students without GCE 'A' Level Chemistry or equivalent must read CM1417 Fundamentals of Chemistry *as a prerequisite* for CM1121 Basic Organic Chemistry or CM1501 Organic Chemistry for Engineers.

Table 3.2.1b: Bioengineering Electives groups according to Area of Focus† *

Biomaterials/Tissue Engineering

BN2001	Independent Study
BN3402	Bio Analytical Methods in Bioengineering
BN4109	Special Topics in Bioengineering
BN4301	Principles of Tissue Engineering
BN4403	Cellular Bioengineering
BN4404	Biomicroelectromechanical Systems – BioMEMs
BN5201	Advanced Biomaterials
BN5203	Advanced Tissue Engineering
CN4241R	Engineering Principles for Drug Delivery
ME4253	Biomaterials Engineering

Biomechanics

BN2001	Independent Study
BN4109	Special Topics in Bioengineering
BN4201	Musculoskeletal Biomechanics
BN4202	Biofluid Dynamics
BN4203	Rehabilitation Engineering
BN5202	Cell, Tissue and Body Mechanics
BN5205	Computational Biomechanics
ME4291	Finite Element Analysis

Biomedical Electronics & Imaging

BN2001	Independent Study
BN4109	Special Topics in Bioengineering
BN4402	Electrophysiology
BN4406	Biophotonics and Bioimaging
BN5207	Medical Imaging Systems
EE3206	Introduction to Computer Vision and Image Processing
EE4212	Computer Vision

† To qualify for an area of focus, students are required to read at least 16 MCs of modules within the specified area.

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

3.2.1.3 Recommended Semester Schedule

Table 3.2.1c: Recommended Semester schedule for Bioengineering Students

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	CS1010E Programming Methodology	4
PC1431 Physics IE	4	EG1109 Statics and Mechanics of Materials	4
EG1108 Electrical Engineering	3	MA1506 Mathematics II	4
EG1531 Critical Thinking & Writing	4	PC1432 Physics IIE	4
Breadth Module 1	4	Breadth Module 2	4
Sub-total	19	Sub-total	~~24~~ 20
Semester 3		Semester 4	
BN2101 Principles of Bioengineering	4	BN2102 Bioengineering Data Analysis	4
BN2202 Introduction to Biotransport	4	BN2201 Quantitative Physiology for Bioengineers	4
BN2401 Biosignals Processing	4	BN2203 Introduction to Bioengineering Design	4
CM1121 Basic Organic Chemistry or CM1501 Organic Chemistry for Engineers	4	LSM2103 Cell Biology	4
LSM1401 Fundamentals of Biochemistry	4	GEM 1 /SS	4
Sub-total	20	Sub-total	20
Semester 5		Semester 6	
BN3101 Biomedical Engineering Design	6	BN3401 Biomedical Electronics & Systems	4
BN3201 Introduction to Biomechanics	4	BN3501 Equilibrium and Kinetic Bioprocesses	4
BN3301 Introduction to Biomaterials	4	HR2002 Human Capital in Organizations	3
BN3501 GEM 1 / SS	4	UEM 1	4
EG2401 Engineering Professionalism	3	UEM 2 / GEM 2	4
Sub-total	21	Sub-total	19
Semester 7		Semester 8	

BN4101R B.Eng. Dissertation	6	BN4101R B.Eng. Dissertation	6
BN Elective 1	4	BN Elective 3	4
BN Elective 2	4	BN Elective 4	4
UEM 2 / GEM 2	4	UEM 4	4
UEM 3	2	UEM 5	4
Sub-total	20	Sub-total	22

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

Note: Students without the GCE 'A' Level Chemistry or equivalent are strongly recommended to read CM1417 Fundamentals of Chemistry as their breadth modules in their first year.

Table 3.2.1d: Recommended Semester schedule for Bioengineering Students with Industrial Attachment

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	CS1010E Programming Methodology	4
PC1431 Physics IE	4	EG1109 Statics and Mechanics of Materials	4
EG1108 Electrical Engineering	3	MA1506 Mathematics II	4
EG1531 Critical Thinking & Writing	4	PC1432 Physics IIE	4
Breadth Module 1	4	Breadth Module 2	4
		GEM 1 / SS	4
Sub-total	19	Sub-total	24
Semester 3		Semester 4	
BN2101 Principles of Bioengineering	4	BN2102 Bioengineering Data Analysis	4
BN2202 Introduction to Biotransport	4	BN2201 Quantitative Physiology for Bioengineers	4
BN2401 Biosignals Processing	4	BN2203 Introduction to Bioengineering Design	4
CM1121 Basic Organic Chemistry or CM1501 Organic Chemistry for Engineers	4	LSM2103 Cell Biology	4
LSM1401 Fundamentals of Biochemistry	4	UEM1	4
Sub-total	20	Sub-total	20

Semester 5		Semester 6	
BN3101 Biomedical Engineering Design	6	UEM 2	4
BN3201 Introduction to Biomechanics	4	UEM 3	4
BN3301 Introduction to Biomaterials	4	UEM 4	4
GEM 1 / SS	4	HR2002+ Human Capital in Organizations	3
EG2401 Engineering Professionalism	3		
Sub-total	21	Sub-total	15
Semester 7		Semester 8	
BN4101R B.Eng. Dissertation	6	BN4101R B.Eng. Dissertation	6
BN Elective 1	4	BN3401 Biomedical Electronics and Systems	4
BN Elective 2	4		4
UEM 3 / GEM 2	4	BN Elective 3	4
UEM 5	2	BN Elective 4	4
Sub-total	20	Sub-total	22

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

Note: Students without the GCE 'A' Level Chemistry or equivalent are strongly recommended to read CM1417 Fundamentals of Chemistry as their breadth modules in their first year.

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 B.Eng. (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.

The programme objectives of B.Eng. (Chemical Engineering) are: (1) to prepare students for challenging careers in the chemical, petroleum, petrochemical, pharmaceutical, food and other related industries, and in the emerging areas such as biotechnology, microelectronics, energy and nano-materials processing; (2) to provide students with an appreciation of the role of chemical technology in society, and the skills of analyzing and solving related industrial problems; (3) to prepare students for graduate study in chemical engineering and related disciplines; and (4) to nurture engineer leaders with a global outlook.

To achieve the above programme objectives, 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 B.Eng. (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 (including enhancement programmes such as industrial attachment) 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 practicing engineers. They are also provided with networking, globalization and technical/business leadership opportunities through student exchange, overseas colleges, entrepreneurship and minor programmes for broader education.

The learning outcomes of B.Eng. (Chemical Engineering) programme are as follows.

1. General Education – intellectual broadening through exposure to information, knowledge and modes of inquiry that are beyond the engineering discipline
2. Science and Math Foundation– knowledge and application of science and mathematics relevant to chemical engineering
3. Chemical Engineering Core – an ability to analyze and solve chemical engineering problems creatively and effectively using basic principles, modern techniques and systems approach, an ability to conduct experiments and analyze results, and an ability to handle open-ended and uncertain problems
4. Engineering Practice – an ability to use the techniques, skills and modern engineering/computing tools necessary for engineering practice, with considerations for environment, health and safety
5. Design – an ability to design chemical and related processes through critical and creative thinking, synthesis and integration of knowledge, to meet the desired needs with due economic, environmental, safety and sustainability considerations; an ability to design products with the desired properties
6. Depth and Breadth– an understanding of and an ability to apply in-depth knowledge of one or more areas within chemical engineering as well as to multidisciplinary problems
7. Sustainability– an ability to assess the impact of engineering solutions in societal context and to apply engineering principles for the development of sustainable processes
8. Critical and Creative Thinking – an ability to apply critical thinking to both technical and non-technical issues through independent thought and informed judgement, and an ability to develop creative and innovative solutions
9. Communications– an ability to communicate effectively through reports, presentations and discussions within both the technical domain and the community at large
10. Professional Relations and Team Work– an ability to work in multi-disciplinary and multi-cultural teams; understand the principles of project management both as a member and leader of such teams
11. Professional Ethics– an ability to work ethically and professionally
12. Life-long Learning– a desire and an ability to learn independently and prepare for a lifetime of careers with increasing challenges and responsibilities

The B.Eng. (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 B.Eng. (ChE):

- Students in the B.Eng. (ChE) programme are required to complete a minimum of 161 MCs with a CAP ≥ 2.0 to graduate from the programme.
- 161 MCs will have to be earned by reading modules in accordance with Table 3.2.2a.
- Students are free to choose any combination of the offered modules from Table 3.2.2b to complete 16 MCs of technical electives.
- A student may choose to specialise in Biomolecular Engineering, Microelectronics Processing or Process Systems Engineering by taking four technical electives from the specified basket of electives and the B.Eng. Dissertation (Research Project) in the specialisation area.
- A student must also satisfy other additional requirements that may be prescribed by the Faculty of Engineering or the University.

Table 3.2.2a: Summary of Modular Requirements and Credits

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) with at least one from Group B: Humanities and Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives	20
Programme Requirements	
Faculty Requirements:	10
EG1531 Critical Thinking and Writing	4
EG2401 Engineering Professionalism	3
ES1102 English*	-
HR2002 Human Capital in Organizations	3
Foundation Requirements:	28
MA1505 Mathematics I	4
MA1506 Mathematics II	4
CM1501 Organic Chemistry for Engineers	4
CM1502 General and Physical Chemistry for Engineers	4
LSM1401 Fundamentals of Biochemistry	4
MLE1101 Introductory Materials Science & Engineering	4

IT1005 Introduction to Programming with Matlab	4
Major Requirements:	
CHE Core Subjects:	47
CN1111 Chemical Engineering Principles	4
CN2108 Chemical Engineering Laboratory I	2
CN2116 Chemical Kinetics and Reactor Design	4
CN2121 Chemical Engineering Thermodynamics	4
CN2122 Fluid Mechanics	4
CN2125 Heat and Mass Transfer	4
CN3108 Chemical Engineering Laboratory II	4
CN3109 Chemical Engineering Laboratory III	2
CN3124 Particle Technology	4
CN3121 Process Dynamics and Control	4
CN3132 Separation Processes	4
CN3135 Process Safety, Health & Environment	3
CN3421 Process Modelling and Numerical Simulation	4
Elective modules	16
Technical Electives (from the modules in Table 3.2.2b)	
Project modules	20
CN4118R B.Eng. Dissertation	10
CN4121 Design Project	10
Total	161

* For students who have not passed or been exempted from the Qualifying English Test at the time of admission to the Faculty.

Table 3.2.2b: Technical Elective Modules in ChE**

BN4404	Bioelectromechanicals systems - BioMEMs
CN4201R	Petroleum Refining
CN4203R	Polymer Engineering
CN4205R	Process Systems Engineering
CN4211R	Petrochemicals and Processing Technologies

CN4215R	Food Technology and Engineering
CN4216R	Electronics Materials Science
CN4217R	Processing of Microelectronic Materials
CN4223R	Microelectronic Thin Films
CN4227R	Advanced Process Control
CN4238R	Chemical & Biochemical Process Modelling
CN4240R	Processes for Effluent Control
CN4241R	Engineering Principles for Drug Delivery
CN4245R	Data Based Process Characterisation
CN4246R	Chemical and Bio-Catalysis
CN4247R	Enzyme Technology
CN4248	Sustainable Process Development
CN4249	Engineering Design in Molecular Biotechnology
CN4291	Selected Topics in Chemical Engineering
CN5111	Optimisation of Chemical Processes
CN5172	Biochemical Engineering
CN5173	Downstream Processing of Biochemical and Pharmaceutical Products
CN5181	Computer Aided Chemical Engineering
CN5185	Batch Process Engineering
CN5186	Design and Operation of Process Networks
CN5191	Project Engineering
CN5222	Pharmaceuticals and Fine Chemicals
CN5251	Membrane Science and Engineering
ESP4402	Transport Phenomena in Energy Systems

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

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 and Table 3.2.2d respectively.

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

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
Singapore Studies	4	CM1502 General and Physical Chemistry for Engineers	4
ES1102 English	-	MA1506 Mathematics II	4
IT1005 Introduction to Programming with Matlab	4	MLE1101 Introductory Materials Science and Engineering	4
		GEM 1 or EG1531 Critical Thinking &	

MA1505 Mathematics I	4	Writing	4
GEM 1 or EG1531 Critical Thinking & Writing	4	UEM 1 or CN1111 Chemical Engineering Principles	4
UEM 1 or CN1111 Chemical Engineering Principles	4		
Sub-total	20	Sub-total	20
Semester 3		Semester 4	
GEM 2	4	CN2108 Chemical Eng Lab I	2
CM1501 Organic Chemistry	4	CN2116 Chemical Kinetics and Reactor Design	4
CN2121 Chemical Engineering Thermodynamics	4	CN2125 Heat and Mass Transfer	4
CN2122 Fluid Mechanics	4	CN3124 Particle Technology	4
LSM1401 Fundamentals of Biochemistry	4	EG2401 Engineering Professionalism	3
		Breadth 1	4
Sub-total	20	Sub-total	21
Semester 5		Semester 6	
CN3108 Chemical Eng Lab II	4	CN3109 Chemical Eng Lab III	2
CN3121 Process Dynamics and Control	4	CN4118R B.Eng. Dissertation	8
CN3132 Separation Processes	4	CN4121 Design Project	3
CN3135 Process Safety, Health & Environment	3	CN42xx Elective 2	4
CN3421 Process Modelling and Numerical Simulation	4	CN42xx Elective 3	4
Sub-total	19	Sub-total	21
Semester 7		Semester 8	
CN42xx Elective 1	4	Breadth 2	4
HR2002 Human Capital in Organizations	3	UEM 2	4
Unrestricted Elective Modules (12 MCs) - Students may earn these from Industrial Attachment (IA) and other Enhancement Programmes of FoE, and/or from modules of student's choice.	12	CN4118R B.Eng. Dissertation (continued)	2
		CN4121 Design Project (continued)	7

		CN42xx Elective 4	4
Sub-total	19	Sub-total	21

The above assumes that students read UEM in Semester 7. However, modules scheduled in Semesters 6 and 7 can be swapped, thus students can also choose to go on IA in Semester 6.

Table 3.2.2d: Recommended Semester Schedule for Common Engineering Entry ChE Students

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
ES1102 English	-	CM1502* General and Physical Chemistry for Engineers	4
EG1108# Electrical Engineering	3	CN1111* Chemical Engineering Principles	4
EG1531 Critical Thinking and Writing	4	EG1109# Statics and Mechanics of Materials	4
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431^ Physics IE	4	MLE1101 Introductory Materials Science and Engineering	4
CS1010E Programming Methodology	4	PC1432^ Physics IIE	4
Sub-total	19	Sub-total	24

^ At least one Physics module (either PC1431 or PC1432)

At least two Engineering modules from MLE1101, EG1108 and EG1109. (MLE1101 is required in order to stream into ChBE. Thus, students need to take either EG1108 or EG1109.)

* Must take both CM1502 *and* CN1111.

Modules	MCs	Modules	MCs
Semester 3		Semester 4	
LSM1401 Fundamentals of Biochemistry	4	CN2108 Chemical Eng Lab I	2
CN2121 Chemical Engineering Thermodynamics	4	CN2116 Chemical Kinetics and Reactor Design	4
CN2122 Fluid Mechanics	4	CN2125 Heat and Mass Transfer	4
CM1501 Organic Chemistry	4	CN3124 Particle Technology	4
GEM 1	4	EG2401 Engineering Professionalism	3

		GEM 2	4
Sub-total	20	Sub-total	21
Semester 5		Semester 6	
CN3108 Chemical Eng Lab II	4	CN42xx Elective 1	4
CN3121 Process Dynamics and Control	4	UEs (read at least 14 MCs) which can include Industrial Attachment (IA) for 6 months (12 MCs)	14-16
CN3132 Separation Processes	4		
CN3135 Process Safety, Health & Environment	3		
CN3421 Process Modelling and Numerical Simulation	4		
Sub-total	19	Sub-total	18-20

The above assumes that students read UEM in Semester 6. However, modules scheduled in Semesters 6 and 7 can be swapped. Thus, students may also choose to go on IA in Semester 7.

Modules	MCs	Modules	MCs
Semester 7		Semester 8	
Singapore Studies	4	HR2002 Human Capital in Organizations	3
CN3109 Chemical Eng Lab III	2	CN4118R B.Eng. Dissertation (continued)	2
CN4118R B.Eng. Dissertation	8	CN4121 Design Project (continued)	7
CN4121 Design Project	3	CN42xx Elective 3	4
CN42xx Elective 2	4	CN42xx Elective 4	4
Sub-total	21	Sub-total	20

3.2.2.4 The Chemical Sciences Programme

The Biomedical Sciences sector in Singapore (comprising pharmaceutical, medical technology, biotechnology and healthcare services industries) has undergone rapid growth in the last few years and further expansion is expected. The Chemical Sciences Programme will augment the existing Specialisation Option in Biomolecular Engineering for the Chemical Engineering students by providing a strong foundation in life and chemical sciences starting from the first year of the B.Eng. (Chemical Engineering) programme. This training in life and chemical sciences coupled with a strong chemical and process engineering background will provide the graduates with the expertise to embark on further research and technology development related to the Biomedical Sciences sector of Singapore.

Students in the Chemical Sciences Programme will be admitted as Chemical Engineering [B.Eng. (Chemical Engineering)] majors. They will be required to fulfil all the course/modular requirements under the B.Eng. (Chemical Engineering) programme. A number of Life Sciences and Chemistry modules are placed under the University and Unrestricted Electives

Requirement. The B.Eng. Dissertation (CN4118R) is also preferably to be carried out in a Life/Chemical Sciences area. The graduates from this programme will be accredited in accordance with the EAB (Singapore) and IChemE (UK) scheme, in a similar manner as the regular B.Eng. (Chemical Engineering) cohort.

The modular requirements and recommended semester schedule for students in this programme are available on the Chemical Sciences website at: http://www.chemicalscience.nus.edu.sg/index.htm. The load in the last semester is intentionally made light so that students can proceed to take graduate modules as part of their Ph.D. programme. This will provide a seamless transition between the B.Eng. (Chemical Engineering) and Ph.D. programmes.

Special features of this course include:

- Eligibility for A*STAR pre-graduate award scheme from the second year of studies onwards if a student secures CAP of 4.25 or more in the first year and fulfilment of other criteria subject to terms and conditions.
- Possibility of a Life Science Minor upon the completion of the Chemical Sciences Programme.
- The Chemical Sciences Programme study plan permits the cohort to read one or more Level-5000 modules required for a Ph.D. programme if they so choose in the last semester, thereby accelerating the completion of the graduate course.

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 practice 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 B.Eng. (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 B.Eng. (Civil Engineering) degree, students are required to:

- Complete a minimum of 161 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 four 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 B.Eng. Dissertation.

Students may apply to specialise in Offshore Engineering at start of Stage 3. They must take a Group Design Project and a B.Eng. Dissertation that is related to offshore engineering, OT5202 Analysis & Design of Offshore Structures and CE5307 Hydrodynamics, and complete a 12-week stint in an offshore or marine-related company under EG3602 Vacation Internship Program.

Table 3.2.3a: Summary of Modular Requirements and Credits (for students matriculated in AY2008/09 onwards)

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) (at least one from Group B: Humanities and Social Sciences)	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives	20
Programme Requirements	
Faculty Requirements:	10
EG1531 Critical Thinking and Writing	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English*	-
Foundation Requirements:	23
MA1505 Mathematics I	4
MA1506 Mathematics II	4
EG1108 Electrical Engineering	3
EG1109 Statics and Mechanics of Materials	4
PC1431 Physics IE	4
MLE1101 Introductory Materials Science & Engineering	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
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 B.Eng. Dissertation	8
CE Electives:	16
Level 3 Technical Elective Modules	4
Higher Level Technical Elective Modules	12
Total	161

* 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.

+ Alphabet 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 160 MCs for graduation). For Polytechnic graduates, 12 MCs of the exempted UE modules will not count towards the 60 MC limit on level-1000 modules.

Table 3.2.3b: Technical Elective Modules

Geotechnical Engineering Modules (G)

CE4216	Geotech. Investigation & Applied Geology
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
ESE4402	Treatment Plant Hydraulics
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
CE5514	Plate and Shell Structures
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)

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

Coastal & Offshore Engineering Modules (H)

CE5307	Wave Hydrodynamics and Physical Oceanography
CE5308	Coastal Processes & Sediment Transport
CE5312	River Mechanics
CE5313	Groundwater Hydrology
CE5883	Topics in Hydraulic & Water Resources
OT5101	Exploration and Production of Petroleum
OT5201	Marine Statics and Dynamics
OT5202	Analysis & Design of Offshore Structures
OT5203	Design of Floating Structures
OT5204	Moorings & Risers
OT5205	Offshore Pipelines
OT5206	Offshore Foundations
OT5207	Arctic Engineering
OT5208	Fatigue and Fracture for Offshore Structures
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
CE4291	Special Topics in Civil Engineering†
CE5701	Special Topics in Civil Engineering†
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 3.2.3c and Poly Direct Entry in Table 3.2.3d.

Table 3.2.3c: Recommended Semester Schedule for CE Students (AY2012/2013 onwards)

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE	4	GEM/SS/Breadth Module	4
EG1109 Statics and Mechanics of Material	4	EG1108 Electrical Engineering	3
CE2409 Computer Applications in Civil Engineering^	4	EG1531 Critical Thinking and Writing	4
GEM/SS/Breadth Module	4	MLE1101 Introductory Materials and Science Engineering	4
ES1102 English*			
Sub-total	20	Sub-total	19

* 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.

^ CA – 100%

Modules	MCs	Modules	MCs
Semester 3		Semester 4	
CE2134 Hydraulics	4	CE2112 Soil Mechanics	4
CE2155 Structural Mechanics and Materials	4	CE3132 Water Resources Engineering	4
CE2184 Infrastructure and the Environment	4	CE2183 Construction Project Management	4
CE2407 Engineering and Uncertainty Analyses	4	ESE3001 Water Quality Engineering	4
GEM/SS/Breadth Module	4	GEM/SS/Breadth Module	4
Sub-total	20	Sub-total	20
Semester 5		Semester 6	
CE3115 Geotechnical Engineering	4	CE3116 Foundation Engineering	4
CE3121 Transportation Engineering	4	CE3155 Structural Analysis	4
CE3166 Structural Steel Design and System	4	CE3165 Structural Concrete Design	4
GEM/SS/Breadth Module	4	Unrestricted Elective Module 2	4
Technical Elective Module 1	4	Unrestricted Elective Module 3	4
Unrestricted Elective Module 1	4		

Sub-total	24	Sub-total	20
Semester 7		Semester 8	
CE4103 Design Project¨	4	CE4104 B.Eng. Dissertation (Cont'd)	4
CE4104 B.Eng. Dissertation	4	Technical Elective Module 4	4
Technical Elective Module 2	4	Unrestricted Elective Module 5	4
Technical Elective Module 3	4	HR2002 Human Capital in Organizations	3
Unrestricted Elective Module 4	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 (AY2011/12 onwards)

Modules	MCs	Modules	MCs
Semester 3		Semester 4	
Breadth module	4	MA1505 Mathematics I	4
MA1301 Introductory Mathematics (fulfils UEM 1)	4	CE2112 Soil Mechanics	4
CE2155 Structural Analysis I	4	ESE3001 Water Quality Engineering	4
CE2184 Infrastructure and the Environment	4	MLE1101 Introductory Materials Science & Engineering	4
Singapore Studies or GEM	4	CE2183 Construction Project Management	4
ES1102 English**	-	PC1431 Physics IE (upon failure of APC test)	(4)
Sub-total	20	Sub-total	20 (24)
Semester 5		Semester 6	
MA1506 Mathematics II	4	CE3116 Foundation Engineering	4
CE2134 Hydraulics	4	CE3155 Structural Analysis	4
CE3115 Geotechnical Engineering	4	CE3165 Structural Concrete Design	4
CE3121 Transportation Engineering	4	CE3132 Water Resources Engineering	4

CE3166 Structural Steel and Design System	4	Unrestricted Elective Module 2	4
Technical Elective Module 1	4		
Sub-total	24	Sub-total	20
Semester 7		Semester 8	
CE2407 Engineering and Uncertainty Analysis	4	CE4104 B.Eng. Dissertation (Cont'd)	4
CE4103 Design Project¨	4	Technical Elective Module 3	4
CE4104 B.Eng. Dissertation	4	Technical Elective Module 4	4
EG1108 Electrical Engineering	3	EG2401 Engineering Professionalism	3
Technical Elective 2	4	Singapore Studies or GEM	4
Sub-total	19	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).

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: http://www.eng.nus.edu.sg/cee/index.html

3.2.4 Bachelor of Engineering (Computer Engineering)

Please refer to http://www.nus.edu.sg/registrar/nusbulletin/Otherprogs/ceg.html

3.2.5 Bachelor of Engineering (Electrical Engineering)

3.2.5.1 Overview

The B.Eng. (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 B.Eng. (Electrical Engineering) curriculum is specially designed to provide its graduates with a headstart 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 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 knowledge of mathematics, science and engineering to the solution of complex engineering problems;
· design and conduct experiments, analyse, interpret data and synthesise valid conclusions;
· design a system, component, or process, and synthesise solutions to achieve desired needs;
· identify, formulate, research through relevant literature review, and solve engineering problems reaching substantiated conclusions;
· 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;
· communicate effectively;
· recognize the need for, and have the ability to engage in lifelong learning;
· understand the impact of engineering solutions in a societal context and to be able to respond effectively to the needs for sustainable development;
· function effectively within multidisciplinary teams and understand the fundamental precepts of effective project management;
· understand professional, ethical and moral responsibility.

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 individual research and design projects. 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 B.Eng. (Electrical Engineering) programme is currently accredited by the Engineering Accreditation Board (EAB) of Singapore for students graduating from the programme up to AY2012/13. The programme will undergo a re-accreditation exercise in 2013 which is expected to cover graduates 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 B.Eng. (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 32 MCs of elective modules. Throughout their programme, they are also expected to broaden their views by reading some general education modules, breadth modules offered by other Faculties, Engineering Professionalism, Critical Thinking and Writing and Human Relations. Students are strongly encouraged to take at least one business module from a prescribed list of business modules. The complete programme structure is specified in Table 3.2.5a.

Table 3.2.5a: Summary of EE Modular Requirements and Credits

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) (at least one from Group B: Humanities and Social Sciences)	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives +	16
Programme Requirements	
Faculty Requirements:	10
EG1531 Critical Thinking and Writing	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
English*	-
Foundation Requirements:	24
MA1505 Mathematics I	4
MA1506 Mathematics II	4
CS1010E Programming Methodology	4
EE1001 Emerging Technologies in Electrical Engineering	4
EE1002 Introduction to Circuits and Systems	4
EE1003 Introduction to Signals and Communications	4
Electrical Engineering Major Requirements	
EE Core Subjects:	36
EE2020 Digital Fundamentals	4
EE2021 Devices and Circuits	4
EE2022 Electrical Energy Systems	4
EE2023 Signals and Systems	4
EE2024 Programming for Computer Interfaces	4
EE2031 Circuits & Systems Design Lab	2
EE2032 Signals & Communications Design Lab	2
EE2011 Engineering Electromagnetics	4

EE2012 Analytical Methods in Electrical & Computer Engineering	4
PC2232 Physics for Electrical Engineers	4
EE Project Modules:	22
EE3031 Innovation & Enterprise I	4
EE3032 Innovation & Enterprise II	6
EE4001 B.Eng. Dissertation (over 2 semesters)	12
EE Electives:	
Elective Modules from Table 3.2.5b to satisfy the breadth and depth requirements of the B.Eng. (EE) programme.	32
Total	160

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

+ EE students are strongly encouraged to take at least one business module from a prescribed list of business modules.

To specialise in different areas, students need to choose elective modules from the outer core in Table 3.2.5b as well as a number of areas of concentrations in Table 3.2.5c as follows: Bioelectronic Systems, Communications & Networks, Integrated Circuits & Embedded Systems, Control, Intelligent Systems & Robotics, Signal Processing and New Media, Microelectronics Technologies & Devices, Microwave and RF, Power and Energy Systems, Engineering Science andInformation Processing. The elective modules in each concentration are categorised as breadth or depth elective modules. A breadth elective module enables students to achieve a broad understanding of concepts in the particular concentration. A depth elective module is a higher level module that provides greater depth and coverage in the particular concentration.

The outer core modules are organised in 8 areas of concentrations in Table 3.2.5b. Students need to read *three* modules from a minimum of *three* areas of concentrations of outer core modules to achieve exposure to various facets of ECE. To achieve depth, students need to read a minimum of *four* depth electives. EE students also need to read *one* elective which can be chosen from the breadth or depth elective of any concentration. At least one technical elective from the *eight* electives must be from the list of Design modules given in Table 3.2.5d. All eight technical electives must add up to at least 32 MCs. EE students should read at least 20 MCs of technical elective modules offered by the ECE Department (i.e., those with EExxxx module codes). By specific choice of electives, EE students will be able to specialise in a variety of areas. The list of specialisation tracks is given in Table 3.2.5e.

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

Outer Core	
Areas of Concentration	Modules in the 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	EE3501C Power Electronics
Signal Processing & New Media	EE3731C Signal Processsing Methods
Engineering Computing	EE3013C Matlab & Labview for Electrical Engineers
	CS1020E Data Structures and Algorithms I

Table 3.2.5c: List of Electives in the Various Concentrations

Bioelectronic Systems	
Breadth	PC3267 Biophysics II
Depth	EE4601 Sensors for Biomedical Applications
	EE4603 Biomedical Imaging Systems
	EE4604 Biological Perception in Digital Media
	EE4605 Bio Instrumentation and Signal Analysis
	BN4402 Electrophysiology
	BN4404 BioMEMS
	BN4406 Biophotonics and Bioimaging
Communications & Networks	
Breadth	EE3204 Computer Communication Networks I
Depth	EE4113 Digital Communications & Coding
	EE4114 Optical Communications
	EE4131 Random Signals
	EE4210 Computer Communication Networks II
Integrated Circuits & Embedded Systems	
Breadth	CG3207 Computer Architecture
	EE3208 Embedded Computer Systems Design
	EE3407 Analog Electronics
Depth	EE4410 Integrated Circuit & System Design (over 2 semesters)
	EE4410A Integrated Circuit Design
	EE4415 Integrated Digital Design
	EE4214 Real-time Embedded Systems

	EE4218	Embedded Hardware System Design
	EE5903	Real-Time Systems
Control, Intelligent Systems & Robotics		
Breadth	EE3302	Industrial Control Systems
	EE3304	Digital Control Systems
Depth	EE4302	Advanced Control Systems
	EE4305	Introduction to Fuzzy/Neural Systems
	EE4306	Distributed Autonomous Robotic Systems
	EE4307	Control Systems Design and Simulation
	ME4245	Robot Kinematics, Dynamics and Control
Microelectronic Technologies & Devices		
Depth	EE4401	Optoelectronics
	EE4408	Silicon Device Reliability
	EE4411	Silicon Processing Technology
	EE4412	Technology and Modelling of Silicon Transistors
	EE4431	Nano Device Engineering
	EE4432	Devices for Electric Energy Generation
	EE4433	Nanometer Scale Information Storage
	ESP4302	Nanophotonics
	CN4223R	Microelectronic Thin Films
Power & Energy Systems		
Depth	EE4501	Power System Management and Protection
	EE4502	Electric Drives and Control
	EE4505	Power Semiconductor Devices and ICs
	EE4509	Silicon Microsystems
	EE4510	Solar Photovoltaic Energy Systems
	EE4511	Sustainable Energy Systems
	EE4512	Renewable Energy Systems Capstone Design
Signal Processing & New Media		
Breadth	EE3206	Introduction to Computer Vision and Image Processing
	EE3701	Digital Media Technologies

	EE3702 Electronic Gaming
Depth	EE4212 Computer Vision
	EE4213 Image Processing
	EE4702 Game World Mechanics
	CS3240 Human Computer Interaction
	CS3248 Design of Interactive Systems
Microwave & RF	
Depth	EE4101 RF Communications
	EE4104 Microwave Circuits & Devices
	EE4110 RFIC and MMIC Design
	EE4112 HF Techniques
Information Processing	
Breadth	CS2102 Database Systems
	CS2103 Software Engineering
	CS2106 Introduction to Operating Systems
	CS3216 Software Development on Evolving Platforms
	CS3230 Design and Analysis of Algorithms
	CS3233 Competitive Programming
	CS3241 Computer Graphics
	CS3243 Foundations of Artificial Intelligence
Depth	CS3221 Operating Systems Design and Pragmatics
	CS4244 Knowledge-based Systems
	CS4247 Graphics Rendering Techniques
Engineering Science	
Breadth	ESP3401 Photovoltaic Devices and Systems
	IE2110 Operations Research I
	IE2130 Quality Engineering I
	ME3291 Numerical Methods in Engineering
	PC3130 Quantum Mechanics II
Depth	PC4259 Surface Physics
General	

Breadth	MT3001 Systems Thinking and Engineering
	MT4002 Technology Management Strategy
	MT4003 Engineering Product Development

Table 3.2.5d: List of Design modules

Design Modules	
CG3207	Computer Architecture
EE3208	Embedded Computer Systems Design
EE3407	Analog Electronics
EE3408C	Integrated Analog Design
EE4110	RFIC and MMIC Design
EE4214	Real-time Embedded Systems
EE4218	Embedded Hardware System Design
EE4302	Advanced Control Systems
EE4307	Control Systems Design and Simulation
EE4410	Integrated Circuit and System Design
EE4410A	Integrated Circuit Design
EE4415	Integrated Digital Design
EE4512	Renewable Energy Systems Capstone Design
EE4702	Game World Mechanics
CS3248	Design of Interactive Media

Table 3.2.5e: Possible Specialisation Tracks in Electrical Engineering

Advanced Control
Biomedical Systems
Computational Sensory Systems
Data Storage Systems
Photonics
Device Technology
Distributed Autonomous Systems

Embedded Systems
IC Manufacturing
Information Storage Materials and Devices
Interactive & Digital Media
Mechatronics and Automation
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 Systems & Components
VLSI design
Wireless Communications

For details on module selections based on possible specialisation tracks, please refer to:http://www.ece.nus.edu.sg/academic/undergraduate/ee/Specialization.html

3.2.5.3 Recommended Semester Schedule

The recommended semester schedule for EE students without / with Industrial Attachment (IA) is presented in Table 3.2.5e and Table 3.2.5f respectively.

Table 3.2.5e: Recommended Semester Schedule for EE students without Industrial Attachment

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
CS1010E Programming Methodology	4	EE1003 Introduction to Signals and Communications	4
EE1001 Emerging Technologies in Electrical Engineering	4	EG1531 Critical Thinking and Writing	4
EE1002 Introduction to Circuits and Systems	4	EE2020 Digital Fundamentals	4
Singapore Studies Module*	4	GEM* x 1	4
Sub-total	20	Sub-total	20

Semester 3		Semester 4	
EE2022 Electrical Energy Systems	4	EE2012 Analytical Methods in ECE	4
EE2023 Signals and Systems	4	EE2021 Devices and Circuits	4
EE2024 Programming for Computer Interfaces	4	EE2032 Signals & Communications Design Lab	2
EE2011 Engineering Electromagnetics	4	Breadth Level Technical Elective x 1	4
ULR-Breadth* x 1	4	PC2232 Physics for Electrical Engineers	4
		GEM* x 1	4
Sub-total	20	Sub-total	22
Semester 5		Semester 6	
EE3031 Innovation & Enterprise I	4	EE3032 Innovation & Enterprise II	6
EG2401 Engineering Professionalism	3	Depth Level Technical Elective x 2	8
EE2031 Circuits & Systems Design Lab	2	Breadth / Depth Level Technical Elective x 1	4
Breadth Level Technical Elective x 2	8	UEM * x 1	4
UEM * x 1	4		
Sub-total	21	Sub-total	22
Semester 7		Semester 8	
EE4001 B.Eng. Dissertation (over 2 semesters)	6	EE4001 B.Eng. Dissertation (over 2 semesters)	6
HR2002 Human Capital in Organizations	3	Unrestricted Elective Module(UEM)* x 2	8
Depth Level Technical Electives x 2	8		
Unrestricted Elective Module(UEM)* x 1	4		
Sub-total	21	Sub-total	14
Total MCs			160

Table 3.2.5f: Recommended Semester Schedule for EE students with Industrial Attachment

Modules	MCs	Modules	MCs

Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
CS1010E Programming Methodology	4	EE1003 Introduction to Signals and Communications	4
EE1001 Emerging Technologies in Electrical Engineering	4	EG1531 Critical Thinking and Writing	4
EE1002 Introduction to Circuits and Systems	4	EE2020 Digital Fundamentals	4
Singapore Studies Module*	4	GEM* x 1	4
Sub-total	20	Sub-total	20
Semester 3		Semester 4	
EE2022 Electrical Energy Systems	4	EE2012 Analytical Methods in ECE	4
EE2023 Signals and Systems	4	EE2021 Devices and Circuits	4
EE2024 Programming for Computer Interfaces	4	EE2032 Signals & Communications Design Lab	2
EE2011 Engineering Electromagnetics	4	EE3031 Innovation & Enterprise I	4
ULR-Breadth* x 1	4	Breadth Level Technical Elective x 1	4
		PC2232 Physics for Electrical Engineers	4
Sub-total	20	Sub-total	22
Semester 5		Semester 6	
EE3032 Innovation & Enterprise II	6	Unrestricted Elective Modules (12 MCs) (Students may earn these 12 MCs from the Enhancement Programmes of Faculty of Engineering including IA *and/or* from unrestricted electives of student's choice)	12
Breadth Level Technical Elective x 2	8		
EG2401 Engineering Professionalism	3		
EE2031 Circuits & Systems Design Lab	2		
ULR-Breadth* x 1	4	Depth Level Technical Elective x 1	4
		Breadth / Depth Level Technical Elective x 1	4
Sub-total	23	Sub-total	20
Semester 7		Semester 8	
EE4001 B.Eng. Dissertation (over 2 semesters)	6	EE4001 B.Eng. Dissertation (over 2 semesters)	6

HR2002 Human Capital in Organizations	3	UEM* x 1	4
Depth Level Technical Electives x 2	8	GEM* x 1	4
		Depth Level Technical Elective x 1	4
Sub-total	17	Sub-total	18
Total MCs			160

* These ULR modules (GEM, SS, ULR Breadth) and UEMs can be read in any semester.

3.2.6 Bachelor of Engineering (Engineering Science)

3.2.6.1 Overview

The Engineering Science Programme (ESP) is a joint initiative by the Faculty of Engineering and the Faculty of Science. This multidisciplinary undergraduate programme aims to combine strong scientific fundamentals with emerging frontiers in engineering.

The 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 one of the following areas of specialisation: (1) Nanoscience and Nanotechnology, (2) Computational Engineering Science, (3) Photonics and Optics, and (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 B.Eng. (Engineering Science) degree.

In summary, the four-year undergraduate ESP will produce graduates who are better prepared to solve new problems, develop innovative designs, integrate systems and work at the interfaces of disciplines.

3.2.6.2 Degree Requirements

The following are the requirements for the degree of B.Eng. (Engineering Science):

- Complete a minimum of 160 MCs with a CAP ≥ 2.0;
- Pass all modules in accordance with Table 3.2.6a;
- Satisfy all requirements as prescribed by the Faculty of Engineering or the University.

Table 3.2.6a: Summary of Modular Requirements and Credits

Modular Requirements	MCs
University Level Requirements	12
General Education Modules (at least one from Group B: Humanities and Social Sciences)	8
Singapore Studies (SS) Module	4

Programme Requirements	
Faculty Requirements:	10
EG1531 Critical Thinking and Writing	4
HR2002 Human Capital in Organisations	3
EG2401 Engineering Professionalism	3
English*	-
Major Requirements:	
First Year Core Modules:	28
CM1402 General Chemistry	4
ESP1104 Introduction to Electronic Systems	4
ESP1107 Computing and Statistics	4
LSM1401 Fundamentals of Biochemistry	4
MA1507 Advanced Calculus	4
MA1508# Linear Algebra with Applications	4
PC1433 Mechanics and Waves	4
Second Year Core Modules:	32
EE2011 Engineering Electromagnetics	4
ESP2106 Principles of Continua	4
MA2501 Differential Equations and Systems	4
PC2130B Applied Quantum Physics	4
PC2133 Applied Solid State Physics	4
PC2230 Thermodynamics and Statistical Mechanics	4
ESP2109 Design Project 1	4
ESP2110 Design Project 2	4
Design and Research Projects Modules	20
Third and Fourth Year Specialisation Modules	40
Unrestricted Elective MODULES	12
EG3602 Vacation Internship Programme	6
Total	160

* For students who have not passed or been exempted from the Qualifying English Test at the time of admission to the Faculty.

SM2/SM3 students, NUS High School students, and JC students who have read and passed MA1101R Linear Algebra I, prior to joining ESP are allowed to map MA1101R to MA1508. As core/essential modules must be taken on a graded basis, MA1101R taken prior to admission/transfer into ESP must also be graded.

At the end of second year, students opt for one of the four specialisations. There are 10 specialisation modules. Five of these modules will be core modules to the specialisation (Table 3.2.6b). For the other five electives, beyond the core electives requirement, two must come from within the chosen specialisation, while the other three electives can come from any other specialisation (Table 3.2.6b and Table 3.2.6c).

Table 3.2.6b: Core Modules for Specialisations

Nanoscience and Nanotechnology Specialisation	MCs
ESP3102 From Making Nano to Probing Nano	4
CM3251 Nanochemistry	4
CM3296 Molecular Modelling: Theory and Practice	4
PC3251 Nanophysics	4
PC4259 Surface Physics	4
Computational Engineering Science Specialisation	MCs
ESP3206 Continuum Mechanics	4
MA3227 Numerical Analysis II	4
MA3501 Mathematical Methods in Engineering	4
IE2110 Operations Research I	4
ME4291 Finite Element Analysis	4
Photonics and Optics Specialisation	MCs
EE2023 Signals and Systems	4
PC3247 Modern Optics	4
BN4406 Biophotonics and Bioimaging	4
ESP4302 Nanophotonics	4
EE4603 Biomedical Imaging Systems	4
Energy Systems Specialisation	MCs
ESP3401 Photovoltaic Devices and Systems	4
ME3122 Heat Transfer	4
ME3221 Energy Conversion Processes	4
EE2022 Electrical Energy Systems	4
ESP4402 Transport Phenomena in Energy Systems	4

Table 3.2.6c: ESP Electives for Specialisations

Nanoscience and Nanotechnology Specialisation

BN5101	Engineering Principles in Medicine I
BN5205	Computational Biomechanics
CM3231	Quantum Chemistry and Molecular Thermodynamics
CM3232	Physical Chemistry of the Solid State and Interfaces
CM4235	Physical Chemistry of Macromolecules
CM5223	Topics in Supramolecular Chemistry
EE3407	Analog Electronics
EE3408C	Integrated Analog Design
EE4401	Optoelectronics
EE4414	Magnetic Materials & Devices for Information Storage
ESP3206	Continuum Mechanics
ESP4302	Nanophotonics
ME4284	Micro Sensors and Micro Actuators
PC3233	Atomic and Molecular Physics I
PC3236	Computational Methods in Physics
PC3241	Solid State Devices
PC4240	Solid State Physics II
PC4253	Thin Film Technology
PC5205	Topics in Surface Physics
PC5212	Physics of Nanostructures

Computational Engineering Science Specialisation

BN5101	Engineering Principles in Medicine I
BN5205	Computational Biomechanics
CE4258	Structural Stability & Dynamics
CM3296	Molecular Modelling: Theory & Practice
CN3421	Process Modelling and Numerical Simulation
EE3407	Analog Electronics
MA3229	Introduction to Geometric Modelling
MA4230	Matrix Computation
MA4255	Numerical Partial Differential Equations
MA5233	Computational Mathematics
ME3291	Numerical Methods in Engineering
ME4211	Applied Mechanics
ME4233	Computational Methods in Fluid Mechanics
MLE5210	Modelling and Simulation of Materials
PC3236	Computational Methods in Physics

Photonics and Optics Specialisation

BN5101	Engineering Principles in Medicine I
BN5205	Computational Biomechanics
CS3216	Software Development on Evolving Platforms
EE3101	Digital Signal Processing
EE3206	Introduction to Computer Vision and Image Processing
EE3407	Analog Electronics
EE3601	Bio-Instrumentation & Signal Analysis
EE4212	Computer Vision
EE4213	Image Processing
EE4305	Introduction to Fuzzy/Neural Systems
EE4401	Optoelectronics
EE4604	Biological Perception in Digital Media
ESP3206	Continuum Mechanics
ESP4301	Charged Particle Optics
PC3243	Photonics

Energy Systems Specialisation

BN5101	Engineering Principles in Medicine I
BN5205	Computational Biomechanics
CM3232	Physical Chemistry of the Solid State and Interfaces
CN3124	Particle Technology
EE3407	Analog Electronics
EE3501C	Power Electronics
EE4501	Power System Management and Protection
EE4510	Solar Photovoltaic Energy Systems
EE4511	Sustainable Energy Systems
EE4512	Renewable Energy Systems Capstone Design
ESP3206	Continuum Mechanics
ESP5402	Materialistic for Energy Systems
ME4223	Thermal Environmental Engineering
ME4225	Industrial Heat Transfer
ME4284	Micro Sensors and Micro Actuators
ME5207	Solar Energy Systems
PC3241	Solid State Devices
PC4253	Thin Film Technology

3.2.6.3 Recommended Semester Schedule

Table 3.2.6d: Recommended Semester Schedule for Engineering Science Students

Modules	MCs	Modules	MCs

Semester 1		Semester 2	
ESP1107 Computing and Statistics	4	CM1402 General Chemistry	4
MA1507 Advanced Calculus	4	ESP1104 Introduction to Electronic Systems	4
PC1433 Mechanics and Waves	4	LSM1401 Fundamentals of Biochemistry	4
EG1531 Critical Thinking and Writing	4	MA1508 Linear Algebra with Applications	4
GEM 1	4	SS Module	4
Sub-total	20	Sub-total	20
Semester 3		Semester 4	
ESP2106 Principles of Continua	4	PC2130B Applied Quantum Physics	4
ESP2109 Design Project 1	4	PC2133 Applied Solid State Physics	4
MA2501 Differential Equations and Systems	4	EE2011 Engineering Electromagnetics	4
PC2230 Thermodynamics and Statistical Mechanics	4	ESP2110 Design Project 2	4
GEM 2	4	UEM 1	4
Sub-total	20	Sub-total	20
EG3602 Vacation Internship Programme (12 weeks during the long vacation either after the 2nd or 3rd year)			6

Nanoscience and Nanotechnology Specialisation

Modules	MCs	Modules	MCs
Semester 5		Semester 6	
ESP3102 From Making Nano to Probing Nano	4	CM3251 Nanochemistry	4
ESP3902 Major Design Project I	4	CM3296 Molecular Modelling: Theory and Practice	4
Nanoscience and Nanotechnology Elective 1	4	PC3251 Nanophysics	4
Nanoscience and Nanotechnology Elective 2	4	ESP3903 Major Design Project II	4
UEM 2	4	UEM 3	4
Sub-total	20	Sub-total	20

Semester 7		Semester 8	
PC4259 Surface Physics	4	ESP4901 Research Project (over 2 semesters)	6
EG2401 Engineering Professionalism	3	HR2002 Human Capital in Organisations	3
ESP4901 Research Project (over 2 semesters)	6	Nanoscience and Nanotechnology Elective 5	4
Nanoscience and Nanotechnology Elective 3	4		
Nanoscience and Nanotechnology Elective 4	4		
Sub-total	21	Sub-total	13

Computational Engineering Science Specialisation

Modules	MCs	Modules	MCs
Semester 5		Semester 6	
ESP3206 Continuum Mechanics	4	MA3501 Mathematical Methods in Engineering	4
MA3227 Numerical Analysis II	4	ESP3903 Major Design Project II	4
ESP3902 Major Design Project I	4	Computational Engineering Science Elective 2	4
Computational Engineering Science Elective 1	4	Computational Engineering Science Elective 3	4
UEM 2	4	UEM 3	4
Sub-total	20	Sub-total	20
Semester 7		Semester 8	
IE2110 Operations Research I	4	ESP4901 Research Project (over 2 semesters)	6
ME4291 Finite Element Analysis	4	HR2002 Human Capital in Organisations	3
EG2401 Engineering Professionalism	3	Computational Engineering Science Elective 5	4
ESP4901 Research Project (over 2 semesters)	6		
Computational Engineering Science Elective 4	4		
Sub-total	21	Sub-total	13

Photonics and Optics Specialisation

Modules	MCs	Modules	MCs
Semester 5		Semester 6	
EE2023 Signals and Systems	4	ESP3903 Major Design Project II	4
PC3247 Modern Optics	4	Photonics and Optics Elective 2	4
ESP3902 Major Design Project I	4	Photonics and Optics Elective 3	4
Photonics and Optics Elective 1	4	Photonics and Optics Elective 4	4
UEM 2	4	UEM 3	4
Sub-total	20	Sub-total	20
Semester 7		Semester 8	
BN4406 Biophotonics and Photonics	4	EE4603 Biomedical Imaging Systems	4
ESP4302 Nanophotonics	4	HR2002 Human Capital in Organisations	3
EG2401 Engineering Professionalism	3	ESP4901 Research Project (over 2 semesters)	6
ESP4901 Research Project (over 2 semesters)	6		
Photonics and Optics Elective 5	4		
Sub-total	21	Sub-total	13

Energy Systems Specialisation

Modules	MCs	Modules	MCs
Semester 5		Semester 6	
ESP3401 Photovoltaic Devices and Systems	4	ME3221 Energy Conversion Processes	4
ME3122 Heat Transfer	4	ESP3903 Major Design Project II	4
ESP3902 Major Design Project I	4	Energy Systems Elective 2	4
Energy Systems Elective 1	4	Energy Systems Elective 3	4
UEM 2	4	UEM 3	4
Sub-total	20	Sub-total	20
Semester 7		Semester 8	
EE2022 Electrical Energy		ESP4402 Transport	

Systems	4	Phenomena in Energy Systems	4
EG2401 Engineering Professionalism	3	HR2002 Human Capital in Organisations	3
ESP4901 Research Project (over 2 semesters)	6	ESP4901 Research Project (over 2 semesters)	6
Energy Systems Elective 4	4		
Energy Systems Elective 5	4		
Sub-total	21	Sub-total	13

3.2.7 Bachelor of Engineering (Environmental Engineering)

3.2.7.1 Overview

The B.Eng. (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 B.Eng. (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 B.Eng. (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 B.Eng. (Environmental Engineering)programme ensure a balanced exposure to science, engineering principles as well as contemporary technology. B.Eng. (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 B.Eng (Environmental Engineering) programme at NUS is accreditated 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 B.Eng. (Environmental Engineering):

- Students in the B.Eng. (Environmental 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 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 to complete ~~28~~ 16 MCs of the technical electives.
- A student must also satisfy other additional requirements that may be prescribed by the Faculty of Engineering or the University.

Table 3.2.7a: Summary of Modular Requirements and Credits

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) (at least one from Group B: Humanities and Social Sciences)	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty**	8
Programme Requirements	
Faculty Requirements:	10
EG1531 Critical Thinking and Writing	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English for Academic Purposes*	-
Major Requirements:	
Foundation Requirements	24
MA1505 Mathematics I	4
MA1506 Mathematics II	4
PC1431 Physics IE	4
MLE1101 Introductory Materials Science & Engineering	4
CE2409 Computer Applications	4
CM1502 General and Physical Chemistry for Engineers	4

Basic Engineering Modules:	16
EG1109 Statics and Mechanics of Materials	4
CE2134 Hydraulics	4
CE2183 Construction Project Management	4
CE2407 Engineering and Uncertainty Analysis	4
Engineering Process/Infrastructure Engineering (3 of the following courses):	12
CE2155 Structural Mechanics and Materials	4
CE2184 Infrastructure and the Environment	4
CM2142 Analytical Chemistry	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
ESE3401 Water & Wastewater Engineering 1	4
Elective Modules ESE Technical Electives Modules (from the modules in Table 3.2.7b)	16
Unrestricted Elective MODULES	20
Projects Modules ESE4501 Design Project 4MCs ESE4502 B.Eng Dissertation 12 MCs	16
Total	162

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

Note: Limit on Level-1000 ModulesStudents should not read more than 60 MCs of Level-1000 modules towards their degree requirements (minimum of 160 MCs for graduation). For Polytechnic graduates, 12 MCs of the exempted UE modules will not count

towards the 60 MC limit on level-1000 modules.

Table 3.2.7b: Technical Elective Modules*

Technical Elective Modules

1) 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
CE3132	Water Resources Engineering
CE5307	Wave Hydrodynamics and Physical Oceanography
CE5603	Engineering Economics & Project Evaluation

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

2) Dept of Chemical and Biomolecular Engineering

SH5002	Fundamentals in Industrial Safety
SH5004	Fundamentals in Industrial Hygiene
SH5101	Industrial Toxicology
SH5402	Advanced SHE Management

3) Dept of School of Design and Environment

LX5104 Environmental Law

3.2.7.3 Recommended Semester Schedule

The recommended semester schedule for EVE students is presented in Table 3.2.7c.

Table 3.2.7c: Recommended Semester schedule for EVE Students with Industrial Attachment (AY2012/13 onwards)

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE ^	4	MLE1101 Introductory Materials Science & Engineering	4
ESE1001 Environmental Engineering Fundamentals	4	EG1109 Statics and Mechanics of Materials	4
CE2409 Computer Applications in Civil Engineering	4	CM1502 General and Physical Chemistry for Engineers	4
ES1000* Basic English Course	-	ES1102* English for Academic Purposes	-
A Singapore Studies Module	4	General Education Module/ Breadth 1:	4
Sub-total	20	Sub-total	20

^ PC1431 Physics IE must be graded.

* 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.

Modules	MCs	Modules	MCs
Semester 3		Semester 4	
CE2155* Structural Mechanics and Materials	4	CM2142* Analytical Chemistry	4
CE2184* Infrastructure and the Environment	4	LSM1401* Fundamentals of Biochemistry	4
CN2121* Chemical Engineering Thermodynamics	4	AR2723* Strategies for Sustainable Architecture	4
LSM1401* Fundamentals of Biochemistry	4	CE2183 Construction Project Management	4
CM2142* Analytical Chemistry	4	ESE2401 Water Science & Technology	4
CE2134 Hydraulics	4	2 x General Education or Breadth Modules	8
CE2407 Engineering and		EG1531** Critical Thinking and	

Uncertainty Analysis	4	Writing	4
ESE2001 Environmental Processes	4		
Sub-total	20/24		
		Sub-total	24/20

* 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 fulfillment of co/pre-requisites, if any.

** Students who are required to read ES1102 have to pass the module before reading EG1413. Students are allowed to read EG1413 in any semester as long as they have passed or been exempted from ES1102.

Modules	MCs	Modules	MCs
Semester 5		Semester 6	
ESE3101 Solid and Hazardous Waste Mgmt	4	Technical Elective Module 1	4
ESE3201 Air Quality Management	4	Technical Elective Module 2	4
ESE3301 Environmental Microbiological Principles	4	Unrestricted Elective Module 1	4
ESE3401 Water & Wastewater Engineering 1	4	Unrestricted Elective Module 2	4
General Education Module/ Breadth	4	Unrestricted Elective Modules 3	4
Sub-total	20	Sub-total	20
Semester 7		Semester 8	
ESE4501 Design Project	4	ESE4502 B.Eng Dissertation (Cont'd)	8
ESE4502 B.Eng. Dissertation	4	Unrestricted Elective Module 5	4
Technical Elective Module 3	4	HR2002 Human Capital in Organizations	3
Technical Elective Module 4	4	EG2401 Engineering Professionalism	3
Unrestricted Elective Module 4	4		
Sub-total	20	Sub-total	18

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

Table 3.2.7d: Recommended Semester Schedule for B.Eng. (Env Eng)students with an accredited Polytechnic Diploma (AY2011/12 onwards)

Modules	MCs	Modules	MCs
MA1301 Introductory Mathematics if no exemption is given	4	Singapore Studies	4
Breadth Module	4	MA1505 Mathematics I	4
ESE2001 Environmental Processes	4	ESE2401 Water Science and Technology	4
CE2409 Computer Applications in Civil Engineering	4	CM1502 General and Physical Chemistry for Engineers*	4
ESE1001 Environmental Engineering Fundamentals	4	PC1431 Physics IE *	4
		ES1102 English for Academic Purposes	4
Sub-total	20	Sub-total	20
Sub-total	20	Sub-total	20

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

Note: Student exempted from MA1301, will take MA1505 in Semester 1 then MA1506 in Semester 2 and CE2407 in Semester 3.

Semester 3		Semester 4	
CE2155* Structural Mechanics and Materials	4	CM2142* Analytical Chemistry (Pre-Req: CM1101)	4
CE2184* Infrastructure and the Environment	4	LSM1401* Fundamentals of Biochemistry	4
LSM1401* Fundaments of Biochemistry	4	AR2723 Strategies for Sustainable Architecture*	4
CN2121* Chemical Engineering Thermodynamics (Pre-Req: CN1111 and CM1502)	4	CE2183 Construction Project Management	4
CM2142* Analytical Chemistry (Pre-Req: CM1101 waived if pass CM1502)	4	Unrestricted Elective Module 1	4
CE2134 Hydraulics	4	Technical Elective Module 1	4
ESE3401 Water and Wastewater Engineering1	4	Technical Elective Module 2	4
Sub-total	20/24	1 GEM	4
		Sub-total	24/20

*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.

Semester 5		Semester 6	
ESE3101 Solid & Hazardous Waste Management	4	Technical Elective Module 3	4
ESE3201 Air Quality Management	4	Technical Elective Module 4	4
ESE3301 Environmental Microbiological Principles	4	ESE4502 BEng Dissertation	8
ESE4501 Design Project	4	EG2401 Engineering Professionalism	3
ESE4502 BEng Dissertation	4	Unrestricted Elective Module 2	4
* CE2407 Engineering and Uncertainty Analysis (if not taken in earlier semesters)	4		
Sub-total	24	Sub-total	23

Note:

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

All poly entry students are considered for the following exemptions (maximum 40 MCs):

Module	MCs	Remark
GEM Module	4	
Breadth Module	4	
EG1109 Statics and Mechanics of Materials	~~4~~	
EG1531 Critical Thinking and Writing	4	Please nc guarantee polytechn
HR2002 Understanding Human Relations in the New Economy	3	
MLE1101 Introductory Materials Science and Engineering	4	
Unrestricted Elective Modules	12	
PC1431 Physics IE	4	Students exemptio
CM1502 General and Physical Chemistry for Engineers	4	module w test.

3.2.8 Bachelor of Engineering (Industrial & Systems Engineering)

3.2.8.1 Overview

The Department of Industrial & Systems Engineering (ISE) was established in the Faculty of Engineering in 1972. It offers an undergraduate B.Eng. (Industrial & Systems Engineering)

degree programme and graduate programmes leading to the M.Sc. (Industrial & Systems Engineering), M.Eng. and Ph.D. 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.

The B.Eng. (Industrial & Systems Engineering) curriculum is designed with the following educational programme objectives:

- To impart fundamental knowledge and skill sets required in the Industrial and Systems Engineering profession, which include the ability to apply basic knowledge of mathematics and science, and the domain knowledge of Industrial and Systems Engineering.
- To produce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
- To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.
- To cultivate the practices of independent learning on the part of the students that will prepare them to function effectively for diverse careers and life-long learning.
- To enable students to understand their role as engineers and their impact on society in the national and global context.

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 Breadth and the 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.

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 demads 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 mindset.

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 162 MCs with a CAP ≥ 2.0;
- Pass the modules in accordance with Table 3.2.8a;
- Pass elective modules with total of at least 24 MCs, as listed in Table 3.2.8ed. Subject to the approval of the Head of ISE Department, students may be permitted to use up to a maximum of 12 MCs from the ISE electives to read science, computer science and engineering modules. The approval of the electives will be done on a case-by-case basis.
- Satisfy all other requirements as prescribed by the Faculty of Engineering or the University.

Table 3.2.8a: Summary of Modular Requirements and Credits

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) (at least one from Group B: Humanities and Social Sciences)	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty+	8
Unrestricted Electives	20
Programme Requirements	
Faculty Requirements	10
EG1531 Critical Thinking and Writing	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
English*	-
Foundation Requirements	27/28
MA1505 Mathematics I	4
MA1506 Mathematics II	4
Basket of Engineering courses**	3/4
Basket of Science courses***	4
CS1010E Programming Methodology	4
ST1131 Introduction to Statistics	4
ST2131 Probability	4
ISE Major Requirements	85
CS1020E Data Structures and Algorithms	4
CS2103 Software Engineering	4
IE2100 Probability Models with Applications	4

IE2101	Introduction to Systems Thinking	4
IE2110	Operations Research I	4
IE2130	Quality Engineering I	4
IE2140	Engineering Economy	4
IE2150	Human Factors Engineering	4
IE3100R Systems Design Project		8
IE3101	Statistics for Engineering Applications	4
IE3110	Simulation	5
IE4100 B.Eng. Dissertation		12
ISE Electives (See Table 3.2.8cd)		24
Total		162

* 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 ES1102. This will be decided by CELC.

** List of Engineering modules in basket (see table 3.2.8b).

*** List of Science modules in basket (see table 3.2.8c)

Table 3.2.8b: List of Engineering Modules

EG1108	Electrical Engineering
EG1109	Statics and Mechanics of Materials
BN2101	Principles of Bioengineering
CE2184	Infrastructure & the Environment
CN1111	Chemical Engineering Principles
CN2116	Chemical Kinetics and Reactor Design
EE2020	Digital Fundamentals
ESE2401	Water Science & Technology
ME2142	Feedback Control Systems
ME3162	Manufacturing Processes

Table 3.2.8c: List of Science Modules

PC1431	Physics I
PC1432	Physics II
CM1111	Basic Inorganic Chemistry
CM1121	Basic Organic Chemistry
CM1501	Organic Chemistry for Engineers
CM1502	General and Physical Chemistry for Engineers
MLE1101	Introductory Materials Science & Engineering

Table 3.2.8d: List of ISE Electives

ISE Technical Electives#	Approved Technical Electives
SYSTEMS ANALYTICS (A)	
IE4210 Operations Research II	MA4262 Game Theory
IE4230 Quality Engineering II	MA3262 Mathematical Modeling
IE4230 Decision Modeling and Risk Analysis	MA3236 Non-Linear Programming
IE4239 Selected Topics in Quality Engineering	CS3230 Design and Analysis of Alorithms
	ST4237 Probability Theory I
	ST4231 Computer Intensive Statistical Methods
	ST4240 Data Mining
SYSTEMS MANAGEMENT (B)	
IE4240 Project Management	MT4002 Technology Management Strategy
IE4242 Cost Analysis and Management	MT5002 Management of Industrial R&D
IE4249 Selected Topics in Engineering Management	
IE4250 System Dynamics Modeling	
IE4259 Selected Topics in Systems Engineering	
IE4251 Process Analysis and Redesign	
IE5121 Quality Planning and Management¬	
IE5213 Service Innovation and Management¬	
IE5301 Human Factors in Engineering and Design¬	
SYSTEMS APPLICATIONS	
Logistics & Supply Chain Systems (C)	
IE3120 Manufacturing Logistics	TP5026 Transportation Management & Policy
IE4220 Supply Chain Modeling	CE5205 Transportation Planning
IE4229 Selected Topics in Logistics	EC3386 Port Economics
IE5108 Facility Layout and Location¬	EC3382 Transport Economics I

	EC3385 Maritime and Shipping Economics
Economic and Service Systems (D)	
IE4242 Cost Analysis and Management	QF3101 Investment Instruments: Theory & Computation
IE4244 Energy: Security, Competitiveness and Sustainability	QF4102 Financial Modeling
	QF4201 Financial Time Series: Theory & Computation
	EC3101 Microeconomic Analysis I
	EC3102 Microeconomic Analysis II
	EC3332 Money and Banking I
	EC3333 Financial Economics I

Students are to select 6 modules from this list to satisfy the ISE Electives requirement with:

- at least four ISE (IExxx) modules (left coloum)

- at least one module from (A), one module from (B), and oen module from either (C) or (D)

[#]IE4299 Selected Topics in Industrial Engineering can be categorized in either (A), (B), (C) or (D), depending on the selected topic offered.

3.2.8.3 Recommended Semester Schedule

The recommended semester schedule for ISE students is presented in Table 3.2.8e

Table 3.2.8e: Recommended Semester Schedule

Modules	MCs	Modules	MCs
MA1505 Mathematics I	4	MA1506 Mathematics II	4
Basket of Science Modules	4	IE2140 Engineering Economy	4
CS1010E Programming Methodology	4	EG1531 Critical Thinking and Writing	4
ST1131[+] Introduction to Statistics	4	Basket of Engineering Modules	3/4
GEM/SS/Breadth/UEM	4	ST2131 Probability	4
Sub-total	20	Sub-total	19/20
MA1505 Mathematics I	4	MA1506 Mathematics II	4

Modules	MCs	Modules	MCs
Semester 3		Semester 4	

IE2110 Operations Research I	4	IE2100 Probability Models with Applications	4
IE2101 Introduction to Systems Thinking	4	IE2130 Quality Engineering I	4
CS1020E Data Structures and Algorithms	4	IE2150 Human Factors Engineering	4
GEM/SS/Breadth/UEM	4	CS2103[#] Software Engineering	4
GEM/SS/Breadth/UEM	4	GEM/SS/Breadth/UEM	4
		GEM/SS/Breadth/UEM	4
		Sub-total	24
Sub-total	20		

[#] Refer to the School of Computing curriculum.

Modules	MCs	Modules	MCs
Semester 5		Semester 6	
IE3100R Systems Design Project	4	IE3100R Systems Design Project (Cont'd)	4
IE3101 Statistics for Engineering Applications	4	IE4xxx ISE Elective Module 2	4
IE3110 Simulation	5	IE4xxx ISE Elective Module 3	4
		HR2002 Human Capital in Organizations	3
IE4xxx ISE Elective Module 1	4	GEM/SS/Breadth/UEM*	4
EG2401 Engineering Professionalism	3	Sub-total	19
Sub-total	20		

** Students taking EG3601 Industrial Attachment are allowed to take up to two modules in the evening, subject to approval.

Modules	MCs	Modules	MCs
Semester 7		Semester 8	
IE4100 B.Eng. Dissertation	6	IE4100 B.Eng. Dissertation (Cont'd)	6
IE4xxx ISE Elective Module 4	4	IE4xxx ISE Elective Module 6	4
IE4xxx ISE Elective Module 5	4	GEM/SS/Breadth/UEM	4
GEM/SS/Breadth/UEM	4	GEM/SS/Breadth/UEM	4

GEM/SS/Breadth/UEM	4		
Sub-total	22	Sub-total	18

3.2.9 Bachelor of Engineering (Materials Science and 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 B.Eng. (Materials Science and Engineering):

- Students in the B.Eng. (Materials Science and Engineering) Programme are required to complete a minimum of 160 MCs with a CAP ≥ 2.0 to graduate from the programme.
- 160 MCs will have to be earned by taking modules in accordance with Table 3.2.9a.
- Students must pass at least four technical electives from Table 3.2.9b.
- 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 3.2.9b). 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

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) (at least one from Group B: Humanities and Social Sciences)	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Elective MODULES	20
Programme Requirements	
Faculty Requirements:	10
EG1531 Critical Thinking and Writing	4

HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
English*	-
Foundation Requirements:	23
MA1505 Mathematics I	4
MA1506 Mathematics II	4
PC1431 Physics IE**	4
PC1432 Physics IIE**	4
EG1108 Electrical Engineering	3
CS1010E Programming Methodology	4
Major Requirements	
MSE Core Modules****	56
CM1111 Basic Inorganic Chemistry***	4
CM1121 Basic Organic Chemistry or CM1501 Organic Chemistry for Engineers***	4
MLE2101 Introduction to Structure of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4
MLE2103 Phase Transformation and Kinetics	4
MLE2104 Mechanical Properties of Materials	4
MLE2105 Electronic Properties of Materials	4
MLE2106 Metallic Materials and Processing	3
MLE2107 Ceramic Materials and Processing	3
2nd Year Materials Laboratory	-
MLE3101 Materials Characterisation	4
MLE3102 Degradation and Failure of Materials	4
MLE3103 Materials Design and Selection	4
MLE3104 Polymeric and Composite Materials	3
MLE3105 Dielectric and Magnetic Materials	3
BN3301 Introduction to Biomaterials	4
3rd Year Materials Laboratory	-
Elective Modules	15

Projects Modules (Design and Final Year Projects):	16
MLE4101 B.Eng. Dissertation (over two semesters)	12
MLE4102 Design Project	4
Total	160

* 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 ES1102. This will be decided by CELC.

** 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 PC1431 and PC1432.

*** Bridging Module: Students without A-level pass in Chemistry must read *CM1417 Fundamentals of Chemistry* as a prerequisite for CM1111 and CM1121 or CM1501.

**** The relevant departments reserve the right to decide the modules to be offered in any given semester.

Table 3.2.9b: MSE Elective Modules***

POLYMERIC AND BIOMEDICAL MATERIALS

(Four 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

(Four 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
PC4253	Thin film Technology
CN4223R	Microelectronic Thin Films

OTHER ELECTIVE MODULES

MLE4207	Growth Aspects of Semiconductor
MLE4209	Magnetism and Magnetic Materials

EE4411	Silicon Processing Technology
EE4401	Optoelectronics
CN4217R	Processing of Microelectronic Materials
PC4258	Advanced Photonic
CN4203R	Polymer Engineering
CN5251	Membrane Science and Technology
ME4283	Micro-fabrication Process
ME4293	Microelectronics Packing

3.2.9.3 Recommended Semester Schedule

The recommended semester schedules for Direct Entry Materials Science and Engineering students and Common Engineering students are presented in Table 3.2.9c and Table 3.2.9d respectively.

For a Common Engineering Entry student, EG1109 Statics and Mechanics of Materials is counted towards Unrestricted Elective Modules (UEMs). It is recommended, that a Common Engineering Entry student may read 16 MCs from Technical Electives (4 modules of 4 MCs) instead of 15 MCs as required (without reading an extra module).

Table 3.2.9c: Recommended Semester Schedule for Direct Entry MSE Students

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE **	4	PC1432 Physics IIE **	4
EG1531 Critical Thinking and Writing	4	CS1010E Programming Methodology	4
Singapore Studies Module	4	EG1108 Electrical Engineering	3
GEM/Breadth/UEM	4	GEM/Breadth/UEM	4
ES1102 English for Academic Purposes	-		
Sub-total	20	Sub-total	19
Semester 3		Semester 4	
CM1501 Organic Chemistry for Engineers or CM1121 Basic Organic Chemistry ***	4	MLE2103 Phase Transformation and Kinetics	4
CM1111 Basic Inorganic Chemistry ***	4	MLE2104 Mechanical Properties of Materials	4
MLE2101 Structure of Materials	4	MLE2105 Electronic Properties of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4	MLE3101 Materials Characterisation	4

GEM/Breadth/UEM	4	GEM/Breadth/UEM	4
2nd Year MSE Laboratory	-	2nd Year MSE Laboratory	-
Sub-total	20	Sub-total	20
Semester 5		Semester 6	
MLE2106 Metallic Materials	3	EG3601 Industrial Attachment / UEMs ++	12
MLE2107 Ceramic Materials	3		
MLE3102 Degradation and Failure of Materials	4		
MLE3103 Materials Design and Selection	4		
MLE3104 Polymeric and Composite Materials	3		
MLE3105 Dielectric and Magnetic Materials	3		
3rd Year MSE Laboratory	-		
Sub-total	20	Sub-total	12
Semester 7		Semester 8	
MLE4101 B.Eng. Dissertation	6	MLE4101 B.Eng. Dissertation	6
MLE4102 Design Project	4	EG2401 Engineering Professionalism	3
MSE Elective 1	4	MSE Elective 3	3
MSE Elective 2	4	MSE Elective 4	4
BN3301 Introduction to Biomaterials	4	GEM/Breadth/UEM	4
HR2002 Human Capital in Organizations	3	GEM/Breadth/UEM	4
Sub-total	25	Sub-total	24
Total MCs			160

** 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 PC1431 and PC1432.

*** Bridging Module:

Students without A-level pass in Chemistry must read *CM1417 Fundamentals of Chemistry* as a prerequisite for CM1111 and CM1121 or CM1501.

++ Students are strongly recommended to take EG3601 Industrial Attachment (IA), which is counted towards UEM requirements.

For the students who are not going for IA, please take minimum 12 MCs (e.g. 3 UEMs of 4

MCs each) instead of IA as required.

Table 3.2.9d: Recommended Semester Schedule for Common Engineering Entry MSE Students

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE **	4	PC1432 Physics IIE **	4
EG1109 Statics and Mechanics of Materials	4	CS1010E Programming Methodology	4
EG1531 Critical Thinking and Writing	4	EG1108 Electrical Engineering	3
Singapore Study Module	4	GEM/Breadth/UEM	4
ES1102 English for Academic Purposes	-		
Sub-total	20	Sub-total	19
Semester 3		Semester 4	
CM1501 Organic Chemistry for Engineers or CM1121 Basic Organic Chemistry ***	4	MLE2103 Phase Transformation and Kinetics	4
CM1111 Basic Inorganic Chemistry ***	4	MLE2104 Mechanical Properties of Materials	4
MLE2101 Structure of Materials	4	MLE2105 Electronic Properties of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4	MLE3101 Materials Characterisation	4
GEM/Breadth/UEM	4	GEM/Breadth/UEM	4
2nd Year MSE Laboratory	-	2nd Year MSE Laboratory	-
Sub-total	20	Sub-total	20
Semester 5		Semester 6	
MLE2106 Metallic Materials	3	EG3601 Industrial Attachment / UEMs ++	12
MLE2107 Ceramic Materials	3		
MLE3102 Degradation and Failure of Materials	4		
MLE3103 Materials Design and Selection	4		
MLE3104 Polymeric and Composite Materials	3		

MLE3105 Dielectric and Magnetic Materials	3		
3rd Year MSE Laboratory	-		
Sub-total	20	Sub-total	12
Semester 7		Semester 8	
MLE4101 B.Eng. Dissertation	6	MLE4101 B.Eng. Dissertation	6
MLE4102 Design Project	4	EG2401 Engineering Professionalism	3
MSE Elective 1	4	MSE Elective 3	3
MSE Elective 2	4	MSE Elective 4	4
BN3301 Introduction to Biomaterials	4	GEM/Breadth/UEM	4
HR2002 Human Capital in Organizations	3	GEM/Breadth/UEM	4
Sub-total	25	Sub-total	24
Total MCs			160

** 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 PC1431 and PC1432.

***Bridging Module:

Students without A-Level pass in Chemistry must read *CM1417 Fundamentals of Chemistry* as a prerequisite for CM1111 and CM1121 or CM1501.

++ Students are strongly recommended to take EG3601 Industrial Attachment (IA), which is counted towards UEM requirements.

For the students who are not going for IA, please take at least 12 MCs (e.g. 3 UEMs of 4 MCs each) instead of IA as required.

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
- Automotive Engineering
- Biomechanical Engineering
- Energy and Thermal Process Engineering
- Materials Engineering in Design
- Mechatronics
- Micro Systems Technology
- Offshore Oil & Gas Technology
- Precision Engineering
- Product Design

Enrolment in a specialisation is subject to approval of the Head of Department. The students are also required to undertake a research-based project leading to a B.Eng. 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.

The curriculum also features an enhanced breadth component comprising Breadth modules, General Education Modules (GEMs) and Unrestricted Elective Modules (UEMs). These are intended to broaden the outlook of the students and develop broad-based skills that complement the professional training of the programme. At the same time, they also afford students greater scope and flexibility to tailor their learning to suit their individual needs for depth and breadth, and even to pursue their personal interest beyond the confines of their chosen major.

In addition to the aforementioned specialisations, which may be read as part of the B.Eng. programme, students may also apply to read a minor in conjunction with the main degree. This will require the students to offer additional modules as stipulated by the requirements of the minor programme. The available minor programmes are listed in the relevant sections of this bulletin.

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 B.Eng. (Mechanical Engineering) degree is accredited by the Engineering Accreditation Board (EAB) in Singapore and is recognised by the signatories of the Washington Accord (http://www.washingtonaccord.org/). The B.Eng. (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 Bachelor of Engineering (Mechanical Engineering) programme are required to satisfy the following requirements to graduate from the course:

- Complete a minimum of 161 MCs with a CAP ≥ 2.0.
- Pass the modules in accordance with Table 3.2.10a.
- Pass at least 20 MCs equivalent of technical elective modules as listed in Table 3.2.10b.

Students may, subject to approval of the Head of Department, offer 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
- Automotive Engineering
- Biomechanical Engineering
- Energy and Thermal Process Engineering
- Materials Engineering in Design
- Mechatronics
- Micro Systems Technology
- Offshore Oil & Gas Technology
- Precision Engineering
- Product Design

• To qualify for a specialisation, a student must pass at least three modules from the chosen area of specialisation as given in Table 3.2.10c. Students in a specialisation programme are required to do their final-year dissertation (12 MCs) in an area related to the specialisation. For updated information on Specialisation programmes, please refer to http://www.me.nus.edu.sg/student_under_mec_spec.php

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 AY2011/12 onwards)

MODULAR REQUIREMENTS	MCs
University Level Requirements	20
General Education Modules (GEM) (at least one from Group B: Humanities and Social Sciences)	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Elective MODULES**	20
Programme Requirements	
Faculty Requirements	10
EG1531 Critical Thinking and Writing	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
English*	-
Foundation Requirements	23
MA1505 Mathematics I	4
MA1506 Mathematics II	4

EG1108 Electrical Engineering	3
EG1109 Statics and Mechanics of Materials	4
PC1431 Physics IE	4
CS1010E Programming Methodology	4
Mechanical Engineering Major Requirements	
ME Core Subjects:	41
ME2113 Mechanics of Materials I	3
ME2114 Mechanics of Materials II	3
ME2121 Engineering Thermodynamics	3
ME2134 Fluid Mechanics I	4
ME2135 Fluid Mechanics II	4
ME2142 Feedback Control Systems	4
ME2143 Sensors and Actuators	4
ME2151 Principles of Mechanical Engineering Materials	4
ME3112 Mechanics of Machines	4
ME3122 Heat Transfer	4
ME3162 Manufacturing Processes	4
ME Design and Project Modules:	27
ME2101 Fundamentals of Mechanical Design	4
ME2103 Engineering Visualisation and Modelling	3
ME3101 Mechanical Systems Design I	4
ME3102 Mechanical Systems Design II	4
ME4101 B.Eng. Dissertation (Over 2 semesters)	12
ME Electives:	
Technical Electives (from Table 3.2.10b)	20
Total	161

* 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 ES1102. This will be decided by CELC.

Table 3.2.10b: ME Technical Electives Modules

Applied Mechanics

ME3211	Mechanics of Solids
ME4211	Applied Mechanics
ME4212	Aircraft Structures
ME4213	Vibration Theory and Applications
ME4214	Vehicle Dynamics

Control and Mechatronics

ME3241	Microprocessor Applications
ME3242	Industrial Automation
ME4241	Aircraft Performance, Stability and Control
ME4245	Robot Kinematics, Dynamics and Control
ME4246	Linear Systems
ME5405◊	Machine Vision
EE4305	Introduction to Fuzzy/Neural Systems

Fluid Mechanics

ME3232	Compressible Flow
ME3233	Unsteady Flow in Fluid Systems
ME4231	Aerodynamics and Propulsion
ME4233	Computational Methods in Fluid Mechanics
ME4234	Experimental Methods in Fluid Mechanics

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
ME4264	Automobile Design and Engineering
ME4265	Automotive Body and Chassis Engineering

Materials Science

ME3251	Materials for Engineers
ME4251	Thermal Engineering of Materials
ME4253	Biomaterials Engineering
ME4254	Materials in Engineering Design
ME4255	Materials Failure

Micro Systems Technology

ME3281	Microsystems Design and Applications
ME4283	Micro fabrication Processes
ME4284	Micro Sensors and Micro Actuators
ME4285	Modelling and Simulation in MST

Thermodynamics

ME3221	Energy Conversion Processes
ME4223	Thermal Environmental Engineering
ME4225	Industrial Heat Transfer
ME4226	Energy and Thermal Systems Analysis
ME4227	Internal Combustion Engine

Multidisciplinary

ME3291	Numerical Methods in Engineering
ME4291	Finite Elements Analysis
ME4293	Microelectronics Packaging
MA3501	Mathematical Methods in Engineering

Others

ME3000	Independent Study 1
ME3001	Independent Study 2
ME4105	Specialisation Study Module
ME4106	Special Topics

Table 3.2.10c: Technical Electives Modules for ME Specialisations

Aeronautical Engineering

ME3232	Compressible Flow
ME3233	Unsteady Flow in Fluid Systems
ME4212	Aircraft Structures
ME4231	Aerodynamics and Propulsion
ME4233	Computational Methods in Fluids Mechanics
ME4234	Experimental Methods in Fluid Mechanics
ME4241	Aircraft Performance, Stability and Control
ME4291	Finite Element Analysis

Automotive Engineering

ME3251	Materials for Engineers

ME3261	Computer aided Design and Manufacturing
ME3263	Design for Manufacturing and Assembly
ME4227	Internal Combusion Engine
ME4254	Materials in Engineering Design
ME4255	Materials Failure
ME4262	Automation in Manufacturing

Biomechanical Engineering

ME4245	Robot Kinematics, Dynamics and Control
ME4253	Biomaterials Engineering
ME4284	Micro sensors and Micro actuators
ME5405◊	Machine Vision
BN4201†	Musculoskeletal Biomechanics (Prerequisites will be waived)
BN4202†	Biofluid Dynamics
BN4301†	Principles of Tissue Engineering (Prerequisite: BN3301. This will be waived if students have taken ME4253 Biomaterials Engineering)
BN4403†	Cellular Bioengineering (Prerequisites LSM2103)
BN4404†	Biomicroelectromechanical Systems – BioMEMS

Energy and Thermal Process Engineering

ME3221	Energy Conversion Processes
ME4223	Thermal Environmental Engineering
ME4225	Industrial Heat Transfer
ME4226	Energy and Thermal Systems Analysis
ME4231	Aerodynamics and Propulsion

Materials Engineering In Design

ME3251	Materials for Engineers
ME4251	Thermal Engineering of Materials
ME4253	Biomaterials Engineering
ME4254	Materials in Engineering Design (Required module)
ME4255	Materials Failure
ME5502◊	Engineering Plastics and Composite Materials
CN4217R†	Processing of Electronic Materials
MST5002†◊	Materials Characterisation

Mechatronics

ME3241	Microprocessor Applications
ME3242	Industrial Automation

ME4245	Robot Kinematics, Dynamics and Control
ME4246	Linear Systems
ME5405◊	Machine Vision
EE4305†	Introduction to Fuzzy/Neural Systems

Micro Systems Technology

ME3281	Microsystems Design and Applications
ME4283	Micro fabrication Processes
ME4284	Micro sensors and Micro actuators
ME4285	Modelling and Simulation in MST
ME4291	Finite Element Analysis
ME4293	Microelectronics Packaging
CN4216R†	Electronic Materials Science (Prerequisites ME2151)
CN4217R†	Processing of Microelectronic Materials (Prerequisites ME2151)

Offshore Oil and Gas Technology

ME3211	Mechanics of Solids
ME3232	Compressible Flow
ME3233	Unsteady Flow in Fluid Systems
ME4213	Vibration Theory and Applications
ME4245	Robot Kinematics, Dynamics and Control
ME4254	Materials in Engineering Design
ME4261	Tool Engineering
ME5506◊	Corrosion of Materials
ESE5901†◊	Environmental Technology
GE3880A†	Topics in Petroleum Geoscience (Required module)
OT5102†◊	Oil and Gas Technology
OT5301†◊	Subsea Systems Engineering

Precision Engineering

ME3261	Computer aided Design and Manufacturing
ME3263	Design for Manufacturing and Assembly
ME4261	Tool Engineering
ME4262	Automation in Manufacturing
ME4283	Micro fabrication Processes

Product Design

One (1) module from:

ME3261	Computer aided Design and Manufacturing

ME3263	Design for Manufacturing and Assembly
ME4254	Materials in Engineering Design

Two (2) modules from:

IE4239†	Selected Topics in Quality Engineering: Reliability for Design and Manufacturing
IE5002†	Applied Engineering Statistics
IE5208†	Systems Approach to Project Management
IE5301†	Human Factors in Engineering and Design
ME5610†◊	Product Development
ME5611†◊	Sustainable Product Design & Manufacturing
ME5612†◊	Computer Aided Product Development

† Subject to acceptance by the offering department.

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

If students withdraw from the specialisation, non ME modules (e.g. CN4216R, CN4217R, etc.) done to satisfy the specialisation requirement CANNOT be used to fulfil the ME Technical Elective requirement. Students may use these modules to fulfil the Unrestricted Elective Modules (UEMs) only (mapping the modules to any other modules required for graduation is not allowed). Students must take approved Technical Elective modules (refer to Table 3.2.10b) to replace the non-ME modules if they fail to fulfil the ME Technical Elective requirement upon withdrawal from the specialisation.

3.2.10.3 Recommended Semester Schedule

The recommended semester schedule for ME students is presented in Table 3.2.10d and 3.2.10e. The scheduling of the modules is a guide and may be subject to changes without prior notice.

Table 3.2.10d: Recommended Semester Schedule for ME students

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE	4	EG1531 Critical Thinking and Writing	4
CS1010E Programming Methodology	4	EG1108 Electrical Engineering	3
EG1109 Statics and Mechanics of Materials	4	Breadth 1*	4
SS*	4	GEM B*	4
Sub-total	20	Sub-total	19
Semester 3		Semester 4	
ME2103 Engineering Visualisation and Modelling	3	ME2101 Fundamentals of Mechanical Design	4

ME2113 Mechanics of Materials I	3	ME2114 Mechanics of Materials II	3
ME2121 Engineering Thermodynamics	3	ME2135 Fluid Mechanics II	4
ME2134 Fluid Mechanics I	4	ME2143 Sensors and Actuators	4
ME2151 Principles of Mechanical Engineering Materials	4	Breadth 2*	4
GEM*	4		
Sub-total	21	Sub-total	19
Semester 5		Semester 6	
ME2142 Feedback Control Systems	4	EG2401 Engineering Professionalism	3
ME3101 Mechanical Systems Design I	4	ME3102 Mechanical System Design II	4
ME3112 Mechanics of Machines	4	ME Technical Elective 1	4
ME3122 Heat Transfer	4	ME Technical Elective 2	4
ME3162 Manufacturing Processes	4	ES2331 Communicating Engineering # (fulfils Unrestricted Elective Module 1)	4
HR2002 Human Capital in Organizations	3		
Sub-total	23	Sub-total	19
Semester 7		Semester 8	
ME4101 B.Eng. Dissertation	6	ME4101 B.Eng. Dissertation	6
ME Technical Elective 3	4	ME Technical Elective 5	4
ME Technical Elective 4	4	Unrestricted Elective Module 4	4
Unrestricted Elective Module 2	4	Unrestricted Elective Module 5	4
Unrestricted Elective Module 3	4		
Sub-total	22	Sub-total	18
Total MCs			161

*These ULR modules (GEM, SS, and Breadth) can be read in any semester. Breadth modules are strictly modules read outside the student's faculty.

ES1531 is a pre-requisite of ES2331. For more details, please refer to the section on English Language Mdoules at http://www.eng.nus.edu.sg/ugrad/MS_timetable_sem1_1213.html#3

Table 3.2.10e: Recommended Semester Schedule for ME Students with an accredited Polytechnic Diploma

Year 2			
Semester 3	MCs	Semester 4	MCs

MA1301 Introductory Mathematics (fulfils Breadth)	4	MA1505 Mathematics I	4
ME2103 Engineering Visualisation and Modelling	3	PC1431 Physics IE	4
ME2151 Principles of Mechanical Engineering Materials	3	ME2143 Sensors and Actuators	4
ME2113 Mechanics of Materials I	4	ME2101 Fundamentals of Mechanical Design	4
ME3162 Manufacturing Processes	4	ME2114 Mechanics of Materials II	3
Sub-Total	18		19
Year 3			
Semester 5	4	Semester 6	MCs
MA1506 Mathematics II	4	EG2401 Engineering Professionalism	3
ME2121 Engineering Thermodynamics	3	ME2135 Fluid Mechanics II	4
ME2142 Feedback Control Systems	4	ME3102 Mechanical Systems Design II	4
ME2134 Fluid Mechanics I	4	ME Technical Elective 1	4
ME3101 Mechanical Systems Design I	4	SS*	4
ME3112 Mechanics of Machines	4	GEM*	4
Sub-Total	23	Sub-Total	23
Year 4			
Semester 7	MCs	Semester 8	MCs
ME4101A B.Eng. Dissertation	6	ME4101A B.Eng. Dissertation (cont'd)	6
ME3122 Heat Transfer	4	Unrestricted Elective Module 1	4
ME Technical Elective 2	4	ME Technical Elective 4	4
ME Technical Elective 3	4	ME Technical Elective 5	4
ES2331 Communicating Engineering # (fulfills Unrestricted Elective Module 1)	4		
Sub-Total	22	Sub-Total	18

~Please note that this semester schedule is only recommended, you need not adhere strictly to this schedule.

*These ULR modules (GEM, SS, Breadth) can be read in any semester.

ES1531 is a pre-requisite of ES2331. Poly students exempted from ES1531 are required to read either ES1102 and/or ES1000 based on thier QET results. The latter basic English modules will be considered equivalent to the pre-requisite to the ES2331 for poly students.

For more details, please refer to the section on English Modules at http://www.eng.nus.edu.sg/ugrad/MS_timetable_sem1_1213.html

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 Credits (MCs) requirements for a Minor Program 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) towards the MCs requirement in the Minor Program. A student may use up to 20 MCs to satisfy the Unrestricted Elective Modules (UEMs) and another 8 MCs from the Breadth component of the University Level Requirement. If a student is unable to double count the minor modules towards his Breadth or UEM, he/she will take them on top of the 160 MCs graduation requirement. The Minor modules will be graded and the Cumulative Average Point (CAP) will be counted towards degree classification. The Minor Programme will be reflected in the student's academic transcript. For more information on these programmes and other minor programmes, please refer to:

http://www.eng.nus.edu.sg/ugrad/programs/minor.html

The following Minor Programmes are offered by the Faculty of Engineering:

3.3.1 Minor in Bioengineering (hosted by the Department of Bioengineering)

Bioengineering 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. Bioengineering 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 Division of Bioengineering website:

http://www.bioeng.nus.edu.sg/edu/ ugrad/minor.htm

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

Requirements:

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

Bioengineering Option	Life Science Option+	Engineering Electives Option
BN2101 Principles of Bioengineering (Compulsory)	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

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 exotic 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 program can be found at:

http://www.eng.nus.edu.sg/minor/materials

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

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 or Minor in Technopreneurship programmes are not eligible to apply for the Minor in MOT Programme. The Minor in MOT is mutually exclusive to these two Minor Programmes. More details of the programme can be found at:

http://www.eng.nus.edu.sg/cmost/Program/minor-mot.htm

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. All six minor modules must be taken on a graded basis (i.e., not on S/U basis). Students are recommended to take Set 1 modules first before taking Set 2 modules.

(A) Set 1 Modules (Choose 2)

MNO1001	Management and Organisation
ACC1002X	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:

TR3001	New Product Development
MT4003	Engineering Product Development

3.4 Enhancement Programmes

Faculty of Engineering offers a host of Enhancement Programmes (EP) which broaden our engineering students' education. Students can select one or more of these programmes to satisfy the Unrestricted Elective Modules (UEMs).

For students matriculated in AY2004/05 & AY2005/06, MCs earned under IA and VIP will NOT be counted towards the 12 MCs allowed under S/U Option. New grades known as 'Completed Satisfactory' ('CS') and 'Completed Unsatisfactory' ('CU') will be awarded for these two modules upon completion. These modules are not counted towards your CAP.

For students matriculated from AY2006/07 onwards, MCs earned under all EP will NOT be counted towards the 12 MCs allowed under S/U Option. New grades known as 'Completed Satisfactory' ('CS') and 'Completed Unsatisfactory' ('CU') will be awarded for these two modules upon completion. These modules are not counted towards your CAP.

The MCs may be used to satisfy the Unrestricted Elective Modules (UEMs) requirement.

For more details about, please refer to: http://www.eng.nus.edu.sg/undergrad/epmc/ep.html

Enhancement Programme Modules	Prerequisites
EG3601 Industrial Attachment Programme (IAP)	Stage 3 standing
EG3602 Vacation Internship Programme (VIP)	EG3602 – Completed Stage 2
EG1603/EG2603A Technopreneurship and Incubation Programme (TIP)	EG2603A – Stage 2 standing
EG2604 Innovation Programme (IP)	Stage 2 standing
EG2605 Undergraduate Research Opportunities Programme (UROP)	Stage 2 standing
EG2606A/B Independent Work Programme (IWP)	Stage 2 standing

3.4.1 EG3601 Industrial Attachment Programme (12 MCs)

EG3601 Industrial Attachment Programme (IAP) is designed to:

- Enable students to translate theories learnt in the classroom into practice in a real-world environment.
- Instill in students the right kind of work attitude and professionalism through interaction with people in organisations and observation of their future roles in industry.
- Enable students to acquire intangible attributes such as working in a team and the use of IT in the workplace.

Students who have achieved Stage 3 of their course are allowed to spend a semester in industry either in a local company (local IAP or LIAP) or in an overseas company (overseas IAP or OIAP) for 24 weeks. Students will need good engineering knowledge to be suitable for the attachment and to be able to contribute to the industrial projects during the attachment. Each student will be awarded 12 MCs upon completing LIAP or OIAP. Students may wish to register with the Faculty in semester 5 (around September/October of each year) for possible allocation of company placements, or to source their own placements. During the attachment period, students need to submit progress reports for continual assessment by their Mentors

assigned to them by the respective Departments.

For more details, please refer to: http://www.eng.nus.edu.sg/undergrad/epmc/iap.html

3.4.2 EG3602 Vacation Internship Programme (6 MCs)

EG3602 Vacation Internship Programme (VIP) has the same objectives as IAP, except that it is of a shorter duration. Students who have completed Stage 2 of their course are allowed to undertake EG3602. Students will need good engineering knowledge to be suitable for the attachment and to be able to contribute to the industrial projects during the attachment. Students may choose to do a short internship of 12-week duration during the vacation (May to July) period in selected local/overseas companies. Students will have to submit a progress report and a final report for assessment at the end of the attachment. Their performance will be closely monitored and graded by their respective mentors. Students who have met the requirements of vacation internship will be awarded 6 MCs. For more information on VIP, please refer to:

http://www.eng.nus.edu.sg/undergrad/epmc/vip.html

It is important to note that students are allowed to get credits for either IAP or VIP, but not both.

3.4.3 EG1603/EG2603A Technopreneurship and Incubation Programme

The overall learning objectives of EG1603/EG2603A Technopreneurship and Incubation Programme (TIP) are:

- To enthuse and prepare students, by classroom tuition and experiential learning, for a career in technology-based entrepreneurship.
- To educate students on how to start up and incubate companies. (Actual incubation may be done in an incubation centre specially created to provide basic facilities and advice).
- 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 EG2603A. MCs are assigned to the successful completion of each part and may be used to count towards the Technopreneurship Minor.

EG1603 – (TIP Instructional Workshops and Seminars) (2 MCs)

The learning objectives of EG1603 are for students to gain insight, confidence, and some basic capabilities about the theoretical and practical aspects of technopreneurship, i.e., the technopreneurship business and technical processes – including the critical success factors, risk management, interpersonal skills of presentation and persuasion. The above learning is acquired via instructional workshops with continual assessment (CA), and supplemented by at least 4 seminars.

EG2603A – TIP (Business Plan) (2 MCs)

Students who have completed Stage 1 of their course can undertake EG2603A. Stage 1 students can still opt to do EG2603A on special permission of the TIP Co-ordinator, Dr John Bauly, engjb@nus.edu.sg. Students will need some basic Engineering knowledge to handle EG2603A on the writing of technopreneurial business plan. The learning objectives of EG2603A are for students to gain additional insight, confidence, and basic capabilities about the theoretical and practical aspects of technopreneurship – particularly regarding overall business planning, i.e., “making the business case”.

For more information, please refer to: http://www.tip.eng.nus.edu.sg/

3.4.4 EG2604 Innovation Programme (4 MCs)

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 mutli-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.

For more information, please refer to: http://www.eng.nus.edu.sg/undergrad/epmc/ip.html

3.4.5 EG2605 Undergraduate Research Opportunities Programme (4 MCs)

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.

For more information, please refer to: http://www.eng.nus.edu.sg/urop

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

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.

For more information, please refer to: http://www.eng.nus.edu.sg/undergrad/epmc/iw.html.

3.5 Special Programmes

3.5.1 University Scholars Programme

Students may apply to join the University Scholars Programme (http://www.scholars.nus.edu.sg/) 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, an interview and an engineering aptitude test. University Scholars in Faculty of Engineering take a slightly different combination of modules from that of other students at the Faculty:

- Eight First Tier modules offered by the Scholars Programme, which include one Critical Thinking and Writing module, three science-based modules and four humanities-based modules (of which one should be Singapore Studies themed); students who choose to read the University Scholars Seminar module will have one less humanities-based module requirement.

- Advanced Curriculum modules equivalent to 16 MCs from the Faculty of Engineering or other faculties (with prior permission from Faculty of Engineering).

- Two years' equivalent of modules in an engineering discipline of the student's choice.

Engineering USP students may replace up to 48 MCs of modules under the University Level Requirements and Unrestricted Elective Modules as well as the following modules: EG1531 Critical Thinking and Writing, SSAxxxx Singapore Studies, and HR2002 Human Capital in Organizations. First Tier modules may be taken any time within the four years of study, although it is preferable that the students complete them by the fifth or sixth semester. Currently, the Faculty offers one Course based Advanced Module: UEG4001 Broadband Networking and numerous topics at Level-3000 or 4000 that can be taken as Independent Study Modules (ISMs). For ISMs, students are required to work out a contract with the relevant mentors on the study topic. The students can also read the USP Multidisciplinary Seminar modules (UMSs) towards their Advanced Curriculum modules requirements. The Advanced Curriculum modules taken will satisfy the UE requirements.

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

3.5.2 NUS Overseas Colleges (in Silicon Valley and Bio Valley USA, Shanghai China, Stockholm Europe and Bangalore India)

In line with Singapore's need to encourage entrepreneurship, programmes which include up to a one-year internship in a company in Silicon Valley (California), Bio Valley (Philadelphia), Shanghai, Stockholm, or Bangalore are available. These unique opportunities enable students to acquire entrepreneurial skills, soak up the culture of business start-ups, and establish personal networks. During the internships, students will attend some courses at the associated partner University. These include Stanford University, University of Pennsylvania, Fudan University, the Swedish Royal Institute of Technology, and the Indian Institute of Science, IISc. Course credits count towards the students' NUS degree academic requirements. At the end of the internships, students return to NUS to complete their studies for a Bachelors with a Technopreneurship Minor. It is hoped that these students will promote the entrepreneurial spirit among their NUS colleagues, and that some of them will assist the nation by eventually becoming entrepreneurs, thus helping create an entrepreneurial hub in Singapore.

For more details, please visit: http://www.overseas.nus.edu.sg/

3.5.3 NUS/Georgia Tech Special Term Programme

This special term programme offers Stage 2 or Stage 3 students a unique cross-cultural educational experience. The courses conducted under this programme involve participation of faculty members and students from both NUS and Georgia Institute of Technology (Georgia Tech). The central theme of the programme is "*Logistics and Supply Chain"* complemented with a historical coverage of Asia in the modern world. Singapore and China, owing to their excellent logistics infrastructure and standing as international hubs, have been identified as optimal locations to conduct the programme. 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. Four Georgia Tech modules are offered and the topics are given below:

· ISYE3103 Introduction to Supply Chain Modelling: Logistics

· ISYE3014 Introduction to Supply Chain Modelling: Manufacturing and Warehousing

· ISYE 4803 Economics Decision Analysis

· HTS2062 Asia in the Modern World

Students who read the module HTS2062 will be considered as satisfying one UEM or one Breadth from the University Level Requirements. These modules will be cross listed to the NUS modules. Some of the modules will be completed in Singapore while the others will be

completed in China. Students must have taken some equivalent modules in basic statistics, as prerequisites for the three technical modules. Students can read in any of modules offered and will be awarded 4 MCs each if they passed the respective modules. Depending on each engineering department requirement, the MCs earned may be used to satisfy either the programme requirements or the Unrestricted Elective Modules.

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

3.5.4 Double Degree Programmes

3.5.4.1 Double Degree Programme with French Grandes Écoles

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 8 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 Ecoles under the DDP:

Ecole Polytechnique (X)
Ecole Centrale Paris (ECP)
Ecole Supérieure d'Électricite (Supélec)
Ecole Nationale Supérieure des Mines de Paris (ENSMP)
Télécom ParisTech (ENST)

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: http://www.eng.nus.edu.sg/ugrad/SP_ddpfrench.html

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

Year	Schedule
1	Faculty of Engineering at NUS • First year Engineering studies at NUS • French language classes at Alliance Française de Singapour or equivalent (40 hours) • 4-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 • Second year Engineering studies at NUS • French language classes at Centre for Language Studies, NUS (40 hours) • 4-week language immersion in France during vacation (100 hours) • Special Mathematics and Physics classes (180 hours)

	• 4-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	Master of Engineering studies at NUS

3.5.4.2 Double Degree Programme in Business Administration and Engineering

Please refer to http://www.nus.edu.sg/registrar/nusbulletin/Otherprogs/ddp.html#5_7

3.5.4.3 Double Degree Programme in Engineering and Economics

Please refer to section R of Part II of this bulletin.

3.5.4.4 Double Degree Programme in Materials Science and Engineering and Physics

Please refer to http://www.nus.edu.sg/registrar/nusbulletin/Otherprogs/ddp.html#5_8

3.5.5 Double Major Programmes

3.5.5.1 Double Major in Management (Technology) Programme

The Major in Management (Technology) Programme [Mgt (Tec) Major], a Double (second) Major as part of NUS Special Undergraduate Programmes, is offered to students from Engineering and all other faculties and schools.

Students may be admitted to the programme in one of the following ways:

- Application by invited students just after they have been offered admissions to NUS, *OR*
- Application by students during their first or second year of study.

Once admitted to the Mgt (Tec) Major, students do not need to maintain any minimum academic performance threshold in order to remain in the programme.

The Minor in Management of Technology (MOT) Programme, which is jointly offered by the NUS Business School and the Faculty of Engineering, is a subset of the Mgt(Tec) Major. Students in the MOT Minor Programme may upgrade to the Mgt (Tec) Major (subject to meeting the admission criteria for the programme). Conversely, Mgt (Tec) Major students may "downgrade" to the MOT Minor.

To fulfil the requirements of the Mgt (Tec) Major, students must complete 12 management modules worth 48 MCs in total, of which up to a maximum of 8 MCs may be double counted for other programmes. Of the 12 modules for the Major, at least six modules must be from the School of Business. Details are shown in the table below.

(Engineering Students reading this Major should take MNO1001 Management & Organisation in place of HR2002 Human Capital in Organizations.)

Modules	Number Of Mcs
(A) Completion of the Minor in Management of Technology (MoT) offered by Faculty of Engineering, by reading the following modules: ACC1002/ Financial Accounting FNA1002/ FNA1002X MKT1003 Principles of Marketing	24

MT3001 Systems Thinking and Engineering TR2202 Technological Innovation TR3001 New Product Development or MT4003 Engineering Product Development MT4002 Technology Management Strategy	
(B) Completion of another six modules relating to general and engineering management, including: DSC2006 Operations Management IE4240 Project Management or PF3204 Project Risk Management and four modules from the following: *Technopreneurship (Biz):* TR2201 Entrepreneurial Marketing *Decision Sciences (Biz):* DSC3219 Quality Management or IE2130 Quality Engineering I DSC3201 Supply Chain Management DSC3202 Purchasing and Materials Management *Quantitative Finance (Biz):* FIN3118/ Financial Risk Management FNA3118 *Management (Biz):* MNO2311 Leadership in Organisation MNO3303 Organisational Effectiveness *Marketing (Biz):* MKT3418 Product and Brand Management *Applied Mathematics(FoS/FASS):* EC4311 Mathematical Economics II MA3253 Inventory & Queuing Models MA4260 Model Building in Operations Research *Systems Engineering (FoE/SDE):* IE2110 Operations Research I IE2140 Engineering Economy PF3101 Project Scheduling & Control *Management of Technology (FoE):* MT5003 Creativity and Innovation MT5005 IP Law for Engineers & Scientists *Management of Information Technology (SoC):* CS2250 Fundamentals of Information Systems CS3251 Technology Strategy and Management CS3253 Management of Information Systems	24
12 Modules	48 MCs

A student who has been awarded the Major in Management (Technology) would not have the Minor in MOT awarded.

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 to:

http://www.eng.nus.edu.sg/sep/universities.htm 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:
http://www.eng.nus.edu.sg/sep

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Faculty's Commitment

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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 among the top universities in Engineering and Technology by The Times Higher Education Supplement in the UK since 2004. The latest London-based Quacquarelli Symonds (QS) Ltd has placed NUS Engineering as among the world's top 10. By technical subject, QS has also ranked NUS Civil Engineering 7th best in the world while 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 Curriculum* (DCC) and the *Global Engineering Programme* (GEP). The DCC places a strong emphasis on cross-disciplinary and problem based learning while the 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 (UROP) and independent work programme. 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's 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 Mr 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, among many other notable names.

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

B.Eng.(Hons)	Bachelor of Engineering degrees - see section 3 for more details.

B.Tech.(Hons)	Bachelor of Technology degrees (part-time) - see section 4 for more details.
M.Eng.	Master of Engineering - see section 5 for more details.
M.Sc.	Master of Science - see section 5 for more details.
Ph.D.	Doctor of Philosophy - see section 5 for more details.

For up to date information on the Faculty, please visit: http://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 B Eng 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.

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Undergraduate Education (Part-time Programmes)

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4.1 Bachelor of Technology Programme

4.1.1 Overview

From AY2012/13, the Faculty of Engineering offers part-time programmes leading to the degree of Bachelor of Technology (Honours) [i.e., B.Tech. (Hons.) degree] in:

B.Tech. (Chemical Engineering)
B.Tech. (Electronics Engineering)
B.Tech. (Industrial & Management Engineering)
B.Tech. (Manufacturing Engineering)
B.Tech. (Mechanical Engineering)

These part-time programmes are specially designed and primarily meant for diploma holders from the local polytechnics who wish to study for a high-quality engineering degree without having to leave their full-time jobs. These courses are specially designed for such students to prepare them to better meet the challenges of a knowledge-based economy. The programmes are designed so that at the point of graduation, the academic standard of the B.Tech. degrees is on par with that of the Faculty's well established full-time B.Eng. degrees. The B.Tech. courses follow closely the curriculum of the B.Eng. courses and makes use of the same high quality teaching staff and teaching facilities.

4.1.2 Admission Requirements

For all B.Tech. courses, the minimum requirement for admission is a relevant diploma from a local polytechnic, or equivalent local/foreign qualifications. In considering an applicant's suitability for admission, factors considered include:

Performance in the diploma course.
Relevance and length of work experience.
Company sponsorship.
Other evidence of post-diploma academic preparation including the advanced diploma and any other mathematics and foundational engineering courses.

Applicants may also be required, by the committee on admission, to sit for admission tests to determine their suitability in coping with the demanding B.Tech. courses.

4.1.3 Curriculum Structure and Degree Requirements

The structure and design of the B.Tech. courses are based on those of the four-year full-time B.Eng. courses offered by the Faculty of Engineering. However, unlike other engineering degree courses which cater primarily to students admitted with GCE 'A' Level qualifications, the unique feature of the B.Tech. Programme is that the curriculum structure and design of the modules are specially tailored to suit the needs and background of polytechnic graduates holding relevant full-time jobs in industry. This is possible because all its students would have a polytechnic diploma, or its equivalent, and working experience when they are admitted. As such, although almost all the upper-year modules are identical to those of the full time B.Eng. courses, the modules in the earlier years are somewhat different and are specially designed to cater to the different needs of the B.Tech. students.

The B.Tech. curriculum structure follows the normal 160 MCs four-year full-time programmes. As all students admitted into the B.Tech. Programme must have the minimum of a recognised polytechnic diploma, all students are granted, upon admission, advanced placement credits of 40 MCs, which is equivalent to one year of the four-year full-time courses. These include

a) 8 MCs of University Level Requirements (ULR),

b) 20 MCs of Programme Requirements, and

c) 12 MCs of Unrestricted Elective Modules (UEMs).

As such, all B.Tech. students follow the 120-MC basic curriculum structure shown in Table 4.1a.

Table 4.1a: B.Tech. Curriculum Structure

Modular Requirements	Minimum MC Requirements for B.Tech. Degree
UNIVERSITY LEVEL REQUIREMENTS (ULR)	16
General Education Module	4
Singapore Studies	4
Breadth	8
PROGRAMME REQUIREMENTS	92
Ethics in Engineering	4
Foundational, Major Requirements	88
Unrestricted Elective Modules (UEMs)	12
Total	120

Note: Individual B.Tech. Programmes may require more than the minimum listed in the above table.

University Level Requirements (ULR)

These requirements aim to broaden a student's intellectual horizon and comprise General Education Modules (GEM), Singapore Studies (SS) modules, and Breadth modules. A selection of such modules (from the wide range available in the University), which can best meet the interests and professional needs of B.Tech. students, will be offered specially in the evenings for them. Such modules offered in recent years include:

General Education Modules

GEK1010T	Property Management
GEK1029T	Managing Change: Power and Paradox
GEK1522T	Global Environmental Issues
GEK1523T	Innovativeness in Engineering Design

Singapore Studies Modules

SSA2220T	Global Economic Dimensions of Singapore
SSB1204T	Labour Laws in Singapore
SSB2216T	Employee Management in Singapore

Breadth Modules

HR1424T	Business, Management and People
HR2002T	Human Capital in Organizations
SE2218T	Changing Economic Landscape of Southeast Asia
SE3218T	Industrialising Singapore and SE Asia
TG1422	Financial and Management Accounting
TG1423	Industrial Management

Programme Requirements

Programme Requirements comprise the Faculty, Foundational and Major Requirements. These are specific to the individual B.Tech. programme and reference should be made to the relevant sections.

Unrestricted Elective Modules (UEMs)

Unrestricted Elective Modules (UEMs) enable students to pursue their interests without any restrictions. To satisfy UEM, students may select any module at any level from among technical, GEM, SS or Breadth modules to meet this requirement.

4.1.4 Advanced Placement Credits and Exemptions

As all students admitted into the B.Tech. courses will have, at the minimum, a recognised polytechnic diploma or its equivalent, all B.Tech. students are granted advanced placement credits of 40 MCs which is equivalent to one year of a typical 160 MCs four-year full-time engineering degree programme. Students with additional post-diploma academic qualifications may, on a case-by-case basis, apply and be considered for additional advanced placement credits. The granting of such additional credits will be entirely at the discretion of the University.

4.1.5 Study Schedule and Candidature Period

Each of the five B.Tech. courses offered by the Faculty of Engineering has two intakes in each Academic Year, one for Semester 1 in August and the other for Semester 2 in January of the following year.

In addition to the two normal semesters (Semester 1 and Semester 2) in each Academic Year, the B.Tech. Programme also runs a 10-week Special Term during May - July.

The minimum and maximum candidature periods are two-and-a-half years and eight years respectively, inclusive of approved leave of absence. Unless otherwise approved by the Director of the B.Tech. Programme, a student may register for up to 16 MCs of modules during a normal semester and 8 MCs in a special term.

If work, family and other commitments permit, students typically attend classes three evenings a week and should normally be able to complete their degree requirements in four years. Those students with strong backgrounds and have more time to do their projects should be able to do this in three-and-a-half years. The curriculum structure is completely modular and flexible and students should study at their own comfortable pace.

Unless their other commitments allow them sufficient time and peace of mind to focus on, and gain the most, out of their studies, students are strongly advised not to rush through their courses. If taking an extra semester to complete their degree requirements can mean getting more out of their studies and even allow them to achieve a better honours degree, this will be a much better alternative because the B.Tech. degree is for life.

4.1.6 Leave of Absence

If for medical or other reasons, a student is unable to register for modules and attend classes satisfactorily during any semester, s/he must apply for leave of absence. Applications for leave of absence are to be submitted to the B.Tech. Office. Any supporting document such as original copies of medical certificates or employer's supporting letter should be submitted together with the application. Students who apply for leave of absence before the end of the second week of the two regular semesters (Semester 1 and 2) will have their administrative fee of S$250 for that semester waived. Those who do so only after this deadline will have to pay the administrative fee.

4.1.7 Other Academic Matters

Students are advised to read carefully other relevant information presented in Part I of this document, in particular the sections on the Modular System, Acceptance Record, Module Enrolment, and Continuation and Graduation Requirements.

Stage Promotion

A student will be deemed to have progressed to the next stage of his study if s/he obtains the number of MCs, including exemptions, as shown in Table 4.1b.

Table 4.1b: Stage Promotion Criteria

Stage 2	36 MCs
Stage 3	76 MCs
Stage 4	112 MCs

4.1.8 Bachelor of Technology (Chemical Engineering)

The Bachelor of Technology in Chemical Engineering [B.Tech. (Chemical Engineering)] programme offered by the Department of Chemical and Biomolecular Engineering follows closely the academic curriculum of the B.Eng. course. It has comparable academic standards and, as with the B.Eng. course, is accredited by the EAB, Institution of Engineers Singapore. The Engineering Accreditation Board (EAB) of Singapore, has given full accreditation to the B.Tech. (Chemical Engineering) course for five years starting with students graduating in AY2010/11. This means that all B.Tech. (Chemical Engineering) graduates for AY2010/11 to AY2014/15 will have their degrees fully accreditated by EAB.

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The ***educational objectives*** of the B.Tech. (Chemical Engineering) programme are:

- To develop knowledge and skills required for immediate employment as a professional engineer in Chemical Engineering.
- To develop an understanding of and an ability to apply basic mathematics, chemical, physical and information sciences to the practice of Chemical Engineering.
- To prepare students for future career paths and life-long learning.
- To enable students to better contribute to national development in the context of globalisation.

The programme aims to achieve the following ***learning outcomes***:

- *Core*: Understanding of and ability to apply the science, mathematics and engineering knowledge fundamental to the discipline.
- *Breadth*: Basic competence in a range of technical areas relevant to chemical engineering.
- *Depth*: Be able to understand and apply in-depth knowledge of one or more specialisations within Chemical Engineering.
- *Design*: An enhanced ability to perform engineering design by the process of creative thinking, synthesis and integration of interdisciplinary knowledge.

4.1.8.1 Degree Requirements

From the AY2007/08 intake onwards, candidates must satisfy the following requirements for the degree of B.Tech. (Chemical Engineering):

- To complete a minimum of 120 MCs with a CAP ≥ 2.0 by taking modules in accordance with Table 4.1c.
- To satisfy any other additional requirements that may be prescribed by the Faculty of Engineering or the University.

Table 4.1c: Degree Requirements – B.Tech. (Chemical Engineering)

Degree Requirements	MCs
University Level Requirements (ULRs)	16
Singapore Studies	4
General Education Module	4
Breadth	8
Programme Requirements	92
Faculty Requirements (4 MCs)	
TG2415 Ethics in Engineering	4
Major Requirements - Essential Modules (76 MCs)	
CN1111E Chemical Engineering Principles	4
TC1401 Mathematics I	4
TC2401 Mathematics II	4
TC1422 Materials for Chemical Engineers	4
TC2421 Mathematics for Chemical Engineers	4
CN2116E Chemical Kinetics and Reactor Design	4
CN2121E Chemical Engineering Thermodynamics	4
CN2122E Fluid Mechanics	4
CN2125E Heat and Mass Transfer	4
CN3121E Process Dynamics and Control	4
CN3124E Particle Technology	4
CN3132E Separation Processes	5
CN3421E Process Modelling & Numerical Simulation	4
CN3135E Process Safety, Health and Environment	3
CN4118E B.Tech. Dissertation	10
CN4121E Design Project	10
Major Requirements - Elective Modules (12 MCs)	
Selected from the modules listed in Table 4.1d	12
Unrestricted Elective Modules (UEMs)	12
Total	120

Note:

+ A module with module code CNxxxxE is equivalent to the module CNxxxx/CNxxxxR offered to the full-time students. Subject to the approval from the Director of B.Tech. and the ChBE Department, a student may select a full-time equivalent module in place of any CNxxxxE module.

Table 4.1d: Electives for B.Tech. (Chemical Engineering)*

Module Code and Title		MCs
CN4203E	Polymer Engineering	4
CN4205E	Process Systems Engineering	4
CN4208E	Biochemical Engineering	4
CN4210E	Membrane Science and Engineering	4
CN4211E	Petrochemicals & Processing Technology	4
CN4215E	Food Technology and Engineering	4
CN4216E	Electronic Materials Science	4
CN4217E	Processing of Microelectronic Materials	4
CN4227E	Advanced Process Control	4
CN4231E	Downstream Processing of Biochemical and Pharmaceutical Products	4
CN4238E	Chemical & Biochemical Process Modeling	4
CN4240E	Unit Operations and Processes for Effluent Treatment	4
CN4246E	Chemical and Bio-Catalysis	4
CN4229E	Computer Aided Chemical Engineering	4

Note:

* Not all electives modules may be offered in any semester/year. An elective module may not be offered if there is not sufficient number of students opting for that module at any particular time. Subject to the approval from the Director of B.Tech., a student may select one Level-3000 or higher module from other programmes within the Faculty of Engineering.

4.1.8.2 Recommended Study Schedules

There are two intakes per academic year, the August Intake (Semester 1) and the January Intake (Semester 2). The recommended study schedules for a four-year candidature are shown in Table 4.1e and Table 4.1f. These recommended schedules are for those students whose work and other commitments allow them sufficient time to properly cope with their studies. Students are strongly advised to slow down if necessary so that they progress at their own comfortable pace.

Table 4.1e: Study schedule for August intake

Semester	4 Year Candidature
	Recommended Modules
Sem 1-1	University Level Requirements 1+ (4)
	TC1401 Mathematics I (4)

	CN1111E Chemical Engineering Principles (4)
Sem 1-2	University Level Requirements 2^+ (4)
	TC2401 Mathematics II (4)
	TC1422 Materials for Chemical Engineers (4)
Sem 1-3	University Level Requirements 3^+ (4)
Sem 2-1	TC2421 Mathematics for Chemical Engineers (4)
	CN2121E Chem. Eng Thermodynamics (4)
	CN2122E Fluid Mechanics (4)
Sem 2-2	CN2116E Chemical Kinetics & Reactor Design (4)
	CN2125E Heat and Mass Transfer (4)
	CN3124E Particle Technology (4)
Sem 2-3	CN3421E Process Modelling & Numerical Simulation (4)
Sem 3-1	CN3121E Process Dynamics & Control (4)
	CN3132E Separation Processes (5)
	CN3135E Process Safety, Health and Environment (3)
Sem 3-2	CN4118E* B.Tech. Dissertation
	Elective Module 1 (4)
	University Level Requirements 4^+ (4)
Sem 3-3	TG2415 Ethics in Engineering (4)
	CN4118E* B.Tech. Dissertation
Sem 4-1	CN4118E* B.Tech. Dissertation (10)
	Elective Module 2 (4)
	TG3001* Industrial Practice
	CN4121E* Design Project
Sem 4-2	CN4121E* Design Project
	Elective Module 3 (4)
	TG3001* Industrial Practice (12)
Sem 4-3	CN4121E* Design Project (10)
	TG3001* Industrial Practice (12)

Note:

+ 1) ULRs are University Level Requirements and can be a General Education Module, a Singapore Studies Module or a Breadth Module.
2) The number of Modular Credits (MC) of a module is denoted by the number in the bracket.

* These are modules stretching over more than one semester and the total number of MC will only be given upon completion of the module.

Table 4.1f: Study schedule for January intake

Semester	4 Year Candidature
	Recommended Modules
Sem 1-1	
Sem 1-2	TC1401 Mathematics I (4)
	TC1422 Materials for Chemical Engineers (4)
	CN1111E Chemical Engineering Principles (4)
Sem 1-3	TC2401 Mathematics II (4)
Sem 2-1	TC2421 Mathematics for Chemical Engineers (4)
	CN2121E Chem. Eng Thermodynamics (4)
	CN2122E Fluid Mechanics (4)
Sem 2-2	CN2116E Chemical Kinetics & Reactor Design (4)
	CN2125E Heat and Mass Transfer (4)
	CN3124E Particle Technology (4)
Sem 2-3	CN3421E Process Modelling & Numerical Simulation (4)
Sem 3-1	CN3121E Process Dynamics & Control (4)
	CN3132E Separation Processes (5)
	CN3135E Process Safety, Health and Environment (3)
Sem 3-2	CN4118E* BTech Dissertation
	Elective Module 1 (4)
	University Level Requirements 1+ (4)
Sem 3-3	TG2415 Ethics in Engineering (4)
	CN4118E* B.Tech. Dissertation
Sem 4-1	CN4118E* B.Tech. Dissertation (10)
	University Level Requirements 2+ (4)
	TG3001* Industrial Practice
	CN4121E* Design Project

Sem 4-2	CN4121E* Design Project
	Elective Module 2 (4)
	TG3001* Industrial Practice
Sem 4-3	CN4121E* Design Project (10)
	TG3001* Industrial Practice (12)
Sem 5-1	Elective Module 3 (4)
	University Level Requirements 3^{+} (4)
	University Level Requirements 4^{+} (4)

Note:

$^{+}$ 1) ULRs are University Level Requirements and can be a General Education Module, a Singapore Studies Module or a Breadth Module.
2) The number of Modular Credits (MC) of a module is denoted by the number in the bracket.

* These are modules stretching over more than one semester and the total number of MC will only be given upon completion of the module.

4.1.9 Bachelor of Technology (Electronics Engineering)

The Bachelor of Technology in Electronics Engineering, a part-time undergraduate programme offered by the ECE Department, aims to graduate professional electronic engineers who have a strong foundation in the relevant sciences and technology and who are able to contribute to society through innovation, enterprise and leadership. The B.Tech. (Electronics Engineering) programme admits working engineering personnel with a good polytechnic diploma. It provides these students with an education that enhances and complements their knowledge and experiences.

In order to prepare graduates for the rapidly evolving landscape of Electronics Engineering and to upgrade polytechnic graduates into learning engineers, the B.Tech. degree programme was specially designed to comprise essential modules, elective modules (both technical and non-technical), enrichment modules, and projects. The essential modules seek to equip students with a strong foundation in computing, mathematics, and in engineering fundamentals. The technical electives provide the breadth and depth in different areas of Electronics Engineering.

Design, which is the heart of engineering, is integrated through various project activities. Non-technical modules introduce students to methodologies of business and management. By providing graduates with a combination of broad-based fundamentals and specialised knowledge, the ECE Department strives to graduate versatile engineers who would be best positioned to lead in a rapidly changing and increasingly knowledge-based economy.

The Engineering Accreditation Board (EAB) of the Institution of Engineers Singapore (IES), has given full accreditation to the B.Tech. (Electronics Engineering) course for five years starting with students graduating in AY2008/2009. This means that all B.Tech. (Electronics Engineering) graduates for AY2008/2009 to AY2012/2013 will have their degrees fully accredited by EAB. The programme will undergo a re-accreditation exercise in 2013 which is expected to cover graduates up to AY2017/18. Singapore became a signatory of the Washington Accord in June 2006. As such, under the Washington Accord, these degrees will also be mutually recognized by other signatory countries which include the US, UK, Canada, Australia, and more than a dozen other countries.

The structure of the B.Tech. (Electronics Engineering) programme is designed to prepare engineers who will be:

technically competent to solve complex problems in electronics 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 and embrace global challenges and opportunities to make a positive impact in society

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

apply knowledge of mathematics, science and engineering to the solution of complex engineering problems;
design and conduct experiments, analyse, interpret data and synthesise valid conclusions;
design a system, component, or process, and synthesise solutions to achieve desired needs;
identify, formulate, research through relevant literature review, and solve engineering problems reaching substantiated conclusions;
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;
communicate effectively;
recognize the need for, and have the ability to engage in lifelong learning;
understand the impact of engineering solutions in a societal context and to be able to respond effectively to the needs for sustainable development;
function effectively within multidisciplinary teams and understand the fundamental precepts of effective project management;
understand professional, ethical and moral responsibility.

4.1.9.1 Degree Requirements

From the AY2007/08 intake onwards, candidates must satisfy the following requirements for the degree of B.Tech. (Electronics Engineering):

• To complete a minimum of 120 MCs with a CAP ≥ 2.0 by taking modules in accordance with Table 4.1g.

• To satisfy any other additional requirements that may be prescribed by the Faculty of Engineering or the University.

Table 4.1g: Degree Requirements – B.Tech. (Electronics Engineering)

Degree Requirements	MCs
University Level Requirements (ULRs)	16
Singapore Studies	4
General Education Module	4
Breadth	8
Programme Requirements	92
Faculty Requirements (4 MCs)	
TG2415 Ethics in Engineering	4
Major Requirements - Essential Modules (60 MCs)	
TG1401 Engineering Mathematics I	4
TE2002 Engineering Mathematics II	4
TE2003 Advanced Mathematics for Engineers	4
TE2101 Programming Methodology	4
EE1001E Emerging Technologies in Electrical Engineering	4
EE2011E Engineering Electromagnetics	4

EE2020E Digital Fundamentals	4
EE2021E Devices & Circuits	4
EE2023E Signals & Systems	4
EE2024E Programming for Computer Interfaces	4
EE2031E Circuit and Systems Design Lab	2
EE2032E Signals and Communications Design Lab	2
EE3031E Innovation & Enterprise I	4
TE4001 B.Tech. Dissertation	12
Major Requirements - Elective Modules (28 MCs)	
Selected from the modules listed in Table 4.1h	28
Unrestricted Elective MODULES (UEMs)	12
Total	120

Note:

+ A module with module code EExxxxE is equivalent to the module EExxxx offered to the full-time students. Subject to the approval from the Director of B.Tech. and the ECE Department, a student may select a full-time equivalent module in place of any EExxxxE module.

Table 4.1h: Electives for B.Tech. (Electronics Engineering)*

Module Code and Title	MCs
Communications	
EE3104E Introduction to RF and Microwave Systems & Circuits	4
EE3131E Communication Systems	4
EE4101E RF Communications	4
EE4112E HF Techniques	4
EE4113E Digital Communications and Coding	4
Computer Engineering	
TE3201 Software Engineering	4
EE3204E Computer Communication Networks I	4
EE3206E Introduction to Computer Vision and Image Processing	4
EE3207E Computer Architecture	4
EE3208E Embedded Computer Systems Design	4

EE4210E Computer Communication Networks II	4
EE4214E Real time Embedded Systems	4
Microelectronics	
EE3408E Integrated Analog Design	4
EE3431E Microelectronics Materials and Devices	4
EE4408E Silicon Device Reliability	4
EE4411E Silicon Processing Technology	4
EE4412E Technology and Modelling of Silicon Transistors	4
EE4415E Integrated Digital Design	4
General	
IE2130E Quality Engineering I	4
EE3302E Industrial Control Systems	4
EE3331E Feedback Control Systems	4
EE3407E Analog Electronics	4
EE3501E Power Electronics	4
EE4305E Introduction to Fuzzy/Neural Systems	4
TE3801 Robust Design of Electronic Circuits	4
ME4245E Robot Kinematics, Dynamics and Control	4

Note:

* Not all electives modules may be offered in any semester/ year. An elective module may not be offered if there is not sufficient number of students opting for that module at any particular time. Unless exemption is obtained from the Director of B.Tech, a student must read at least three Level-4000 electives and three electives from the following list (EE3104E, EE3131E, EE3331E, EE3431E, EE3408E, EE3501E and TE3201). In addition, subject to the approval from the Director of B.Tech., a student may select up to two Level-3000 or higher modules from other programmes within the Faculty of Engineering.

4.1.9.2 Recommended Study Schedules

There are two intakes per academic year, the August Intake (Semester 1) and the January Intake (Semester 2). The recommended study schedules for a four-year candidature are shown in Table 4.1i and Table 4.1j respectively. These recommended schedules are for those students whose work and other commitments allow them sufficient time to properly cope with their studies. Students are strongly advised to slow down if necessary so that they progress at their own comfortable pace.

Table 4.1i: Study schedule for August intake

Semester	4 Year Candidature
	Recommended Modules
	University Level Requirements 1^{+} (4)

Sem 1-1	TG1401 Engineering Mathematics I (4)
	EE1001E Emerging Technologies in EE (4)
Sem 1-2	TE2002 Engineering Mathematics II (4)
	EE2020E Digital Fundamentals (4)
	TE2101 Programming Methodology (4)
Sem 1-3	University Level Requirements 2^+ (4)
Sem 2-1	TE2003 Advanced Mathematics for Engineers (4)
	EE2024E Programming for Computer Interfaces (4)
	EE2023E Signals & Systems (4)
Sem 2-2	EE2011E Engineering Electromagnetics (4)
	Elective 1 (4)
	EE2021E Devices & Circuits (4)
Sem 2-3	TG2415 Ethics in Engineering (4) / University Level Requirements 3^+ (4)
	EE2031E Circuits and Systems Design Lab (2)
Sem 3-1	Elective 2 (4)
	Elective 3 (4)
	TG3001* Industrial Practice
	University Level Requirements 4^+ (4)
Sem 3-2	EE3031E Innovation & Enterprise I (4)
	Elective 4 (4)
	Elective 5 (4)
	TG3001* Industrial Practice
Sem 3-3	TG2415 Ethics in Engineering (4)/ University Level Requirements 4^+ (4)
	EE2032E Signals and Communications Design Lab (2)
	TG3001* Industrial Practice (12)
Sem 4-1	Elective 6 (4)
	TE4001* B.Tech. Dissertation
Sem 4-2	Elective 7 (4)
	TE4001* B.Tech. Dissertation (12)

Note:

+ 1) ULRs are University Level Requirements and can be a General Education Module, a Singapore Studies Module or a Breadth Module.
2) The number of Modular Credits (MC) of a module is denoted by the number in the bracket.

* These are modules stretching over more than one semester and the total number of MC will only be given upon completion of the module.

Table 4.1j: Study schedule for January intake

Semester	4 Year Candidature
	Recommended Modules
Sem 1-1	
Sem 1-2	TG1401 Engineering Mathematics I (4)
	EE2020E Digital Fundamentals (4)
	TE2101 Programming Methodology (4)
Sem 1-3	University Level Requirements 1+ (4)
Sem 2-1	TE2002 Engineering Mathematics II (4)
	EE2024E Programming for Computer Interfaces (4)
	EE1001E Emerging Technologies in EE (4)
Sem 2-2	TE2003 Advanced Mathematics for Engineers (4)
	EE2011E Engineering Electromagnetics (4)
	EE2021E Devices & Circuits (4)
Sem 2-3	University Level Requirements 2+ (4)
	EE2031E Circuits and Systems Design Lab (2)
Sem 3-1	EE2023E Signals and Systems (4)
	Elective 1 (4)
	Elective 2 (4)
	TG3001* Industrial Practice
Sem 3-2	EE3031E Innovation & Enterprise I (4)
	Elective 3 (4)
	Elective 4 (4)
	TG3001* Industrial Practice
Sem 3-3	TG2415 Ethics in Engineering (4)/ University Level Requirements 3+ (4)
	EE2032E Signals and Communications Design Lab (2)
	TG3001* Industrial Practice (12)

Sem 4-1	Elective 5 (4)
	Elective 6 (4)
	University Level Requirements 4^+ (4)
Sem 4-2	Elective 7 (4)
	TE4001* B.Tech. Dissertation
Sem 4-3	TG2415 Ethics in Engineering (4)/ University Level Requirements 4^+ (4)
	TE4001* B.Tech. Dissertation
Sem 5-1	TE4001* B.Tech. Dissertation (12)

Note:

$^+$ 1) ULRs are University Level Requirements and can be a General Education Module, a Singapore Studies Module or a Breadth Module.
2) The number of Modular Credits (MC) of a module is denoted by the number in the bracket.

* These are modules stretching over more than one semester and the total number of MC will only be given upon completion of the module.

4.1.10 Bachelor of Technology (Industrial & Management Engineering)

The Bachelor of Technology in Industrial & Management Engineering, a part-time undergraduate programme offered by the ISE Department, aims to graduate professional industrial and management engineers who have a strong foundation in the relevant modelling and methodological expertise together with a systems mindset, who can contribute to society through innovation, enterprise and leadership. The B.Tech. (Industrial & Management Engineering) programme admits working engineering personnel with a good polytechnic diploma. It provides these students with an education that enhances and complements their knowledge and experiences. This programme was launched in August 2007. Accreditation from the Engineering Accreditation Board of Singapore will be sought in due course.

In order to prepare graduates for the rapidly evolving landscape of Industrial and Management Engineering and to upgrade polytechnic graduates into learning engineers, the B.Tech. degree programme was specially designed to comprise essential modules, elective modules (both technical and non technical), enrichment modules, and projects. The essential modules seek to equip students with a strong foundation in mathematics, probability and statistics in engineering fundamentals. The technical electives provide the breadth and depth in different areas of Industrial and Management Engineering.

Design, which is the heart of engineering, is integrated through various project activities. Non-technical modules introduce students to methodologies of business and management. By providing graduates with a combination of broad-based fundamentals and specialised knowledge, the ISE Department strives to graduate versatile engineers who would be best positioned to lead in a rapidly changing and increasingly knowledge-based economy.

The structure of the B.Tech. (Industrial & Management Engineering) programme is designed to meet the following programme objectives:

To impart fundamental knowledge and skill sets required in the Industrial and Management Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial and Management Engineering.
To produce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.

To cultivate the practices of independent learning on the part of the students that will prepare them to function effectively for diverse careers and life-long learning.
To enable students to understand their role as engineers and their impact to society in the national and global context.

The B.Tech. (Industrial & Management Engineering) programme aims to achieve the following learning outcomes:

Core: Understanding of and ability to apply the mathematical and statistical concepts, and the engineering knowledge fundamental to the discipline.
Breadth:Basic competence in a range of technical areas relevant to Industrial and Management Engineering.
Depth: Be able to understand and apply in-depth knowledge of one or more specialisations within Industrial and Management Engineering.
Design:An enhanced ability to perform engineering design by the process of creative thinking, synthesis and integration of interdisciplinary knowledge.

4.1.10.1 Degree Requirements

From AY2007/08 intake onwards, candidates are required to meet the following requirements for the degree of B.Tech. (Industrial & Management Engineering):

- To complete a minimum of 121 MCs with a CAP ≥ 2.0 by taking modules in accordance with Table 4.1k.
- To satisfy any other additional requirements that may be prescribed by the Faculty of Engineering or the University.

Table 4.1k: Degree Requirements – B.Tech. (Industrial & Management Engineering)

Degree Requirements	MCs
University Level Requirements (ULrs)	16
Singapore Studies	4
General Education Module	4
Breadth	8
Programme Requirements	93
Faculty Requirements (4 MCs)	
TG2415 Ethics in Engineering	4
Major Requirements - Essential Modules (73 MCs)	
TG1401 Engineering Mathematics I	4
TE2101 Programming Methodology	4
IE2010E Introduction to Industrial Systems	4
IE2120E Probability and Statistics	4
IE2100E Probability Models with Applications	4
IE2110E Operations Research I	4
IE2130E Quality Engineering I	4
IE2140E Engineering Economy	4
IE2150E Human Factors Engineering	4

IE3100E Systems Design Project	8
IE3101E Statistics for Engineering Applications	4
IE3110E Simulation	5
IE4240E Project Management	4
IE4100E B.Tech. Dissertation	12
IE3010E Systems Thinking and Design	4
Major Requirements - Elective Modules (16 MCs)	
Selected from the modules listed in Table 4.1l	16
UNRESTRICTED Elective MODULES (UEMs)	12
Total	121

Note:

+ A module with module code IExxxxE is equivalent to the module IExxxx offered to the full-time students. Subject to the approval from the Director of B.Tech. and the ISE Department, a student may select a full-time equivalent module in place of any IExxxxE module.

Table 4.1l: Electives for B.Tech. (Industrial & Management Engineering)*

Module Code and Title	MCs
IE4220E Supply Chain Modelling	4
IE4230E Quality Engineering II	4
IE4242E Cost Analysis and Management	4
IE5108 Facility Layout and Location	4
IE5121 Quality Planning and Management	4
IE5203 Decision Analysis	4
IE5301 Human Factors in Engineering and Design	4
IE4229E Selected Topics in Logistics	4
IE4239E Selected Topics in Quality Engineering	4
IE4249E Selected Topics in Engineering Management	4
IE4259E Selected Topics in Systems Engineering	4
IE4299E Selected Topics in Industrial Engineering	4
TM4209 Management of New Product Development	4

Note:

* Not all electives modules may be offered in any semester/ year. An elective module may not be

offered if there is not sufficient number of students opting for that module at any particular time. Subject to the approval from the Director of B.Tech., a student may select one Level-3000 or higher module from other programmes within the Faculty of Engineering.

4.1.10.2 Recommended Study Schedules

There are two intakes per academic year, the August Intake (Semester 1) and the January Intake (Semester 2). The recommended study schedules for a four-year candidature are shown in Table 4.1m and Table 4.1n respectively. These recommended schedules are for those students whose work and other commitments allow them sufficient time to properly cope with their studies. Students are strongly advised to slow down if necessary so that they progress at their own comfortable pace.

Table 4.1m: Study schedule for August intake

Semester	4 Year Candidature
	Recommended Modules
Sem 1-1	TG1401 Engineering Mathematics I (4)
	TE2101 Programming Methodology (4)
	IE2010E Introduction to Industrial Systems (4)
Sem 1-2	IE2150E Human Factors Engineering (4)
	IE2140E Engineering Economy (4)
	IE2130E Quality Engineering I (4)
Sem 1-3	University Level Requirements 1^+ (4)
	University Level Requirements 2^+ (4)
Sem 2-1	IE2120E Probability and Statistics (4)
	IE2110E Operations Research I (4)
	IE3110E Simulation (5)
Sem 2-2	IE2100E Probability Models with Applications (4)
	IE3010E Systems Thinking and Design (4)
	TG3001* Industrial Practice
Sem 2-3	University Level Requirements 3^+ (4)
	TG3001* Industrial Practice
Sem 3-1	IE3101E Statistics for Engineering Applications (4)
	IE3100E* Systems Design Project
	TG3001* Industrial Practice (12)
Sem 3-2	Elective 1 (4)
	TG2415 Ethics in Engineering (4)
	IE3100E* Systems Design Project (8)

Sem 3-3	University Level Requirements 4+ (4)
	Elective 2 (4)
Sem 4-1	IE4240E Project Management (4)
	Elective 3 (4)
	IE4100E* B.Tech. Dissertation
Sem 4-2	Elective 4 (4)
	IE4100E* B.Tech. Dissertation (12)

Note:

+ 1) ULRs are University Level Requirements and can be a General Education Module, a Singapore Studies Module or a Breadth Module.
2) The number of Modular Credits (MC) of a module is denoted by the number in the bracket.

* These are modules stretching over more than one semester and the total number of MC will only be given upon completion of the module.

Table 4.1n: Study schedule for January intake

Semester	4 Year Candidature
	Recommended Modules
Sem 1-1	
Sem 1-2	TG1401 Engineering Mathematics I (4)
	IE2140E Engineering Economy (4)
	IE2130E Quality Engineering I (4)
Sem 1-3	University Level Requirements 1+ (4)
	University Level Requirements 2+ (4)
Sem 2-1	TE2101 Programming Methodology (4)
	IE2010E Introduction to Industrial Systems (4)
	IE2120E Probability and Statistics (4)
Sem 2-2	IE2100E Probability Models with Applications (4)
	IE2150E Human Factors Engineering (4)
	IE3010E Systems Thinking and Design (4)
Sem 2-3	University Level Requirements 3+ (4)
	University Level Requirements ~~3~~ 4+ (4)

Sem 3-1	IE2110E Operations Research 1 (4)
	IE3110E Simulation (5)
	IE3101E Statistics for Engineering Applications (4)
Sem 3-2	IE3100E* Systems Design Project
	Elective 1 (4)
	TG3001* Industrial Practice
Sem 3-3	IE3100E* Systems Design Project
	TG3001* Industrial Practice
Sem 4-1	IE4240E Project Management (4)
	IE4100E* B.Tech. Dissertation
	TG3001* Industrial Practice (12)
	IE3100E* Systems Design Project (8)
	Elective 2 (4)
Sem 4-2	TG2415 Ethics in Engineering (4)
	IE4100E* B.Tech. Dissertation (12)
	Elective 3 (4)
Sem 4-3	Elective 4 (4)

Note:

+ 1) ULRs are University Level Requirements and can be a General Education Module, a Singapore Studies Module or a Breadth Module.
2) The number of Modular Credits (MC) of a module is denoted by the number in the bracket.

* These are modules stretching over more than one semester and the total number of MC will only be given upon completion of the module.

4.1.11 Bachelor of Technology (Mechanical/Manufacturing Engineering)

The Bachelor of Technology in Mechanical Engineering and Manufacturing Engineering [B.Tech. (Mechanical/ Manufacturing Engineering)] programmes offered by the Department of Mechanical Engineering follow closely the academic curriculum of the B.Eng. course. The Engineering Accreditation Board (EAB) of the Institution of Engineers Singapore (IES), has given full accreditation to the B.Tech. (Mechanical Engineering) and B.Tech. (Manufacturing Engineering) courses for five years starting with students graduating in AY2008/2009. This means that all B.Tech. (Mechanical/Manufacturing Engineering) graduates for AY2008/2009 to AY2012/2013 will have their degrees fully accredited by EAB. Singapore became a signatory of the Washington Accord in June 2006. As such, under the Washington Accord, these degrees will also be mutually recognized by other signatory countries which include the US, UK, Canada, Australia, and more than a dozen other countries.

The curriculum is designed with the following educational programme objectives:

- To provide the necessary foundation for entry level engineering positions or further engineering

degrees by rigorous instruction in the engineering sciences and extensive laboratory and design experience.

- To offer students the opportunity to deepen their technical understanding in a particular subject through a programme of related technical electives, or to obtain a broader education in engineering by a flexible choice of technical and free electives.

- To prepare graduates who will create new ways to meet society's needs through the application of the fundamentals of engineering science to solve practical problems using design, analysis, and synthesis of components, systems, and tools, and through basic and applied research.

- To inspire graduates who will have the curiosity, ability and desire for life-long learning, and to instill in them the ability of critical thinking and the self-confidence to adapt to rapid and major changes.

- To ensure that students are exposed to the social sciences and humanities so that they understand the necessities for professionalism, ethical responsibilities, and the need to function effectively in multidisciplinary and multicultural teams.

- To provide an integrated introduction to team work, communications, ethics, social and environmental awareness needed to prepare the graduates for successful careers and leadership positions.

Programme objectives are achieved through a number of learning outcomes. Outcomes are specific attributes in knowledge, skills and attitudes attained by the students at the end of the programme. On completion of the B.Tech. programme the graduate will have achieve the following:

- Breadth-Fundamentals: Understanding of and ability to apply the basic science, the mathematics and the basic mechanical engineering sciences.

- Breadth-Core: Basic competence in a range of technical areas relevant to mechanical engineering. Ability to design and conduct experiments, analyse, interpret data and synthesise valid conclusions.

- Depth: To be able to understand and apply in-depth knowledge of one or more area of specializations within mechanical engineering. In-depth technical competence in at least one engineering discipline.

- Engineering Practice: Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

- Desig*n*: Ability to perform engineering design and system design by the process of analysis, synthesis and integration of knowledge in Mechanical Engineering within constraints posed by economic, environmental, social and safety considerations.

- System Approach: Ability to use a system approach to identify, formulate, and solve engineering problems involving complexity and uncertainty.

- Professional Relations and Team Work: Ability to work with others, in professional and social settings. Ability to function effectively within multi-disciplinary and multicultural teams and understand the fundamental precepts of effective project management both as a member and leader of such teams.

- Professional ethics: A commitment to professional and ethical responsibility. Ability to recognize and appreciate the importance of ethical standards and moral responsibility in professional work.

- Critical thinking: Ability to apply critical thinking to both technical and non-technical issues through independent thought and informed judgment. The graduate will have the ability of critical thinking and the self-confidence to adapt to rapid and major changes.

- Sustainability and Awareness: Ability to apply the principles of sustainability in engineering practice. Understand the impact of engineering solutions in societal context and to be able to respond effectively to the needs for sustainable development. Awareness of their engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints.

- Life-Long Learning: Graduates will have the curiosity, ability and desire for life-long learning,

- Communications: Ability to communicate effectively both within the technical domain and within the community at large. Ability to communicate effectively by listening, writing, and elocution, through multimedia.

- General education: Intellectual broadening through an exposure to information, knowledge and modes of inquiry which are beyond the engineering discipline.

4.1.11.1 Degree Requirements

From the AY2007/08 intake onwards, candidates must satisfy the following requirements for the degree of B.Tech. (Mechanical/Manufacturing Engineering):

- To complete a minimum of 120 MCs with a CAP ≥ 2.0 by taking modules in accordance with Table 4.1o.

- To satisfy any other additional requirements that may be prescribed by the Faculty of Engineering or

the University.

Table 4.1o: Degree Requirements - B.Tech. (Mechanical/Manufacturing Engineering)+

Degree Requirements	MCs
University Level Requirements (ulrs)	16
Singapore Studies	4
General Education Module	4
Breadth	8
Programme Requirements	92
Faculty Requirements (4 MCs)	
TG2415 Ethics in Engineering	4
Major Requirements – Essential Modules (68 MCs)	
TG1401 Engineering Mathematics I	4
TM2401 Engineering Mathematics II	4
ME2114E Mechanics of Materials II	3*
ME2121E Engineering Thermodynamics	3*
ME2134E Fluid Mechanics I	4
ME2135E Fluid Mechanics II	4
ME2142E Feedback Control Systems	4
ME2143E Sensors and Actuators	4
ME2151E Principles of Mechanical Engineering Materials	4
ME3112E Mechanics of Machines	4
ME3122E Heat Transfer	4
ME3162E Manufacturing Processes	4
ME2101E Fundamentals of Mechanical Design	4
TM3101^ Mechanical Systems Design	6
TM4101 B.Tech. Dissertation	12
Major Requirements – Elective Modules (20 MCs)	
Selected from the modules listed in Table 4.1p	20
Unrestricted Electives MODULES (UEMs)	12
Total	120

Note:

+ A module with module code MExxxxE is equivalent to the module MExxxx offered to full-time students. Subject to the approval of the Director of B.Tech., a student may select a full-time equivalent module in place of any MExxxxE module.

* 3 MCs as offered in B.Eng.

^ One-semester 6 MC module involving a design and built project.

Table 4.1p: Electives for B.Tech. (Mechanical/Manufacturing Engineering)*

Module Code and Title		MCs
ME3291E	Numerical Methods in Engineering^	4
ME3211E	Mechanics of Solids^	4
ME3251E	Materials for Engineers^	4
ME3241E	Microprocessor Applications+^	4
ME3242E	Industrial Automation+	4
ME3261E	Computer Aided Design and Manufacturing+	4
ME3263E	Design for Manufacture and Assembly+	4
ME4213E	Vibration Theory and Applications^	4
ME4223E	Thermal Environmental Engineering^	4
ME4225E	Industrial Heat Transfer^	4
ME4234E	Experimental Methods in Fluid Mechanics^	4
ME4245E	Robot Kinematics, Dynamics and Control^	4
ME4251E	Thermal Engineering of Materials^	4
ME4254E	Materials in Engineering Design^	4
ME4261E	Tool Engineering+	4
ME4262E	Automation in Manufacturing+^	4
ME4283E	Micro fabrication Processes+	4
IE2010E	Introduction to Industrial Systems+	4
IE2130E	Quality Engineering I+	4
TM4209	Management of New Product Development+	4
TM4263	Manufacturing Simulation & Data Communication+	4

Note:

Not all elective modules may be offered in any semester/year. An elective module may not be offered if there is not sufficient number of students opting for that module at any particular time.

* Subject to the approval from the Director of B.Tech., a student may select up to two Level-3000 or

higher modules from other programmes within the Faculty of Engineering.

+ Manufacturing Engg degree (student to do three + out of total five electives).

^ Mechanical Engg degree (student to do three ^ out of total five electives).

4.1.11.2 Recommended Study Schedules

There are two intakes per academic year, the August Intake (Semester 1) and the January Intake (Semester 2). The recommended study schedules for a four-year candidature are shown in Table 4.1q and Table 4.1r respectively. These recommended schedules are for those students whose work and other commitments allow them sufficient time to properly cope with their studies. Students are strongly advised to slow down if necessary so that they progress at their own comfortable pace.

Table 4.1q: Study schedule for August intake

Semester	4 Year Candidature
	Recommended Modules
Sem 1-1	TG1401 Engineering Mathematics I (4)
	ME2121E Engineering Thermodynamics (3)
	ME2151E Principles of Mechanical Engineering Materials (4)
Sem 1-2	TM2401 Engineering Mathematics II (4)
	ME2114E Mechanics of Materials II (3)
	ME2101E Fundamentals of Mechanical Design (4)
Sem 1-3	University Level Requirements 1^{+} (4)
	University Level Requirements 2^{+} (4)
Sem 2-1	ME2134E Fluid Mechanics I (4)
	ME3112E Mechanics of Machines (4)
	ME3162E Manufacturing Processes (4)
Sem 2-2	ME2143E Sensors and Actuators (4)
	ME2135E Fluid Mechanics II (4)
	TG2415 Ethics in Engineering (4)
	TG3001* Industrial Practice
Sem 2-3	University Level Requirements 3^{+} (4)
	TG3001* Industrial Practice
Sem 3-1	ME2142E Feedback Control Systems (4)
	ME3122E Heat Transfer (4)
	TG3001* Industrial Practice (12)
	TM3101 Mechanical Systems Design (6)

Sem 3-2	Elective 1 (4)
	Elective 2 (4)
Sem 3-3	University Level Requirements 4+ (4)
Sem 4-1	Elective 3 (4)
	Elective 4 (4)
	TM4101* B.Tech. Dissertation
Sem 4-2	Elective 5 (4)
	TM4101* B.Tech. Dissertation (12)

Note:

+ 1) ULRs are University Level Requirements and can be a General Education Module, a Singapore Studies Module or a Breadth Module.
2) The number of Modular Credits (MC) of a module is denoted by the number in the bracket.

* These are modules stretching over more than one semester and the total number of MC will only be given upon completion of the module.

Table 4.1r: Study schedule for January intake

Semester	4 Year Candidature
	Recommended Modules
Sem 1-1	
Sem 1-2	TG1401 Engineering Mathematics I (4)
	ME2114E Mechanics of Materials II (3)
	ME2101E Fundamentals of Mechanical Design (4)
Sem 1-3	University Level Requirements 1+ (4)
	University Level Requirements 2+ (4)
Sem 2-1	TM2401 Engineering Mathematics II (4)
	ME2121E Engineering Thermodynamics (3)
	ME2134E Fluid Mechanics I (4)
Sem 2-2	ME2143E Sensors and Actuators (4)
	ME2135E Fluid Mechanics II (4)
	TM3101 Mechanical Systems Design (6)
Sem 2-3	University Level Requirements 3+ (4)

Sem 3-1	ME2151E Principles of Mechanical Engineering Materials (4)
	ME3112E Mechanics of Machines (4)
	ME3162E Manufacturing Processes (4)
	TG3001* Industrial Practice
Sem 3-2	Elective 1 (4)
	Elective 2 (4)
	TG2415 Ethics in Engineering (4)
	TG3001* Industrial Practice
Sem 3-3	University Level Requirements 4+ (4)
	TG3001* Industrial Practice (12)
Sem 4-1	ME2142E Feedback Control Systems (4)
	ME3122E Heat Transfer (4)
	Elective 3 (4)
Sem 4-2	Elective 4 (4)
	TM4101* B.Tech. Dissertation
	Elective 5 (4)
Sem 4-3	TM4101* B.Tech. Dissertation
Sem 5-1	TM4101* B.Tech. Dissertation (12)

Note:

+ 1) ULRs are University Level Requirements and can be a General Education Module, a Singapore Studies Module or a Breadth Module.
2) The number of Modular Credits (MC) of a module is denoted by the number in the bracket.

* These are modules stretching over more than one semester and the total number of MC will only be given upon completion of the module.

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Graduate Education

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The NUS Faculty of Engineering has about 300 distinguished faculty members and a graduate student enrolment of some 2,400. 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 mindset 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 University of Illinois at Urbana Champaign (UIUC); Massachusetts Institute of Technology (MIT); US Naval Postgraduate School (NPS); Monterey; French Grandes Écoles; Technische Universiteit Eindhoven (TU/e), Tsinghua University; Australian National University (ANU) and Indian Institute of Technology, Bombay (IITB).

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.

5.1 Research Programmes

5.1.1 Doctor of Philosophy (Ph.D.) and Master of Engineering (M.Eng.)

5.1.1.1 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:

- Bioengineering
- Chemical & Biomolecular Engineering
- Civil and Environmental Engineering
- Electrical & Computer Engineering
- Engineering & Technology Management
- Industrial & Systems Engineering
- Materials Science & Engineering
- Mechanical Engineering

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

NUS Research Institutes/Centres:

- NUS Nanoscience and Nanotechnology Initiative (NUSNNI)
- 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)

5.1.1.2 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 Ph.D. students and 16 MCs (typically four graduate modules) for M.Eng. students. Students of some departments may be required to read additional modules. For example, Ph.D. 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 requirement for research programme in Dept of Electrical and Computer Engineering only

Ph.D coursework requirements :

EE6990 Research Attachment
3 core modules
3 approved level 6000 modules
EE6999 Doctoral Seminars

M.Eng coursework requirements :

2 core modules
2 approved level 6000 modules
EE5999 Doctoral Seminars

Compulsory ES5101 Technical Communication for Engineers for both Ph.D and M.Eng programs.

Based on the research area the student is assigned, the core and level 6000 module requirements in that area will apply.

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.

Ph.D. Qualifying Examination

A doctoral candidate must complete a prescribed set of modules before proceeding to the Ph.D. Qualifying examination (QE). The QE comprises a comprehensive examination and an oral defence of the Ph.D. thesis proposal. The comprehensive examination tests the general competence of the candidate in his/her discipline(s), while the oral defence 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 Ph.D. 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 Ph.D. 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 Ph.D. thesis. Doctoral students are required to pass their oral defence thesis examination before they are conferred their doctoral degree.

5.1.2 NUS-IITM Joint Doctor of Philosophy (Ph.D.) Programme

5.1.2.1 Overview

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

5.1.2.2 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 IITM, 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 IITM.

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 Ph.D. (NUS-IITM) or Ph.D. (IITM-NUS) with his/her home university mentioned first.

5.1.3 NUS-Imperial College Joint Doctor of Philosophy (Ph.D.) Programme

5.1.3.1 Overview

The Joint Doctoral programme is offered by NUS and Imperial College London and it is for students who would like to benefit from the expertise of the two academic research groups with complementary strengths of each university. The programme admitted its first cohort of students in August 2010.

5.1.3.2 Degree Requirements

Coursework element

The prevailing requirements for coursework/education plan for each student of each university shall apply. Candidates would spend at least half of their candidature each at NUS and Imperial, either reading modules and/or undertaking research.

Joint Supervision

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

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 Ph.D. (NUS-Imperial) or Ph.D. (Imperial-NUS) with his/her home university mentioned first.

5.1.4 NUS-Supelec Joint Doctor of Philosophy (Ph.D.) Programme

5.1.4.1 Overview

A joint Ph.D. degree programme between NUS and Supelec (École Supérieure d'Électricite) was launched in August 2004. SUPELEC is one of France's prestigious Grandes Écoles.

Five key research areas have been identified for the initial phase of the joint Doctoral programme – infocomms, microwaves and radio frequencies, microelectronics, power systems, and control. 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.

SUPELEC is one of the partners on 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. For the initial phase, NUS will select suitable candidates from their current pool of Ph.D. students. In future, students who have completed their Bachelors degree (with at least a Second Class Upper Honours) and students upgrading from Master's level research programmes will also be considered. For SUPELEC, students who have completed their Master's degree will be considered.

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

5.1.4.2 Degree Requirements

The prevailing requirements for Ph.D. students of each university shall apply (see section 5.1.1.2).

5.1.5 NUS-TU/e Joint Doctor of Philosophy (Ph.D.) Programme

5.1.5.1 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.

5.1.5.2 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 Ph.D. degree. Candidates would spend at least two semesters of their candidature each at NUS and TU/e, 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.

5.1.6 NUS-UIUC Joint Doctor of Philosophy (Ph.D.) Programme (Chemical Engineering)

5.1.6.1 Overview

In this four-year programme, each student spends an approximately equal proportion of time in NUS and the University of Illinois at Urbana Champaign (UIUC), USA, reading modules and/or undertaking research. The programme taps on the research strengths of both universities in Chemical & Biomolecular Engineering. Through their exposure to different learning and research environments, the programme also aims to enrich the students' educational experience, help them develop both adaptability and a perspective to excel, thereby equipping them for leadership roles in a competitive global environment.

5.1.6.2 Degree Requirements

For continuation, candidates must not obtain grades (for coursework) below Grade C+ twice.

Graduation

The graduation requirements include the following:

- A minimum average grade of B for coursework of all eight modules, comprising four postgraduate Chemical Engineering modules from NUS and/or UIUC and a coherent programme of four additional postgraduate modules.
- A satisfactory grade for the graduate seminar module CN6999 PG Seminar module at NUS and CHBE 565 Chemical Engineering Seminar at UIUC.

Pass both the Ph.D. Comprehensive Qualifying Examination and the Oral Qualifying Examination which can be taken either at NUS or UIUC.

Satisfactory thesis — The material for Ph.D. thesis constitutes results derived from original research pursued under faculty guidance. All students in the programme are jointly supervised by NUS and UIUC faculty members.

Pass the Ph.D. Oral Defense exam (the oral defense may be conducted via videoconferencing).

5.2 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 Master of Science (M.Sc.) 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 M.Sc. 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.

5.2.1 Master of Science (Chemical Engineering)

5.2.1.1 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.

5.2.1.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.0 (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 M.Sc. (Chem.Eng.) 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
CN5115	Distillation Dynamics and Control
CN5121	Electrochemical Systems and Methods
CN5131	Colloids and Surfaces
CN5152	Chiral Sciences and Technologies
CN5161	Polymer Processing Engineering
CN5162	Advanced Polymeric Materials
CN5172	Biochemical Engineering
CN5173	Downstream Processing of Biochemical & Pharmaceutical Products
CN5174	Biopharmaceutical Manufacturing
CN5181	Computer Aided Chemical Engineering
CN5183	Multivariable Controller Design
CN5185	Batch Process Engineering
CN5186	Design and Operation of Process Networks
CN5191	Project Engineering
CN5193	Instrumental Methods of Analysis
CN5222	Pharmaceuticals and Fine Chemicals
CN5241	Viscoelastic Fluids
CN5251	Membrane Science and Technology
CN5371	Special Topics in Biochemical Engineering and Bioseparations
CN5391	Selected Topics in Advanced Chemical Engineering – I
CN5392	Selected Topics in Advanced Chemical Engineering - II

CN6132	Advanced Statistical Thermodynamics for Chemical Engineers
CN6143	Transport and Reaction in Heterogeneous Media
CN6152	Principles of Adsorption and Adsorption Processes
CN6162	Advanced Polymeric Materials
CN6163	Inorganic Nanomaterials for Sustainability
CN6181	Chemical & Biochemical Process Modelling
CN6222	Pharmaceuticals and Fine Chemicals
CN6251	Membrane Science and Technology

Group 2

ESE5602	Environmental Management Systems
ESE5202	Air Pollution Control Technology
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.

5.2.2 Master of Science (Civil Engineering)

5.2.2.1 Overview

The M.Sc. (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.

5.2.2.2 Degree Requirements

To be awarded with the M.Sc. (Civil Engineering) degree with or without specialisation, a candidate must successfully complete a programme of study consisting of at least 10 modules equivalent to 40 Modular Credits (MCs). At least 30 MCs must be taken from Level-5000 and Level-6000 modules. In addition, a student must obtain a minimum CAP of 3.0 (Grade B-) for the best modules equivalent to 40 MCs (inclusive of compulsory modules, where required).

Specialisation in Structural Engineering

Candidates who wish to obtain the M.Sc. (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 elective modules* (20 MCs) to satisfy the degree requirements may be selected from Level-5000 and Level-6000 modules offered by the Department of Civil and Environmental Engineering. Modules taken outside the Department of Civil and Environmental Engineering are subject to general guidelines and the Department's approval.

Specialisation in Geotechnical Engineering

Candidates who wish to obtain the M.Sc. (CE) with specialisation in Geotechnical Engineering must pass *at least five* 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 Foundations
CE5108	Earth Retaining Structures

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 elective modules* (20 MCs) to satisfy the degree requirements may be selected from Level-5000 and Level-6000 modules offered by the Department of Civil and Environmental Engineering. Modules taken outside the Department of Civil and Environmental Engineering are subject to general guidelines and the Department's approval.

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 Engineering or his nominee.

In addition, he/she must complete *at least three* (12 MCs) of the following modules:

CE5207	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 elective modules* (8 MCs) to satisfy the degree requirements may be selected from Level-5000 and Level-6000 modules offered by the Department of Civil and Environmental Engineering, which also include the above mentioned modules. Modules taken outside the Department of Civil and Environmental Engineering are subject to general guidelines and the Department's approval.

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

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

5.2.3 Master of Science (Electrical Engineering)

5.2.3.1 Overview

The M.Sc. (Electrical Engineering) programme provides excellent opportunities for practicing 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, digital and wireless communications, intelligent control systems, electronic and optoelectronic materials and devices, silicon integrated circuits, microwaves and electromagnetics, and electrical energy systems. It is structured around lectures (conducted in the evening) and end-of-semester examinations.

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

- Automation and Control Engineering
- Communications Engineering
- Computer Engineering
- Microelectronics

Whether or not a specialisation is taken, a candidate may offer projects in lieu of graduate modules. Two types of projects are available: (1) an independent study module (equivalent to one graduate module, or 4 MCs), or (2) a technical project (equivalent to two graduate modules or 8 MCs).

5.2.3.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.0 (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.

Specialisation in Automation and Control Engineering

Compulsory Modules

EE5101R	Linear Systems

EE5103R	Computer Control Systems
MCH5206	Instrumentation and Sensors

Elective Modules for Specialization (at least 3 modules)

EE5102	Multivariable Control Systems OR
EE6102	Multivariable Control Systems (Advanced)
EE5104	Adaptive Control Systems OR
EE6104	Adaptive Control Systems (Advanced)
EE5106R	Advanced Robotics
EE5107	Optimal Control Systems OR
EE6107	Optimal Control Systems (Advanced)
EE6105	Non-linear Dynamics and Control
EE6701	Evolutionary Computation
EE5703R	Modeling and Control of Electrical Actuators

Other Recommended Elective Modules

EE5301	Adaptive Signal Processing
OR	OR
EE5137R	Stochastic Processes
EE5903	Real-Time Systems
EE5904R	Neural Networks
CN5115	Distillation Dynamics and Control
MCH5002	Applications of Mechatronics
MCH5003	Modeling of Mechatronic Systems
MCH5212	Factory Automation
ME5405	Machine Vision
ME5606	Intelligent Systems in Manufacturing

Specialisation in Communications Engineering

Compulsory Modules

EE5137R	Stochastic Processes
EE5139R	Communication Systems

Elective Modules for Specialization (at least 3 modules)

EE5131	Wireless Communications
EE5134	Optical Networks
EE5138R	Optimization for Communication Systems
EE5301	Adaptive Signal Processing
EE5303R	Microwave Electronics
EE5308R	Antenna Engineering

EE5401	Cellular Mobile Communications
EE5404	Satellite Communications
EE5831R	Electromagnetic Wave Theory
EE6135	Digital Communications

Other Recommended Elective Modules

EE5101R	Linear Systems

Specialisation in Computer Engineering

Compulsory Modules

EE5902R	Multiprocessor Systems
EE5903	Real-Time Systems

Elective Modules for Specialization (at least 3 modules)

EE4212	Computer Vision
EE4213	Image Processing
EE5201	Magnetic Recording Technology
EE5732	Real Media Design (New module in AY12/13)
EE5904R	Neural Networks
EE5907R	Pattern Recognition

Other Recommended Elective Modules

EE5101R	Linear Systems
EE5131	Wireless Communications
EE5134	Optical Networks
EE5137R	Stochastic Processes
EE5138R	Optimization for Communication Systems
EE5139R	Communication Systems
EE5401	Cellular Mobile Communications
EE5518R	VLSI Digital Circuit Design
CS5223	Distributed Systems
CS5231	Cryptographic Techniques & Data Security
CS6206	Advanced Topics in Human Computer Interaction
CS6240	Multimedia Analysis

Note: MSc students can take at most 2 x Level 4 modules to count towards the M.Sc. degree.

Specialisation in Microelectronics

Compulsory Modules

EE5508	Semiconductor Fundamentals
EE5434	CMOS Processes and Integration OR
EE5432R	Microelectronics Processes and Characterization

Elective Modules for Specialization (at least 3 modules)

EE4401	Optoelectronics
EE4415	Integrated Circuit Design
EE4433	Nanometer Scale Information Storage
EE5502	MOS Devices
EE5507R	Analog Integrated Circuit Design
EE5517	Optical Engineering
EE5518R	VLSI Digital Circuit Design
EE5520	Nano/Micro Electromechanical Systems (N/MEMS)
EE5433R	Functional Devices
PC5203	Advanced Solid State Physics

Note: MSc students can take at most 2 x Level 4 modules to count towards the M.Sc. degree.

5.2.4 Master of Science (Environmental Engineering)

5.2.4.1 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 (M.Sc.) 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 graduate modules equivalent to 12 MCs per semester and attend lectures three evenings per week.

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

5.2.4.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.0

(equivalent to an average of Grade B-) for the best 40 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 Environmental Engineering Program.

Core Modules

ESE5001	Environmental Engineering Principles

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
ESE5601	Environmental Risk Assessment
ESE5602	Environmental Management Systems
ESE5603	Pollution Minimisation and Prevention
ESE5604	Process Engineering Design Principles
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
ESE6402	Advanced Water Treatment Processes
ESE6403	Topics in Membrane Purification
ESE6404	Advanced Contaminant Transport

Programme Structure for M.Sc. (Environmental Engineering)

A. To complete the following core module

ESE5001	Environmental Engineering Principles

B. At least 7 modules from the following

ESE5xxx	Any ESE5000 level series graduate module
ESE6xxx	Any ESE6000 level series graduate module

C. At least 2 additional modules for a total of 10 modules for the MSc.

Note that all ten required modules can be from Environmental Engineering Program 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 Environmental Engineering Program):

DE5107	Environmental Planning
GE6211	Spatial Data Processing
LX5103	Environmental Law
SH5101	Industrial Toxicology
SH5104	Occupational Health

All modules listed are of 4 MCs each.

5.2.5 Master of Science (Geotechnical Engineering)

5.2.5.1 Overview

The primary objective of the M.Sc. (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.

5.2.5.2 Degree Requirements

The M.Sc. (Geotechnical Engineering) programme consists of seven compulsory core modules (total of 28 MCs) and seven elective modules (total of 28 MCs). The core modules are formulated specifically to address the primary objective, while the elective modules are formulated to address the secondary objective.

To satisfy graduation requirements, a candidate must obtain a minimum Cumulative Average Point (CAP) of 3.0 (equivalent to an average of Grade B-) for the best 40 MCs, inclusive of seven core 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
CE6101	Geotechnical Constitutive Modelling
CE5111	Underground Construction Project
CE5112	Structural Support Systems for Excavation
CE5113	Geotechnical Investigation & Monitoring
CE6102	Geotechnical Analysis1

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] CE6102 needs two pre-requisites/co-requisites, namely CE4257 and CE6101. (CE6102 will draw heavily from CE4257 and CE6101, so it is advisable to take them as early as possible.)

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

5.2.6 Master of Science (Industrial & Systems Engineering)

5.2.6.1 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 bases. Admission requires a good bachelor's degree with honours (at least Second Class) or its equivalent from institutions of recognised standing. Admissions are on a competitive basis and meeting the minimum admission requirements does not guarantee admission. Candidates applying for the part-time programme should preferably have had a period of relevant practical experience after obtaining their first degrees. Candidates may opt for either a general programme of study, or a programme with specialisation in either one of the two areas: 1) Logistics and Operations Research, and 2) Project Management.

5.2.6.2 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 M.Sc. (Ind & Sys Eng) degree, a student must complete a minimum of 40 MCs in coursework with a minimum CAP of 3.0 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 5.2.6.2a. All modules are of 4 MCs. Some modules are offered in selected years only. See Modules Listings under Industrial and Systems Engineering of Part III Section F for details.

Table 5.2.6.2a: 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

IE5107	Material Flow Systems

IE5108	Facility Layout and Location
IE5202	Applied Forecasting Methods
IE5203	Decision Analysis
IE5401	Industrial Logistics
IE5402	Introduction to Systems Engineering and Architecture
IE5403	Systems Engineering Case Studies
IE5404	Large Scale Systems Engineering
IE5405	Inventory Systems
IE5409	Topics in Systems Engineering
IE5504	Systems Modelling and Advanced Simulation
IE5506	Computer Based Decision Systems
IE5508	Applied Systems Optimisation

Quality and Reliability Engineering

IE5006	Learning from Data
IE5121	Quality Planning and Management
IE5122	Statistical Quality Control
IE5123	Reliability Engineering
IE5124	Quality and Reliability by Design
IE5125	Software Quality Engineering
IE5126	Statistical Desiqn and Analvsis of Experiments
IE5129	Topics in Quality and Reliability Engineering

Engineering Management

IE5201	Service Operations Analysis and Design
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
IE5217	Fundamentals of Lean Six Sigma
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	Mathematical Programming for Engineering
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
IE6405	Advanced Inventory Systems
IE6499	Advanced Topics in Systems Engineering
IE6503	Advanced Operations Research
IE6504	Advanced Systems Modelling and Simulation
IE6506	Advanced Computer Based Decision Systems

Areas of Specialisation

With effect from August 2008, students may opt for one of the following optional areas of specialisation. Not all modules will necessarily be offered in one academic year:

Logistics and Operations Research

This specialisation aims to equip the students with the requisite quantitative tools and management skills essential to the effective solution of logistics and operations research problems relevant to industry needs. To be considered for the award of this specialisation, a student must complete a minimum of 40 MCs with a satisfactory good CAP as follows:

- The five ISE graduate foundation modules: IE5001, IE5002, IE5003, IE5004 and IE5401
- At least four of the following elective modules for specialisation:

IE5107	Material Flow Systems
IE5108	Facility Layout and Location
IE5123	Reliability Engineering
IE5203	Decision Analysis
IE5405	Inventory Systems
IE5409	Topics in Systems Engineering
IE5504	Systems Modelling and Advanced Simulation
IE5506	Computer Based Decision Systems
IE5901	Independent Study in L&OR
IE5902	Research Project in L&OR

- 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 specialization. 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. There are two types of projects of which a candidate can select to do *one* type only.

i. IE5901 Independent Study in L&OR (4 MCs) to be completed in one semester.
ii. IE5902 Research Project in L&OR (8 MCs) to be completed in two semesters

Project Management

This specialisation aims to equip the students with the requisite skills in managing engineering projects with emphasis on the management of R&D and product development. The students will be exposed to quantitative tools and behavioural techniques at the cutting edge of practice. To be considered for the award of this specialisation, a student must complete a minimum of 40 MCs with a good CAP as follows:

- The five ISE graduate foundation modules: IE5001, IE5002, IE5003, IE5004 and either 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
IE5212	Management of Technological Innovation
IE5291	Topics in Engineering Management
IE5301	Human Factors in Engineering and Design
IE5404	Large Scale Systems Engineering
IE5903	Independent Study in PM
IE5904	Research Project in PM

- 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 specialization. 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. There are two types of projects of which a candidate can select to do *one* type only.

i. IE5903 Independent Study in PM (4 MCs) to be completed in one semester.
ii. IE5904 Research Project in PM (8 MCs) to be completed in two semesters.

5.2.7 Master of Science (Intellectual Property Management)

5.2.7.1 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 M.Sc. in 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 Division of Engineering & Technology 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.

5.2.7.2 Degree Requirements

A full-time or part-time candidate for the degree of M.Sc. in IP Management must successfully complete a program 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:

(a) Must successfully complete the GCIP programme with a minimum satisfactory performance level

(b) For the MOT programme, must obtain a minimum CAP of 3.0 (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 3.0. In general, all students are expected to graduate after obtaining 20 MCs and achieving a CAP of at least 3.0.

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
MT5013	Global Innovation Management
MT5014	Systems Approach to Project Management
MT5015	The Financial and Business Aspects of IP
MT5016	Business Models for Hi-Tech Products
MT5880	Topics in Management of Technology
MT6001	Research in Technology and Innovation Management

SDM5003	Knowledge Management
SDM5004 / IE5208	Systems Engineering Project Management; (or Systems Approach to Project Management)
MT5900	MOT Project (8 MCs)

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

5.2.8 Master of Science (Management of Technology)

5.2.8.1 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 should R&D 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 M.Sc. (MOT) programme.

5.2.8.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.0 (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.

A full-time or part-time candidate for the degree of Master of Science in MOT must successfully complete a programme of study consisting of:

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

(b) The remaining MCs can be obtained from both the list of core and elective modules, to make up a total of 40 MCs. (Each module is 4 MCs unless otherwise stated)

Core Modules

MT5001	IP Management
MT5002	Management of Industrial R&D
MT5003	Creativity and Innovation
MT5007 / BMA5115	Management of Technological Innovation
MT5011/ IE5003	Finance for Engineering & Technology Management; (or Cost Analysis and Engineering Economy)
MT5012	Marketing of High-Tech Products & Innovations

SDM5004 / IE5208	Systems Engineering Project Management; (or Systems Approach to Project Management)

Elective Modules

MT5004	User centred Engineering & Product Development
MT5005	IP Law for Engineers and Scientists
MT5006	Strategic and New Product Development; (or
IE5211	New Product Management)
MT5008/BMA5404	Corporate Entrepreneurship
MT5009	Analysing High Tech Opportunities
MT5010	Technology Intelligence & IP Strategy
MT5013	Global Innovation Management
MT5014	Systems Approach to Project Management
MT5015	The Financial and Business Aspects of IP
MT5016	Business Models for Hi-Tech Products
MT5017	Integrative Design Thinking Workshop
MT5880	Topics in Management of Technology
MT5900	MOT Research Project
MT5901	Management Practicum
MT5902	Management Extended Practicum
MT6001	Research in Technology and Innovation Management
IE5203	Decision Analysis
IE5211	New Product Management
IE5121	Quality Planning and Management
IE5401	Industrial Logistics
BMA5108	Technopreneurship
BMA5004A	Management and Organisation (2 MCs)
BMA5010A	Managing Operations (2MCs)
SDM5001	Systems Architecture
SDM5002	Systems Engineering
SDM5003	Knowledge Management

Subject to the approval of the Programme Manager, students may be allowed to take up to 8 MCs outside this list.

5.2.9 Master of Science (Materials Science and Engineering)

5.2.9.1 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 M.Sc. (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 M.Sc. (Materials Science and Engineering) programme are trained to be spirited, self-reliant, open and egalitarian.

5.2.9.2 Degree Requirements

To graduate, a student needs to accumulate a total of no less than 40 MCs and obtain a minimum Cumulative Average Point (CAP) of 3.0 (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 M.Sc. (Materials Science and Engineering):

Core Modules

MST5001	Structures and Properties of Materials
MST5002	Materials Characterisation

Elective Modules

BN5201	Advanced Biomaterials
CN5161	Polymer Process Engineering
CN5162	Advanced Polymeric Materials
CN5251	Membrane Science and Technology
CE5604	Advanced Concrete Technology
EE5207	Tribology and Mechanics of Magnetic Storage Systems
EE5508	Semiconductor Fundamentals
EE5516	Plasma Processes and Interconnects
ME5101	Applied Stress Analysis
ME5102	Applied Plasticity
ME5161	Optical Techniques in Experimental Stress Analysis
ME5502	Engineering Plastics and Composite Materials
ME5506	Corrosion of Materials
ME5513	Fracture and Fatigue of Materials
ME5515	Friction and Wear of Materials
ME5603	Metal Forming Technology
ME6102	Topics in Applied Mechanics
ME6103	Optical Measurement and Quality Inspection
ME6104	Fracture Mechanics and Applications
ME6501	Research Topics in Materials Science
ME6502	Topics in Materials Science
ME6503	Theory of Transformations in Metals
ME6504	Defects and Dislocations in Solids
ME6604	Modelling of Machining Processes
MLE5101	Thermodynamics and Kinetics of Materials
MLE5102	Mechanical Behaviours of Materials
MLE5103	Structures of Materials
MLE5104	Physical Properties of Materials
MLE5201	Principles, Technology and Properties of Thin Films
MLE5202	Structural and Electronic Ceramics

MLE5203	Electrochemical Techniques in Environmental Engineering
MLE5204	Advanced Processing of Metallic Materials
MLE5205	Advanced Polymeric Biomaterials
MLE5208	Mechanical Properties of Solid Films
MLE5209	Fundamentals of Materials Science
MLE5210	Modelling and Simulation of Materials

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.

5.2.10 Master of Science (Mechanical Engineering)

5.2.10.1 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 M.Sc. (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 M.Sc. (Mechanical Engineering) course its unique features. The success of this M.Sc. (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 M.Sc. (Mechanical Engineering) with or without a specialisation. The specialisations available are:

- Computation and Modelling
- Manufacturing Technology and Automation

5.2.10.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.0 (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 taking a specialisation are required to complete at least six modules selected from the respective core lists.

Core list for Specialisation in Computation and Modelling

ME5302	Computational Fluid Mechanics
ME5307	Computational Aerodynamics
ME5361	Advanced Computational Fluid Dynamics
ME5362	Advanced Fluid Transients Computation and Modelling
ME5404/EE5904R	Neural Networks
ME5605	Computational Techniques for Numerical Control
ME5701	Mathematics for Engineering Research
ME6301	Research Topics in Fluid Dynamics
ME6302	Topics in Fluid Dynamics
ME6303	Advanced Fluid Dynamics
ME6304	Turbulence in Fluid Flows

Core list for Specialisation in Manufacturing Technology and Automation

ME5402/EE5106R	Advanced Robotics
ME5403/EE5103R	Computer Control Systems
ME5405	Machine Vision
ME5602	Manufacturing Systems Engineering
ME5603	Metal Forming Technology
ME5605	Computational Techniques for Numerical Control
ME5609	Rapid Response Manufacturing
ME5610	Product Development
ME5611	Sustainable Product Design & Manufacturing
ME5612	Computer Aided Product Development
ME6602	Topics in Manufacturing
ME6604	Modelling of Machining Processes
ME6605	Abrasive and Non-Conventional Processes

5.2.11 Master of Science (Mechatronics)

5.2.11.1 Overview

Mechatronics synergistically merges mechanical and electronics engineering and integrates mechanical devices with sensors and actuators, intelligent controllers and computers to realise useful products and systems. Almost all systems ranging from consumer products to machines in industry have mechatronics components. The M.Sc. (Mechatronics) programme equips its graduates with in-depth knowledge of the fundamentals needed for the mechatronics system design approach, broad exposure to different topics offered by its specialised electives, and the multidisciplinary training required for students with different backgrounds to be able to effectively operate, understand, analyse and design mechatronic systems.

5.2.11.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.0 (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.

A student needs to complete:

- Four compulsory core modules. Note that the core module, Mechatronic System Design, has a duration of one academic year – Students can choose to propose their own Industrial Project in the area of mechatronics for consideration and approval by the programme committee. When the industrial project is not possible or not suitable, students will have to complete a prescribed series of laboratory experiments and mini projects. Please refer to: http://serve.me.nus.edu.sg/mch for more details on the mini projects.
- Five optional modules of which at least two must be foundation modules and at least two must be specialised modules.

Core Modules

MCH5001	Power Electronics and Applications to Electro-mechanical Systems
MCH5002	Applications of Mechatronics
MCH5003	Modelling of Mechatronic Systems
MCH5004	Mechatronic System Design (one-year module)

Foundation Modules

EE2024	Programming for Computer Interfaces
MCH5101	Electrical Components and Systems
MCH5102	Signal Processing in Mechatronics
ME5403/EE5103R	Computer Control Systems
MCH5105	Mechanical Components and Systems
MST5001	Structure and Properties of Materials
MCH5107	Kinematics and Dynamics of Mechanisms

Specialised Modules

ME5401/EE5101R	Linear Systems
ME5404/ EE5904R	Neural Networks
EE5703R	Modelling and Control of Electrical Actuators
EE5903	Real Time Systems
MCH5206	Instrumentation and Sensors
ME5606	Intelligent Systems in Manufacturing
MCH5208	Precision Handling and Miniaturised Assembly
ME5402/EE5106R	Advanced Robotics
ME5502	Engineering Plastics and Composite Materials
ME5405	Machine Vision
MCH5212	Factory Automation
MCH5214	Topics in Mechatronics

All modules are worth 4 MCs each except for MCH5004 Mechatronic System Design, which is worth 8 MCs.

5.2.12 Master of Science(Offshore Technology)

5.2.12.1 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.

5.2.12.2 Degree Requirements

To qualify for the degree of Master of Science in Offshore Technology, a full-time or part-time candidate must successfully complete a programme of study consisting of at least 40 MCs, which consists of the following:

(a) At least 28 MCs from the list of modules in Offshore Technology below.

(b) The remaining MCs may come from the list of Elective Modules. Up to two (2)modules may be selected from outside the list of Elective Modules with prior approval to be sought from the Programme Management Committee.

In addition, a student must obtain a minimum CAP of 3.0 (B-) for the best modules equivalent to 40 MCs, inclusive of at least 28 MCs of modules in Offshore Technology below.

Modules in Offshore Technology

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
OT5208	Fatigue and Fracture for Offshore Structures
OT5301	Subsea Systems Engineering
OT5881	Topics in Offshore Engineering
OT5882	Topics in Subsea Engineering
CE5307	Wave Hydrodynamics and Physical Oceanography
ME5301	Flow System Analysis
ME5506	Corrosion of Materials

Note: All modules are 4 MCs each with the exception of OT5001 Independent Study Module which is 8 MCs.

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
CE5307	Wave Hydrodynamics and Physical Oceanography
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
ME5602	Manufacturing Systems Engineering
ME5708	Pressure Surges in Oil & Gas Flow Systems
SH5204	Safety Engineering

[α] *Only offered once a year in August*

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

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

5.2.13.1 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 M.Sc. 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.

5.2.13.2 Degree Requirements

The graduation requirements include obtaining a minimum Cumulative Average Point (CAP) of 3.0 (equivalent to an average of Grade B-) for the best 40 MCs, inclusive of foundation 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.

A candidate (full-time and part-time) must successfully complete a programme of study consisting of four Foundation modules and six elective modules.

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 by choosing from either group 1, 2, 3 or 4.

The four Foundation modules are:

SH5000	Basic Sciences for SHE
SH5002	Fundamentals in Industrial Safety
SH5003	Fundamentals in Environmental Protection
SH5004	Fundamentals in Industrial Hygiene

The elective modules can be selected from topics in group one to group three.

Group One (Industrial Hygiene Option)

SH5101	Industrial Toxicology
SH5102	Occupational Ergonomics
SH5104	Occupational Health
SH5105	Noise in the Occupational Environment
SH5106	Radiation
SH5107	Industrial Ventilation
SH5880	Topics in Industrial Hygiene

Group Two (Process Safety Option)

SH5201	Hazard Identification and Evaluation
SH5202	Quantified Risk Analysis
SH5203	Emergency Planning
SH5204	Safety Engineering
SH5205	Incident Management
SH5881	Topics in Process Safety

Group Three (Environment Protection Option)

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 Minimisation and Prevention
SH5882	Topics in Environment Protection

Group Four (Common Safety, Health and Environment Protection Modules)

SH5401	SHE and Quality Management Systems / ESE5602 Environmental Management Systems
SH5402	Advanced SHE Management
SH5403	Independent Study
SH5404	Safety Health and Environmental Project (8MCs)

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

5.2.14 Master of Science (Supply Chain Management)

5.2.14.1 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, and (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.

Applications are open to candidates with at least a second class lower honours degree in Engineering, Physical Science, Computer Science, Mathematics, Business Administration,or a related technical discipline from institutions of recognized standing. Candidates with other qualifications and relevant work experience may be considered subject to recommendation and approval by the Board of Graduate Studies. Admissions are competitive and thus meeting the minimum admission requirements does not guarantee admission. Candidates opting for the programme on part-time should preferably have 1 to 3 years of relevant practical work experience after their first degree.

5.2.14.2 Degree Requirements

To graduate with a M.Sc(SCM) degree, a student is required to pass the examinations for 9 modules equivalent to 40 modular credits (MCs). There are 6 core modules and 3 elective modules (selected from a list of 7 elective modules). For full-time course of study, a student must achieve a minimum Cumulative Average Point (CAP) of 3.0 for all the 40 MCs (inclusive of the core modules, where required) within a specified maximum period of his/her candidature of 2.5 years. The 6 core modules must include DSC 5211A (4MCs), DSC 5211B (4MCs), IE 5004 (4MCs), LI 5001 (8MCs), LI 5101 (4MCs) and LI 5202 (4MCs). The remaining 12 MCs would come from any 3 elective modules listed in the M.Sc(SCM) programme structure.

The graduate modules offered in the M.Sc(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:
http://www.tliap.nus.edu.sg/mscm/module%20description.pdf

Modules in Master of Science (Supply Chain Management)

Core Modules (6):

DSC 5211A	Supply Chain Coordination and Risk Management
DSC 5211B	Analytical Tools for Consulting
IE 5004	Engineering Probability and Simulation
LI 5001	Research Project (8MCs)

LI 5101	Supply Chain Management Thinking and Practice.
LI 5202	Special topics in Supply Chain Management

Elective Modules (Select 3):

DSC 4211C	Operations Strategy
DSC 4211D	Managerial Decision Analysis
IE 5001	Operations Planning and Control I
IE 5108	Facility Layout and Location
IE 5401	Industrial Logistics
IE 5405	Inventory Systems
LI 5201	Special Topics in Logistics

5.2.15 Master of Science (Systems Design & Management)

5.2.15.1 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 FoE 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, economical 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.

5.2.15.2 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 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 Master of Science in SDM must successfully complete a Programme of study consisting of 40 MCs:

i. All four core modules (16 MCs);
ii. 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:

i. Must obtain a minimum CAP of 3.0 (B-) for the best modules equivalent to 40 MCs; and
ii. 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 FoE (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.

1. Systems methodology and management

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

2. 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 OR IE5211	Strategic and New Product Development OR 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)

5.2.16 Master of Science (Transportation Systems and Management)

5.2.16.1 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.

5.2.16.2 Degree Requirements

To qualify for the M.Sc. (Transportation Systems and Management) degree with or without specialisation, a candidate must successfully complete a programme of study consisting of 36 MCs from modules listed in the curriculum. In addition, a student must obtain a minimum CAP of 3.0 (Grade B-) for the best modules equivalent to 40 MCs (inclusive of compulsory modules, where required). Students may choose to graduate with the following degrees:

- M.Sc. (Transportation Systems and Management), or
- M.Sc. (Transportation Systems and Management) with specialisation in Logistics and Distribution Management

Specialisation in Logistics and Distribution Management

Distinct modules (choose minimum of ***any five 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

Electives modules (choose minimum of ***any four modules***)

BMA5004A	Management and Organisation
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

The remaining *one module* (4 MCs) may be selected from Level-5000 and 6000 modules offered by the Department of Civil and Environmental Engineering. Prior approval must be sought from the Head of Department or his nominee.

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

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

5.2.17 Executive Master in Systems Engineering and Management

5.2.17.1 Overview

The Executive Master in Systems Engineering and Management (EMSEM) aims to educate mid-career senior engineers and managers with substantive working experience to become engineer-leaders in the engineering and management of large-scale complex socio-technical systems.

EMSEM programme is for engineer-leaders overseeing large-scale, complex projects or programmes who must not only possess the requisite engineering knowledge and skills, but also have the finesse to manage socio-technological systems that transcends nations and different types of systems. Hence they are required to have a skill set that differs from the traditional domain-specific engineering disciplines. This programme focuses primarily on serving professionals who have substantial work experience and/or mid-career engineering managers who have been earmarked by employers or have the potential to take on greater responsibilities. In view of this emphasis, some of the admission criteria are different from other existing MSc programs of the Faculty of Engineering. The criteria shall be based on the following:

a) Academic qualifications

b) Relevant work experiences

c) Leadership quality or potentials

Candidates are expected to have at least a bachelor's degree with honours (Second Class Lower) or equivalent in Engineering, Science, Computing or a related discipline which deals with quantitative methodologies. Applicants whose academic qualifications fall short of the minimum requirements will be interviewed.

Candidates who wish to enter the program should preferably have accrued a substantial number of years of post-graduate work experience in relevant industries and have demonstrated strong analytical abilities through a strong scholastic performance and/or work experience in a technically demanding position. It is expected that students' work experience will in one way or another be related to systems engineering and their work performance could be greatly enhanced after going through the proposed program.

Candidates who graduated from universities in which English is not the medium of instruction are also strongly encouraged to present their TOEFL or IELTS scores; and/or GRE or GMAT scores. They will be interviewed to ascertain their communication skills in English.

5.2.17.2 Degree Requirements

EMSEM students complete a total of 10 modules to complete 40 modular credits (MCs) of coursework covering relevant topics in systems engineering and management.

To successfully graduate with an Executive Master in Systems Engineering and Management, a candidate must obtain 40 modular credits (equivalent to passing 10 modules) within the specified maximum period of candidature. In addition, the candidate must have obtained a Cumulative Average Point (CAP) of at least 3.0.

A student may complete the programme in one year or opt for a longer period of study depending on his work and family commitments. Students admitted into the programme are expected to complete all the requirements within a maximum period of four (4) years. A candidate may be granted leave of absence as per the University guidelines.

Modules

EMSEM offers core fundamentals and a wide range of electives. The programme consists of 4 segments.

During the first two segments, students focus on core requirements and in the last two segments, students will select electives. Each module comprises of lectures, discussions, case studies and visits. All modules are of 4 modular credits (MCs). The following curriculum shows how required and elective courses are paced across the one-year part-time programme.

Segment	Month	Duration	Modules Offered
1 (Core)	May	2 weeks	SyE5002 Large Scale Systems Project Management SyE5004 Large Scale Systems Engineering
2 (Core)	Sep	3 weeks	SyE5001 Systems Engineering and Architecture SyE5003 Engineering Finance SyE5005 Management Science in Systems Engineering
3 (Electives)	Jan	2 weeks	SyE5202 Lean Six Sigma SyE5302 Leadership in Engineering SyE5403 Systems Engineering Project and Case Studies
4 (Electives)	May	3 weeks	SyE5201 Integrated Logistics Systems SyE5203 Decision Analysis and Risk Management SyE5301 Humans and Systems Engineering

For more details of the programme, please visit: http://www.ise.nus.edu.sg/SyE/index.html

5.2.18 Graduate Diploma (Aviation Management)

5.2.18.1 Overview

Established for more than 10 years, this unique programme combines the academic disciplines of transportation management with the operational elements of airport management and taps on Singapore Changi Airport's experience. Participants will graduate with an internationally recognised professional qualification.

The Aviation Management course is designed to provide an understanding of the multi-skilled approach to running an airport and how the airport system fits into the air transport industry. The learning process will include:

- A comprehensive coverage of topics on airport management, operations, planning and design.
- Review of topical issues in the wider context of transportation economics, management and development.
- Projects, case studies and seminar discussions to facilitate application of knowledge.
- Site visits and briefing of key facilities at Singapore Changi Airport.

Admission for the graduate diploma requires a recognised bachelor's degree in Engineering, Technology, Sciences, Social Sciences, Business Management or related fields. Candidates are also expected to have relevant experience and be proficient in the English Language.

Students can complete the programme within 11 weeks of intensive full-time study or three years of part-time study. Most of our graduate diploma students opt for and are able to complete their requirements within 11 weeks of full-time study.

5.2.18.2 Graduate Diploma Requirements

The normal requirements for the graduate diploma include obtaining a minimum Cumulative Average Point (CAP) of 2.25 for all modules taught by NUS and accumulating a total of no less than 12 MCs, in addition to achieving a satisfactory grade for all three modules offered by the Singapore Aviation Academy. Each graduate module offered by NUS of 39 lecture hours is usually assigned 4 Modular Credits.

5.3 Special Programmes

Double Degree Programmes

5.3.1 Double M.Sc. Degree Programme with Delft University of Technology, the Netherlands

In response to the Singapore government's desire to develop Singapore as a global hydrohub, NUS has partnered with the Delft University of Technology (TUD) to provide students with the opportunity to learn from two institutions which have extensive links with the public and private sectors of the water industry in their respective countries. Students will be exposed to the latest knowledge, cutting-edge research and the different work environments and cultures in Asia and Europe.

The double M.Sc. degree programme with TUD is a two-year full-time programme where students are expected to spend one year at each institution. Students will complete a mix of core modules, elective modules, additional research modules, breadth modules and a compulsory M.Sc. thesis. Bond-free study grants are available through the Singapore-Delft Water Alliance (SDWA) to help cover the differences in the cost of living between the Netherlands and Singapore.

Students who successfully complete the programme will be conferred the Master of Science in Hydraulic Engineering and Water Resources Management from NUS and a Master of Science in Civil Engineering with either Hydraulic Engineering or Water Management tracks from TUD.

For more details, please visit: http://www.sdwa.nus.edu.sg/index.php?option=com_content&view=article&id=63&Itemid=85

Table 5.3a: Double M.Sc. Degree Programme with the Delft University of Technology, the Netherlands.

Year	Schedule
1	Semester 1 at NUS • Students complete majority of core modules from NUS and TUD Semester 2 at TUD • Students will take core and elective modules
2	Students spend 1 semester at NUS and 1 semester at TUD, the sequence will depend on the students' M.Sc. thesis and remaining modules.

5.4 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, examination fees and other approved 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:

http://www.nus.edu.sg/admissions/graduate-studies/scholarships-lkc.php

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:

http://www.nus.edu.sg/admissions/graduate-studies/scholarships-pgf.php

NUS Research Scholarship

(Applicable for Ph.D. and M.Eng. 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 Ph.D. candidates.

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

For international students, with effect from January 2013, there will be two options available with regards to tuition fee subsidy:

(a) Full tuition fee subsidy is awarded if the Research Scholar chooses to work in a Singapore-registered company for 3 years upon graduation.

(b) For those who do not choose to work in Singapore after graduation, a generous tuition fee subsidy equal to the fee payable students with Service Obligation will be awarded

For research scholars in a Masters/Graduate Programme, the monthly stipend is S$1,500. For Research Scholars in a Ph.D. programme, monthly stipends for Singapore citizens, Singapore Permanent Residents and foreigners are currently S$2,500, S$2,200 and S$2,000 respectively. For students intake prior to AY2010, the monthly stipend for Singapore citizen is S$2,300. There is no bond for this scholarship.

Research scholars may also be eligible for an additional stipend of up to $500 per month upon passing the Ph.D. 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:

http://www.nus.edu.sg/admissions/graduate-studies/scholarships-nrs.php

A*STAR Research Scholarship

Singaporeans and Singapore Permanent Residents are eligible for the A*STAR Research Scholarship for NUS-UIUC Joint Ph.D. programme on Chemical Engineering Initiative in Biomedical Sciences, which will cover tuition fees, stipend, airfare and set-up costs.

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:

https://www.singa.a-star.edu.sg

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.

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