Faculty of Engineering

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5.2.9 Master of Science (Management of Technology)

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

5.2.14 Master of Science (Supply Chain Management)

5.2.15 Master of Science (Systems Design & Management)

5.2.16 Master of Science (Transportation Systems and Management)

5.3 Special Programmes

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

5.4 Financial Assistance and Awards

Faculty's Commitment

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

The Faculty of Engineering has been consistently ranked 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 Programme (DCP) and the Global Engineering Programme (GEP). The DCP 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 Prof Liew Mun Leong, President and Chief Executive Officer, CaptiaLand Group, and Ms Aw Kah Peng, CEO, Singapore Tourism Board, Mr Tan Gee Paw, Chairman of Singapore PUB and Mr Teh Bong Lim, Group Managing Director of MMI Holdings Ltd, 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.

Key Contact Information

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2.1 Deanery

Title & Name	Designation/Responsibility	Telephone 6516 xxxx	Email xxxx@nus.edu.sg
Prof CHUA Kee Chaing	Dean	2142	engdean
Assoc Prof CHAU Fook Siong	Vice-Dean (Administration)	4123	engcfs
Prof QUEK Ser Tong	Vice-Dean (Graduate Studies)	6283	engqst
Prof Victor SHIM	Vice-Dean (External Relations & Outreach)	2166	engspwv
Prof TEO Kie Leong	Vice-Dean (Research & Technology)	6063	engvdr
Assoc Prof Christina LIM	Vice-Dean, Student Life (Community & Engagement)	5021	englimc
Assoc Prof Lanry Yung	Vice-Dean (Undergraduate Studies)	5048	engyly

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 Biomedical Engineering	5259	biehead
Prof LEE Jim Yang	Head, Department of Chemical & Biomolecular Engineering	2186	chehead
Prof PHOON Kok Kwang	Head, Department of Civil & Environmental Engineering	2148	ceehead
Assoc Prof THONG John	Head, Department of Electrical & Computer Engineering	2108	elehead
Prof WANG Chien Ming	Director, Engineering Science Programme Director, Global Engineering Programme	2157	esphead
Prof HANG Chang Chieh	Head, Division of Engineering & Technology Management	8501	etmhead
Prof TANG Loon Ching	Head, Department of Industrial & Systems Engineering	2203	isehead
Prof WANG JOHN	Head , Department of Materials Science & Engineering	3325	msehead
Prof TAY Tong Earn	Head, Department of Mechanical Engineering	2210	mpehead
Assoc Prof Ganesh SAMUDRA	Director, Office of Bachelor of Technology	2224	eleshanr
Assoc Prof TOH Siew Lok	Deputy Head, Department of Biomedical Engineering	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
Prof Vivian NG	Deputy Head, Department of Electrical & Computer Engineering	2292	elengv
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 CHEW Ek Peng	Deputy Head, Department of Industrial & Systems Engineering	6554	isecep
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 Biomedical Engineering			
Assoc Prof TOH Siew Lok	Level-1000 and Level-4000 Advisor	2920	bietohsl
Assoc Prof KIM SangHo	Level 2000 Advisor	6713	bieks
Assoc Prof Evelyn YIM	Level 3000 Advisor	7322	bieykfe
B. Department of Chemical & Biomolecular Engineering			
Assoc Prof HONG Liang	Level-1000 Advisor	5029	chehongl
Assoc Prof JIANG Jianwen	Level-2000 Advisor	5083	chejj
Dr PHOTINON, Kanokorn	Level-3000 Advisor	8609	chepk
Dr JANGAM, Sachin Vinayak	Level-3000 Advisor	66013459	chejsv
Assoc Prof HIDAJAT Kus	Level-4000 Advisor	2191	chehidak
Dr LU Xianmao	Level-4000 Advisor	1071	chelxm
C. Department of Civil & Environmental Engineering			
Dr CHIAN Siau Chen Darren	Level-1000 Advisor	4729	ceecsc
Dr LOW Ying Min	Level-2000 Advisor	4127	ceelowym
Assoc Prof QIAN Xudong	Level-3000 Advisor	6827	ceeqx

Assoc Prof MENG Qiang	Level-4000 Advisor	5494	ceemq
Assoc Prof HU Jiangyong	EVE Program Director	4540	ceehujy
Dr KELLY Barry	Year 1 Advisor	3764	ceekbc
Assoc Prof CHEN Jia-Ping, Paul	Year 2 Advisor	8092	ceecjp
Assoc Prof BAI Renbi	Year 3 Advisor	4532	ceebair
Assoc Prof YU Liya	Year 4 Advisor	6474	ceeley
D. Department of Electrical & Computer Engineering			
Assoc Prof TAN Woei Wan	Associate Head (Undergraduate Programs)	8323	eletanww
Assoc Prof TAY Arthur	Associate Head (Student Life)	6326	eletaya
Assoc Prof MOUTHAAN, Koenraad	Level-1000 & Level-2000 Advisor (EE)	7871	elemk
Assoc Prof TAN Leng Seow	Level-3000 & Level-4000 Advisor (EE)	2125	eletanls
Dr Colin TAN Keng Yan	Level-1000 Advisor (CEG)	7352	colintan
Assoc Prof Bharadwaj VEERAVALLI	Level-2000 & Level-3000 Advisor (CEG)	5158	elebv
Assoc Prof CHAN Mun Choon	Level-4000 Advisor (CEG)	7372	dcscmc
E. Engineering Science Programme			
Assoc Prof Anjam KHURSHEED	Advisor (all levels)	2295	eleka
F. Department of Industrial & Systems Engineering			
Assoc Prof CHEW Ek Peng	Advisor (all levels)	6554	isecep
G. Department of Materials Science & Engineering			
Assoc Prof XUE Jun Min	Level-1000 Advisor	4655	msexuejm
Assoc Prof CHEN Jingsheng	Level-2000 Advisor	7574	msecj
Dr CHIU Cheng Hsin	Level-3000 Advisor	4502	msecch
Prof GONG Hao	Level-4000 Advisor	4632	msegongh
H. Department of Mechanical Engineering			
Assoc Prof CHEN Chao Yu, Peter	Level-1000 Advisor	8837	mpechenp
Assoc Prof HONG Geok Soon	Level-2000 Advisor	2272	mpehgs
Assoc Prof LU Wen Feng	Level-3000 Advisor	1228	mpelwf
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 / Dr SAHOO Sanjib Kumar	Coordinator, B.Tech. (Electronics Engineering)	2293/ 6470	Eleshanr/ elesahoo
Assoc Prof POH Kim Leng / Assoc Prof NG Kien Ming	Coordinator, B.Tech. (Industrial & Management Engineering)	2193/ 5541	Isepohkl/ isenkm
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 6516 xxxx	Email 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 Mansoor Bin Abdul Jalil	M.Eng. and Ph.D. (Electrical and Computer Engineering)	2125	elembaj
Assoc Prof ZHU Chun Xiang	M.Sc. (Electrical Engineering)	8930	elezhucx
Assoc Prof HE Jianzhong	M.Sc. (Environmental Engineering)	3385	ceehj
Prof CHEONG Hin Fatt	M.Sc. (Hydraulic Engineering and Water Resources Management)	2287	ceechf
Assoc Prof NG Kien Ming	M.Sc. (Industrial & Systems Engineering)	5541	isenkm
Assoc Prof CHAI Kah Hin	M.Sc. (Intellectual Property Management) and M.Sc. (Management of Technology)	2250	etmckh
Assoc Prof CHEN Jingsheng	M.Sc. (Materials Science & Engineering)	7574	msecj
Assoc Prof KUMAR A Senthil	M.Sc. (Mechanical Engineering)	6800	mpeask
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
Dr ONG Ghim Ping, Raymond	M.Sc. (Transportation Systems and Management)	2279	ceeongr
Assoc Prof Madapusi P SRINIVASAN	M.Eng. and Ph.D. (Chemical & Biomolecular Engineering)	2171	chesmp
Assoc Prof Martin BUIST Lindsay	M.Eng. and Ph.D. (Biomedical Engineering)	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 Hin	M.Eng. and Ph.D. (Engineering & Technology Management)	7615	etmckh
Assoc Prof NG Tsan Sheng, Adam	M.Eng. and Ph.D. (Industrial & Systems Engineering)	2562	isentsa
Prof DING Jun	M.Eng. and Ph.D. (Materials Science & Engineering)	4317	msedingj
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
Prof CHEONG Hin Fatt	Double Degree Programme with Delft University of Technology	2287	ceechf
Assoc Prof HIDAJAT Kus	Industrial Attachment Programme and Vacation Internship Programme	2191	chehidak
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	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
Ms LIM Yee Cheng	Executive for Examinations, Prizes & Medals, Scholarships, Student appeals (exams/dismissal), Streaming, Leave of Absence/Withdrawals	2269	englyc
Ms Davina THAM	Assistant Manager for Student Exchange Programme, NUS Overseas Colleges, French Double Degree Programme, NUS/Georgia Tech Special Term,	1659	engdtwn

	International Summer Programmes		
Ms Lisa MOO	Executive for Enhancement Programmes (Industrial Attachment, Vacation Internship, Technopreneurship, UROP, Innovation Programme, Independent Work), NUS Bulletin, Secretariat for Faculty Teaching Excellence Committee, Outstanding Undergraduate Researcher Prize, NUS Pre-Medical Program	6217	engmrc
Ms Nuraini Nazeha Bte S S MOHD HABEEB	Senior 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 THNG Leng Li, Lindy	Assistant Manager for Student Matters (Mechanical/Manufacturing Engineering and Industrial & Management Engineering)	5369	engtlll
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 LOO Shi Yun Melinda	Executive for Undergraduate and Graduate Programmes	1611	bieloosy
Ms CHEN Li Hua	MAO for Undergraduate and Graduate Programmes	3553	biechlh
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 WOON Swee Yoke	Executive for Graduate Research Programmes	5031	chewsy
F. Department of Civil and Environmental Engineering			
Ms LIM Chi Cheng Christina	Assistant Manager for Undergraduate Programmes	4270	ceelccc
	Assistant Manager for Double Degree Programme with Delft University of		

Ms Cecilia SHANTI DEWI	Technology, M.Sc. Programmes, Student Exchange Programme (for CEE Undergraduate Students)	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 PHUA Wei Qi Nicole	Executive for EE Student Life	2109	elepwqn
Ms WONG Yoke Cheng Eunice	Manager for Graduate Programmes	3809	elewyc
Ms CHUA Wei Nee Winnie	Assistant Manager for CEG Undergraduate Programmes	4186	elecwn
H. Engineering Science Programme			
Ms Violet TAY	Assistant Manager for Undergraduate Programme	3354	espttlv
Ms SHANMUGA Priya D/O Subramaniam	MAO for Undergraduate Programme	8664	espsps
I. Division of Engineering & Technology Management			
Ms CHIN Yuen Yee Mavis	Manager for all programmes	8502	etmcyy
J. Department of Industrial & Systems Engineering			
Mr CHIANG Tee Hwa, Steven	Manager for Undergraduate Programme	4499	isecth
Ms OW Lai Chun	MAO for Undergraduate Programme (SEP), M. Eng. and Ph.D Programme	2206	iseowlc
Mr TANG Kang Wei	Executive for M.Sc. (Supply Chain Management) and Undergraduate (SDP, Single Degree) Programme	8726	isetkw
Ms LAU Siew Keok, Maggie	MAO for MSc (ISE), and Undergraduate Programme (FYP, DDP,and NUS-Georia Tech Special Term Program)	5497	iselausk
K. Department of Materials Science & Engineering			
Ms HO Sen Lin	Assistant Manager for Undergraduate Programme	4672	msehslk

Dr KONG Hui Zi	Executive for Graduate Programme	7508	msekhz
Dr ZHANG Liuhang	Assistant for Graduate Programme	1301	msezlh
L. Department of Mechanical Engineering			
Ms LIM Wee Lee, Eileen	Manager for Undergraduate Programme	13505	mpeeile
Ms CHNG Lay Eng, Esther	Senior Executive for Undergraduate Programme	4494	mpechng
Ms LEE Meng Kiow	Assistant Manager for Graduate Programmes	7610	mpelmk

MAO – Management Assistant Officer

LT – Laboratory Technologist

3 Undergraduate Education (Full-time Programme)

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. (Biomedical Engineering)
- 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

Overview of the Engineering Curriculum

Table 3.1.1: Engineering Undergraduate Curriculum

University Level Requirements (Ulr)	Programme Requirements[1]		Unrestricted Elective Modules (UeMs)
General Education Modules (GEMs) (8 MCs) 1 Singapore Studies (SS) module (4 MCs)	**Faculty Requirements:** Aim to develop abilities required of well-rounded engineers and includes modules related to Critical Thinking, Writing & Communications, Engineering Ethics & Professionalism and Management Basics.	**Foundational Requirements :** *Foundational modules* in Mathematics, Sciences, Programming/Computing and others. *Discipline-specific modules* for various engineering programmes: Biomedical, Chemical, Civil, Computer,	Unrestricted Elective Modules (UEMs)

Breadth Modules (outside student's Faculty) (8 MCs)		Electrical, Environmental, Industrial & Systems, Materials Science and Mechanical.	
Sub-total = 20 MCs (12.5%)	**Sub-total = 10 MCs (6.25%)**	**Sub-total = 110 MCs (68.75%)**	**Sub-total = 20 MCs (12.5%)**
Minimum required for graduation = 160 MCs			

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

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

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

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 (GE) Modules 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 GE modules

GE modules offered by the Faculty of Engineering (in Group A) include:

GEK1501 Information Technology and Us
GEK1512 Understanding how the Internet Works
GEK1513 Wireless Communications — Past, Present and Future
GEK1514 Microelectronics Revolution – From Sand to Integrated Circuits (ICs)
GEK1522 Global Environmental Issues
GEK1523 Innovativeness in Engineering Design
GEK1524 Living with Fluids
GEK1546 Harnessing Patterns of Light
GEM2501 Electric Energy — Powering the New Millennium

GEM2502 Modes of Invention

Engineering students must read at least one GE module from Group B (the Humanities & Social Sciences group). Additional GE modules (beyond the required two modules) will count as Breadth or Unrestricted Electives

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.

Students should seek guidance from the departmental academic advisors on their elective choices. As these modules can be used to satisfy the requirements of various special programmes (including Minors, Second Majors, Second-Degrees etc.), students should carefully plan the use of the Breadth Requirement and Unrestricted Electives.

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
SC1101E Making Sense of Society	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 modules related to Critical Thinking, Writing & Communications (see below); Engineering Ethics & Professionalism (EG2401 Engineering Professionalism); and a Management module (HR2002 Human Capital in Organizations),

- Foundational Requirements include Mathematics, Sciences, Programming/Computing and other modules as defined by the student's engineering discipline (details in section 3.2);
- Discipline Specific Modules which are core/essential modules, technical electives modules, project modules, industry engagement modules (see below) and independent study modules as defined by the student's engineering discipline (details in section 3.2).

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

Faculty of Engineering students are required to read a Critical Thinking & Writing (CTW) module and a Communications module; preferably read in the first-year semester of study. GEK1549 Critical Thinking & Writing and ES2331 Communicating Engineering offered by the Centre for English Language Communication (CELC) would meet these requirements. GEK1549 addresses the need to develop critical thinking and communication skills which will enable engineering students to ask good questions, think & reason well and be able to convince others when they practise their profession. ES2331 provides students with an opportunity to enhance their communication skills through competent and effective use of language in interpersonal, academic and public contexts.

GEK1549 Critical Thinking & Writing is designed to prepare students to think, speak, and write critically and effectively. While oral communication skills are emphasized throughout the engineering curriculum, the compulsory oral communications module, **ES2331 Communicating Engineering** provides engineering students further opportunity to harness their communication skills through competent and effective use of language in interpersonal, academic and public contexts, focussing on elements of engineering practice. While ES2331 satisfies the Programme Requirements, GEK1549 will satisfy the General Education requirement (Group A).

Engineering students can read a single module, **ES1501X Academic Expository Writing** (ES1501A, ES1501B etc) in place of **GEK1549 and ES2331**. ES1501X's content-specific nature allows a contextualised platform to hone argumentation skills required in academic expository writing.

Engineering students who complete the requirements of the University Scholars Program (USP) and the University Town (UTown) Residential Program need not read GEK1549 & ES2331. Computer Engineering students would read another set of writing and communications modules in lieu of GEK1549/ES2331 (please read section 3.2.4 for more details).

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

Industry Engagement (Programme Requirements)

For students admitted into the B.Eng. programmes from AY2014/2015, industry engagement will feature as a **compulsory requirement**. The type of industry engagement varies according to the engineering discipline and includes the 6-month industrial attachment/internships, 'projects with industry' and etc. (details in section 3.2). Such industry engagement facilitates a form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skill development in a professional setting. The programme also enables students to learn about the latest developments in various industries and to interact /network with engineers & other professionals as they join in on projects or tasks that help to develop or enhance their skills whilst contributing to the organization. By participating in internships, students gain invaluable experience that will make them stronger candidates when applying for jobs after graduation. Internships / industrial-attachment are optional for students undergoing the following special programmes: Double Degree Programmes (DDP), Concurrent Degree Programmes (CDP), Global Engineering Programme (GEP) and Chemical Science Program (CSP). The modular credits for the internship/industrial-attachment for students in these special programmes will be considered as 'Free Electives' i.e., Unrestricted Electives.

Students admitted from AY2014 will also undertake the **specially designed 'HeadStart Module"** which is a 5-week

tutorial module to sensitize freshmen to the importance of planning and preparing for their future careers. Students can then start to plan their education and projects, hone their expertise and experiences and develop a credible portfolio towards their career goals.

UNRESTRICTED ELECTIVES (UE)

Unrestricted Elective Modules (UEs) enable students to pursue their interests without any restrictions. Students may use UE space to partially or wholly satisfy exciting academic programmes such as the Enhancement Programmes (see Section 3.4), a Minor, a Second-Major or even a Second Degree. To achieve a greater depth in their engineering major, students may also take engineering technical electives as UE modules.

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: Unrestricted Electives offered by ISE Dept.

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 UE and ULR-Breadth Modules

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

General Degree Requirements

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

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

Students are advised to take careful note of the degree requirements. It is the students' responsibility to understand their graduation requirements and plan their course of study appropriately. Important announcements related to curriculum updates will be placed 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) of all modules completed at all levels.

Please carefully read the information on *"Undergraduate Continuation and Graduation Requirements"* at the general information section of the NUS Bulletin (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

Other Academic Matters

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: one General Education Module and one Breadth module

b) Up to 12 MCs from Unrestricted Electives

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).

Mathematics Bridging Module for Polytechnic Graduates

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

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** must be taken by students who are required to read either one or both of these modules after taking the Qualifying English Test (QET) at the time of admission to the Faculty. There are no MCs assigned to either of these modules, but a pass is required for the award of the degree.
Students required to read ES1000 should do so in the first semester before reading ES1102 in the second semester.
Those required to read only ES1102 should do so in the first semester before proceeding to read modules to satisfy the Critical Thinking & Writing (CTW) and communications requirements.

Common Engineering

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

- MA1505 Mathematics I
- MA1506 Mathematics II
- CS1010E Programming Methodology (mapped to IT1005/CE2409 for students who enter Chemical/Civil/Environmental Engineering)
- Critical Thinking & Writing module (GEK1549 or equivalent)
- Communications module (ES2331 or equivalent)
- At least one physics module: either PC1431 Physics IE or PC1432 Physics IIE
- At least two engineering modules from: MLE1101 Introductory Materials Science and Engineering, EG1108 Electrical Engineering and EG1109 Statics and Mechanics of Materials.

Table 3.1.4 shows the modules that common engineering students are required to read to **qualify to apply for entry** into the various engineering disciplines. Common Engineering 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, Chemistry and Engineering modules which would qualify them to apply for entry into **at least three engineering disciplines**. Common Engineering students who have not read one or more of the required modules for an engineering discipline of interest may still be considered for the various disciplines on a case by case basis.

Table 3.1.4: Physics, Chemistry and Engineering modules required to be read by common engineering students to qualify for the various engineering disciplines

Engineering Programme	Physics Modules	Engineering Modules	Chemistry Modules
Biomedical	PC1431, PC1432	EG1108, EG1109	-
Chemical	-	MLE1101, CN1111	CM1502
Civil	PC1431	EG1109, MLE1101	-
Electrical	-	EG1108 (*satisfies EE1002*)	-
Computer	PC1432	EG1108 (*satisfies CG1108*)	-
Environmental	PC1431	EG1109	CM1502
Industrial & Systems	-	EG1108, EG1109	-
Mechanical	PC1431	EG1108, EG1109	-
Materials Science	PC1432	EG1108, EG1109	-

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. In order to nurture GEP students to become future engineer leaders, the Faculty of Engineering have crafted modules, such as MT2001 Experiencing Engineering Leadership and SSE1201 Building a Dynamic Singapore – Role of Engineers. Moreover, GEP students will get opportunities to touch base with CEOs from various industries in deep dialogue sessions.

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

Design-Centric Programme

The Design-Centric Programme (DCP) is a design focused learning pathway open to all engineering students in NUS. Students who have been offered one of the Engineering programmes are eligible to apply to the DCP. Being design focused, it is a complementary programme which enhances the learning outcomes of engineering students. DCP aims to produce engineering graduates with a broader perspective, and who have the ability to identify and solve complex challenges of societal importance.

A key focus of the DCP is the multi-year, multi-disciplinary projects which address complex problems within the five broad themes of Aerospace Systems, Engineering in Medicine, Future Transportation Systems, Innovative Systems, and Smart and Sustainable Cities. DCP students will spend 3 to 3.5 years (depending on the nature of the projects undertaken) working together on these projects in teams which may comprise students from different engineering disciplines. They will be guided by teams of mentors with diverse background. Students have the flexibility to determine the nature of their projects. For example, some students choose to work on projects which contribute to the improvement of lives in our societies, while others prefer to design advanced medical devices to assist doctors in their work. The DCP learning environment encourages creativity, team learning and collaboration/cooperation across disciplinary boundaries. DCP students have access to machine tools to help them realize their designs.

DCP 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). Upon completion of this module, students have the opportunity to continue on this pathway to further hone their design thinking skills to eventually design and create products which address the real needs of users. Others may move on to participate in community projects or to design medical devices and other innovative systems. Students who choose the Aerospace Systems track will participate in designing interesting payloads for satellites. Whichever project the students choose to embark on, the learning journey in DCP is a worthwhile experience for all Engineering students.

Website: http://www.eng.nus.edu.sg/edic/dcp.html

3.2 Bachelor of Engineering Degree Programmes

3.2.1 Bachelor of Engineering (Biomedical Engineering)

Overview

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

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

Our Programme Educational Objectives are to prepare our graduates so that they are able to (a) apply the core concepts of biomedical engineering, its underlying sciences, and relevant technologies in their chosen profession; (b) utilise

effective communication, learning, and teamwork skills to facilitate continued professional development; (c) possess a high standard of personal and professional integrity and ethical responsibility and (d) progress into positions of increasing leadership responsibilities.

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

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

Degree Requirements

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

- Complete a minimum of 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 12 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) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives	16
Programme Requirements	
Faculty Requirements:	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
ES2331 Communicating Engineering (Breath/UE)	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
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
Biomedical Engineering Major Requirements	
BME Core Subjects:	44
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[3] or CM1501* Organic Chemistry for Engineers[3]	4
BN2401 Biosignals Processing	4
LSM1401+ Fundamentals of Biochemistry or LSM1101+ Biochemistry of Biomolecules	4
LSM2103 Cell Biology	4
BME Design and Project Modules:	20
BN2103 Bioengineering Design Workshop	2
BN2203 Introduction to Bioengineering Design	4
BN3101 Biomedical Engineering Design	6
BN4101M B.Eng. Dissertation (over 2 semesters)	8
BME Electives:	
Technical Electives (from the modules in Table 3.2.1b)	12
EG3601 Industrial Attachment Programme[4]	12
Total	161

[1] BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.

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

[3*] 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.

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

Table 3.2.1b: Biomedical 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 12 MCs of modules within the specified area.
* The Department reserves the right to decide on the modules to be offered in any given semester.

Recommended Semester Schedule

Table 3.2.1c: Recommended Semester schedule for Biomedical Engineering Students

Modules	MCs	Modules	MCs
Semester 1		**Semester 2**	
MA1505 Mathematics I	4	GEK1549 Critical Thinking & Writing	4
PC1431 Physics IE	4	EG1108 Electrical Engineering	3
EG1109 Statics and Mechanics of Materials	4	MA1506 Mathematics II	4
CS1010E Programming Methodology	4	PC1432 Physics IIE	4
GE/SS/UE/Breadth 1*	4	ES2331 Communicating Engineering (Breadth/UE 2)	4
		BN2103 Bioengineering Design Workshop#	2
Sub-total	**20**	**Sub-total**	**21**
Semester 3		**Semester 4**	
BN2103 Bioengineering Design Workshop#	2	BN3501 Equilibrium & Kinetic Bioprocesses	4
BN2102 Bioengineering Data Analysis	4	BN2201 Quantitative Physiology for Bioengineers	4

BN2202 Introduction to Biotransport	4	BN2203 Introduction to Bioengineering Design	4
CM1501 Organic Chemistry for Engineers or CM1121 Basic Organic Chemistry	4	BN2401 Biosignals Processing	4
LSM1401 Fundamentals of Biochemistry	4	LSM2103 Cell Biology	4
GE/SS/UE/Breadth 3	4		
Sub-total	**22**	**Sub-total**	**20**
Semester 5		**Semester 6**	
BN3101 Biomedical Engineering Design	6	EG2401 Engineering Professionalism	3
BN3201 Introduction to Biomechanics	4	EG3601 Industrial Attachment Programme+	12
BN3301 Introduction to Biomaterials	4	GE/SS/UE/Breadth 4	4
BN3401 Biomedical Electronics & Systems	4		
HR2002 Human Capital in Organizations	3		
Sub-total	**21**	**Sub-total**	**19**
Semester 7		**Semester 8**	
BN4101M B.Eng. Dissertation	4	BN4101M B.Eng. Dissertation	4
BN Elective 1	4	BN Elective 3	4
BN Elective 2	4	GE/SS/UE/Breadth 7	4
GE/SS/UE/Breadth 5	4	GE/SS/UE/Breadth 8	4
GE/SS/UE/Breadth 6	4	GE/SS/UE/Breadth 9	4
Sub-total	**20**	**Sub-total**	**20**

* 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.

Half Cohort

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

Table 3.2.1d: Recommended Semester schedule for Biomedical Engineering Students without Physics

Modules	MCs	Modules	MCs
Semester 1		**Semester 2**	
CS1010E Programming Methodology	4	BN2103 Bioengineering Design Workshop#	2
MA1505 Mathematics I	4	EG1108 Electrical & Computer Engineering	3
EG1109 Statics and Mechanics of Materials	4	MA1506 Mathematics II	4
GE/SS/UE/Breadth 1 (PC1221)	4	PC1431 Physics IE	4
GE/SS/UE/Breadth 2 (PC1222)	4	PC1432 Physics IIE	4
		GEK1549 Critical Thinking & Writing	4
Sub-total	**19**	**Sub-total**	**21**
Semester 3		**Semester 4**	
BN2103 Bioengineering Design Workshop#	2	BN2201 Quantitative Physiology for Bioengineers	4

BN2102	Bioengineering Data Analysis	4	BN2203	Introduction to Bioengineering Design	4
BN2202	Introduction to Biotransport	4	BN2401	Biosignals Processing	4
CM1501 or CM1121	Organic Chemistry for Engineers / Basic Organic Chemistry	4	BN3501	Equilibrium & Kinetic Bioprocesses	4
ES2331	Communicating Engineering (Breadth/UE)	4	LSM2103	Cell Biology	4
LSM1401	Fundamentals of Biochemistry	4			
Sub-total		**22**	**Sub-total**		**20**
Semester 5			**Semester 6**		
BN3101	Biomedical Engineering Design	6	EG2401	Engineering Professionalism	3
BN3201	Introduction to Biomechanics	4	EG3601	Industrial Attachment Programme+	12
BN3301	Introduction to Biomaterials	4	GE/SS/UE/Breadth 3		4
BN3401	Biomedical Electronics & Systems	4			
HR2002	Human Capital in Organizations	3			
Sub-total		**21**	**Sub-total**		**19**
Semester 7			**Semester 8**		
BN4101M	B.Eng. Dissertation	4	BN4101M	B.Eng. Dissertation	4
BN Elective 1		4	BN Elective 3		4
BN Elective 2		4	GE/SS/UE/Breadth 6		4
GE/SS/UE/Breadth 4		4	GE/SS/UE/Breadth 7		4
GE/SS/UE/Breadth 5		4	GE/SS/UE/Breadth 8		4
Sub-total		**20**	**Sub-total**		**20**

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

3.2.2 Bachelor of Engineering (Chemical Engineering)

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.

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

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

To achieve the above PEO, the four-year undergraduate Chemical Engineering programme has been designed to provide a complete learning experience by incorporating the three essential components of the university's curriculum structure, namely, University Level Requirements (ULRs, to provide broad-based education), Programme Requirements (to provide strong background in the discipline) and Unrestricted Elective Modules (UEMs, to give flexibility to students to meet their own aspirations).

The requirements for the 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 that complement individual career plans or to simply pursue personal curiosity and interest. All Chemical Engineering students are exposed to industrial practice through internship, site visits and/or lectures by practising engineers. They are also provided with networking, globalization and technical/business leadership opportunities through student exchange, overseas colleges, entrepreneurship and minor programmes for broader education.

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

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

The 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.

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 12 MCs of technical electives.
- A student may choose to specialise in Biomolecular Engineering, Microelectronics Processing or Process Systems Engineering by taking 4 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[1]

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives	20
Programme Requirements	
Faculty Requirements:	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
GEK2331 Communicating Engineering (Breadth/UE)	4
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
HR2002 Human Capital in Organizations	3
Foundation Requirements:	24
MA1505 Mathematics I	4
MA1506 Mathematics II	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
Chemical Engineering Major Requirements:	**87**
CHE Core Subjects:	49
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	Fluid-Solid Systems	3
CN3121	Process Dynamics and Control	4
CN3132	Separation Processes	4
CN3135	Process Safety, Health & Environment	3
CN3421	Process Modelling and Numerical Simulation	4
CN4122	Process Synthesis and Simulation	3
CHE Design and Project modules		14
CN4118	**B.Eng. Dissertation**	8
CN 4123R	**Design Project**	6
CHE Electives		12
3 Technical Electives (from Table 3.2.2b)		
EG3601 Industrial Attachment Programme[3]		**12**
Total		161

[1] BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.

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

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

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

Biomolecular Engineering

CN4233R Good Manufacturing Practices in Pharmaceutical Industry
CN4241R Engineering Principles for Drug Delivery
CN4246R Chemical and Bio-Catalysis
CN4247R Enzyme Technology
CN4249 Engineering Design in Molecular Biotechnology
CN5172 Biochemical Engineering
CN5173 Downstream Processing of Biochemical and Pharmaceutical Products
CN5222 Pharmaceuticals and Fine Chemicals

Microelectronics Processing

BN4404 Bioelectromechanicals systems – BioMEMs
CN4216R Electronics Materials Science
CN4217R Processing of Microelectronic Materials
CN4223R Microelectronic Thin Films

Process Engineering

CN4205R Process Systems Engineering
CN4227R Advanced Process Control
CN4238R Chemical & Biochemical Process Modelling
CN4245R Data Based Process Characterisation
CN4248 Sustainable Process Development
CN5111 Optimisation of Chemical Processes
CN5181 Computer Aided Chemical Engineering
CN5185 Batch Process Engineering
CN5186 Design and Operation of Process Networks
CN5191 Project Engineering
ESP4402 Transport Phenomena in Energy Systems

Process Technology

CN4201R Petroleum Refining
CN4203R Polymer Engineering
CN4211R Petrochemicals and Processing Technologies
CN4215R Food Technology and Engineering
CN4240R Processes for Effluent Control
CN5251 Membrane Science and Engineering

Others

CN4291 Selected Topics in Chemical Engineering

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

Recommended Semester Schedule

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

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

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
GEK1549 Critical Thinking & Writing	4	ES2331 Comunicating Engineering (UEM 1)	4
GE 1 OR CN1111 Chemical Engineering Principles	4	CM1502 General and Physical Chemistry for Engineers	4
IT1005 Introduction to Programming with Matlab	4	CN1111 Chemical Engineering Principles OR GEM 1	4
MA1505 Mathematics	4	MA1506 Mathematics II	4
Singapore Studies	4	MLE1101 Introductory Materials Science and Engineering	4
ES1102 English for Academic Purposes	-		
Sub-total	**20**	**Sub-total**	**20**
Semester 3		Semester 4	

CN2121 Chemical Engineering Thermodynamics	4	CN2108 Chemical Eng Lab I	2
CN2122 Fluid Mechanics	4	CN2116 Chemical Kinetics and Reactor Design	4
LSM1401 Fundamentals of Biochemistry	4	CN2125 Heat and Mass Transfer	4
GE 2	4	CN3124 Fluid-Solid Systems	3
UE 2	4	EG2401 Engineering Professionalism	3
		Breadth 1	4
Sub-total	**20**	**Sub-total**	**20**
Semester 5		Semester 6[#]	
CN3108 Chemical Eng Lab II	4	CN3109 Chemical Eng Lab III	2
CN3121 Process Dynamics and Control	4	CN4118 B.Eng. Dissertation	7
CN3132 Separation Processes	4	CN4122 Process Synthesis and Simulation	3
CN3135 Process Safety, Health & Environment	3	UE 3	4
CN3421 Process Modelling and Numerical Simulation	4	Breadth 2	4
HR2002 Human Capital in Organizations	3		
Sub-total	**22**	**Sub-total**	**20**
Semester 7[#]		Semester 8	
Technical Elective 1	4	CN4118 B.Eng. Dissertation (continued)	1
Technical Elective 2	4	CN4123R Design Project	6
EG3601 Industrial Attachment Programme	12	Technical Elective 3	4
		UE 4	4
		UE 5	4
Sub-total	**20**	**Sub-total**	**19**

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

3.2.2.1 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 (CN4118) should preferably be carried out in a Life/Chemical Sciences area. Industrial Attachment (IA) is optional for students in this programme. 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:

- 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)

Overview

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

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

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

The 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.

Degree Requirements

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

- Complete a minimum of 162 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.
- Students are required to read ES2331 Communicating Engineering towards the ULR-Breadth requirement.

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

For students aspiring for a First Class Honours Degree, they must obtain at least an 'A-' grade for CE4104 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 Wave Hydrodynamics and Physical Oceanography, and complete a 12-week stint (equivalent to at least 6 MCs) in an offshore or marine-related company under EG3602 Vacation Internship Program.

Table 3.2.3a: Summary of Modular Requirements and Credits (for A-level or equivalent students matriculated in AY2014/2015)

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives	20
Programme Requirements	
Faculty Requirements:	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
GEK2331 Communicating Engineering (Breadth/UE)	4
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
HR2002 Human Capital in Organizations	3
Foundation Requirements:	16
MA1505 Mathematics I	4
MA1506 Mathematics II	4
EG1109 Statics and Mechanics of Materials	4
PC1431 Physics IE	4
CE Computing Requirement:	**4**
CE2409 Computer Applications in Civil Engineering	4
Civil Engineering Major Requirements	
CE Core Subjects:[+]	56
CE2112 Soil Mechanics (G)	4
CE2134 Hydraulics (H)	4
CE2155 Structural Mechanics and Materials (S)	4

CE2183	Construction Project Management (C)	4
CE2184	Infrastructure and the Environment (C)	4
CE2407	Engineering and Uncertainty Analyses	4
ESE3001	Water Quality Engineering (E)	4
CE3115	Geotechnical Engineering (G)	4
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:		12
Level 3 Technical Elective Modules		4
Higher Level Technical Elective Modules		8
Industrial Engagement[3]		12
Total		162

[1] BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.

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

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

+ 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 162 MCs for graduation).

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
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)
CE4221 Design of Land Transport Infrastructure
CE4282 Building Information Modelling for Project Management
CE5204 Pavement Design and Rehabilitation
CE5205 Transportation Planning
CE5207 Pavement Network Management Systems
CE5603 Engineering Economics and Project Evaluation
CE5804 Global Infrastructure Project Management
CE5805 Construction Equipment and Methods
CE5806 Construction Project and Site Control
CE5880 Topics in Project Management Engineering †
CE5882 Topics in Transportation Engineering †
TP5025 Intelligent Transportation Systems
TP5026 Transport Management & Policy
TP5027 Transport & Freight Terminal Management
TP5028 Intermodal Transportation Operations

Coastal & Offshore Engineering Modules (H)
CE4231 Earth's Climate: Science & Modelling
CE4247 Treatment Plant Hydraulic
CE5307 Wave Hydrodynamics and Physical Oceanography
CE5308 Coastal Processes & Sediment Transport
CE5312 River Mechanics
CE5313 Groundwater Hydrology
CE5883 Topics in Hydraulic & Water Resources
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

Recommended Semester Schedule

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

Table 3.2.3b: Recommended Semester Schedule for CE Students (AY2014/2015 onwards)

Modules	MCs	**Modules**	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE	4	CE2134 Hydraulics	4
EG1109 Statics and Mechanics of Material	4	CE2155 Structural Mechanics and Materials	4
CE2409 Computer Applications in Civil Engineering^	4	GE/SS/Breadth Module	4
GEK1549 Critical Thinking and Writing	4	GE/SS/Breadth Module	4
ES1102 English for Academic Purposes *	-		
Sub-total	20	Sub-total	20

* For students who have not passed or been exempted from the Qualifying English Test at the time of admissions to the Faculty, they have to do ES1000 and / or ES1102. This will be decided by CELC. GEK1549 must be read and it can be used to fulfil GEM A.
^ CA – 100%

Modules	**MCs**	**Modules**	**MCs**	
Semester 3		Semester 4		
CE2112 Soil Mechanics	4	CE3115 Geotechnical Engineering	4	
CE2183 Construction Project Management	4	CE3132 Water Resources Engineering	4	
CE2184 Infrastructure and the Environment	4	CE3155 Structural Analysis	4	
CE2407 Engineering and Uncertainty Analyses	4	ESE3001 Water Quality Engineering	4	
ES2331 Communicating Engineering	4	GE/SS/Breadth Module	4	

Sub-total	20	Sub-total	20	
Semester 5		Semester 6		
CE3116 Foundation Engineering	4	Industrial Engagement	12	
CE3121 Transportation Engineering	4	UE 1	4	
CE3165 Structural Concrete Design	4	UE 2	4	
CE3166 Structural Steel Design and System	4			
Technical Elective Module 1	4			
GE/SS/Breadth Module	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	UE 4	4	
Technical Elective Module 2	4	Unrestricted Elective Module 5	4	
Technical Elective Module 3	4	HR2002 Human Capital in Organizations	3	
UE 3	4	EG2401 Engineering Professionalism	3	
Sub-total	20	Sub-total	18	

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

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

Semester 5		**Semester 6**	
Modules	MCs	Modules	MCs
Semester 3		Semester 4	
MA1301 Introductory Mathematics *(fulfills UE 4)*	4	MA1505 Mathematics I	4
CE2155 Structural Mechanics and Materials	4	CE2112 Soil Mechanics	4
CE2184 Infrastructure and the Environment	4	CE2134 Hydraulics	4
PC1431 Physics IE *(upon failure of APC test)*	4	ESE3001 Water Quality Engineering	4
Breadth module	4	GEK1549 Critical Thinking and Writing	4
ES1102 English for Academic Purposes **	-		
Sub-total	**20**	Sub-total	**20**

Note:

- @ PC1431 is a compulsory module and can be read in any semester if you choose to. Or you can also take PC1221 Fundamental of Physics 1 (can count towards Breadth) before taking PC1431.
- GEK1549 must be read and it can be used to fulfil GEM A.

Semester 5		Semester 6	
MA1506 Mathematics II	4	CE3116 Foundation Engineering	4
CE2183 Construction Project Management	4	CE3165 Structural Concrete Design	4
CE3115 Geotechnical Engineering	4	CE3166 Structural Steel and Design System	4
CE3155 Structural Analysis	4	CE3132 Water Resources Engineering	4
Singapore Studies	4	Technical Elective Module 1	4
		Free Elective	4
Sub-total	**24**	Sub-total	**24**
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
CE3121 Transportation Engineering	4	EG2401 Engineering Professionalism	3
Free Elective x 2	8	UE	4
Sub-total	**20**	Sub-total	**19**

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

Note:
Polytechnic graduates admitted into BEng programmes with the (12MC) Industrial Engagement requirement, may take the 12-week internship (6MC via EG3602) and/or 'Free Elective' modules in lieu of the 12 MC for EG3601. Students can consider taking their Free Elective module/s during Special Terms.

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/programmes/BEng_Civil.html

3.2.4 Bachelor of Engineering (Computer Engineering)

Please refer to
http://www.nus.edu.sg/registrar/nusbulletin/other-multidisciplinary-special-programmes/bachelor-engineering-computer-engineering-programme
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3.2.5 Bachelor of Engineering (Electrical Engineering)

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.

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 20 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) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty +	8
Unrestricted Electives +	16
Programme Requirements	
Faculty Requirements:	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
ES2331 Communicating Engineering (Breadth/UE)	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
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:		40
EE2020	Digital Fundamentals	5
EE2021	Devices and Circuits	4
EE2023	Signals and Systems	4
EE2024	Programming for Computer Interfaces	5
EE2025	Power Electronics	4
EE2031	Circuits & Systems Design Lab	3
EE2032	Signals & Communications Design Lab	3
EE2011	Engineering Electromagnetics	4
EE2012	Analytical Methods in Electrical & Computer Engineering	4
PC2232	Physics for Electrical Engineers	4
EE Project Modules:		18
EE3031	Innovation & Enterprise I	4
EE3032	Innovation & Enterprise II	6
EE4002	B.Eng. Dissertation (over 2 semesters)	8
EG3601	**Industrial Attachment Programme[3]**	**12**
EE Electives:		
Elective Modules from Table 3.2.5b to satisfy the breadth and depth requirements of the B.Eng. (EE) programme.		20
Total		160

[+] Students need to take ES2331 Communicating Engineering (4 MC), a compulsory Faculty requirement as ULR Breadth-

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

[1] BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.

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

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

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 and Information 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 two modules from a minimum of two 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 two depth electives. EE students also need to read one elective which can be chosen from the breadth or depth elective of any concentration. All five technical electives must add up to

at least 20 MCs. EE students should read at least 12 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 3.2.5d.

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	EE3505C Electrical Energy Systems
Signal Processing & New Media	EE3731C Signal Processsing Methods
Engineering Computing	EE3013C 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	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	
	EE3407 Analog Electronics	

Depth	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	
	EE4434	Integrated Circuit Technology, Design and Testing	
	ESP4302	Nanophotonics	
	CN4223R	Microelectronic Thin Films	
Power & Energy Systems			
Depth	EE4501	Power System Management & Protection	
	EE4502	Electric Drives and Control	
	EE4505	Power Semiconductor Devices and ICs	
	EE4509	Silicon Microsystems	
	EE4510	Solar Photovoltaic Energy Systems	
	EE4511	Sustainable Energy Systems	
Signal Processing & New Media			
Breadth	EE3206	Introduction to Computer Vision and Image Processing	
	EE3701	Digital Media Technologies	
	EE4212	Computer Vision	
Depth	EE4213	Image Processing	
	CS3240	Interaction Design	
Microwave & RF			
	EE4101	RF Communications	

Depth	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	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	

Table 3.2.5d: Possible Specialisation Tracks in Electrical Engineering

Advanced Control
Biomedical Systems
Computational Sensory 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/education/undergraduate/ee/Specialization.html

Recommended Semester Schedule

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

Table 3.2.5e: Recommended Semester Schedule for EE students

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
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	GEK1549 Critical Thinking and Writing	4
EE1002 Introduction to Circuits and Systems	4	EE2020 Digital Fundamentals	5
Singapore Studies Module*	4	GE* x 1	4
Sub-total	**20**	**Sub-total**	**21**
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	5	EE2032 Signals & Communications Design Lab	3
EE2011 Engineering Electromagnetics	4	EE3031 Innovation & Enterprise I	4
ULR-Breadth* x 1 : ES2331 Communication Engineering	4	Breadth Level Technical Elective x 1	4
		PC2232 Physics for Electrical Engineers	4
Sub-total	**21**	**Sub-total**	**23**
Semester 5		Semester 6	
EG3601 Industrial Attachment Programme	12		

EE3031 Innovation & Enterprise I	4	EG2401 Engineering Professionalism	3
		EE3032 Innovation & Enterprise II	6
		EE2031 Circuits & Systems Design Lab	3
		Breadth Level Technical Elective x 2	8
Sub-total	**16**	**Sub-total**	**20**
Semester 7		Semester 8	
EE4002 B.Eng. Dissertation (over 2 semesters)	4	EE4002 B.Eng. Dissertation (over 2 semesters)	4
HR2002 Human Capital in Organizations	3	UE* x 3	4
Depth Level Technical Electives x 1	4		
Breadth / Depth Level Technical Elective x 1	4	Depth Level Technical Elective x 1	4
ULR-Breadth* x 1	4		
Sub-total	**19**	**Sub-total**	**18**
Total MCs			160

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

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

3.2.6 Bachelor of Engineering (Engineering Science)

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.

Degree Requirements

The following are the requirements for the degree of B.Eng. (Engineering Science)*(for students matriculated from AY2014/15)*:

- 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	**20**
General Education Modules (GEM) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Module	8
Programme Requirements	
Faculty Requirements:	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
ES2331 Communicating Engineering (Breadth/UE)	4
HR2002 Human Capital in Organisations	3
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
Engineering Science 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
ESP3902 Major Design Project 1	4
ESP3903 Major Design Project 2	4
ESP4901 Research Project	12
Third and Fourth Year Specialisation Modules	24
Unrestricted Elective Modules	20
EG3602 Vacation Internship Programme[3]	6
Total	160

[#] Students who have read and passed MA1101R Linear Algebra I prior to joining ESP are allowed to map MA1101R to MA1508.
[1] BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.
[2] For students who have not passed or been exempted from the Qualifying English Test at the time of admission to the Faculty.
[3] For BEng students in the following special programmes: DDPs, CDPs, GEP & CSP, internship / industrial-attachment is optional and the modular credits for the internship/industrial-attachment will be become 'Free Electives' i.e., Unrestricted Electives (UE).

Note: Limit on Level-1000 Modules

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

ESP Specialisations

At the end of the second year, students opt for one of the four specialisations. In each of the specialisation, students need to complete 4 core modules and 2 technical electives from the same chosen specialisation.

ESP Specialisations in Year 3 and 4	MCs
Nanoscience and Nanotechnology	24
Computational Engineering Science	24
Photonics and Optics	24
Energy Systems	24

Nanoscience and Nanotechnology Specialisation
Core modules
ESP3102 From Making Nano to Probing Nano
CM3296 Molecular Modelling: Theory and Practice
PC3251 Nanophysics
PC4259 Surface Physics
Technical electives (choose 2)
BN5101 Engineering Principles in Medicine I
BN5205 Computational Biomechanics
CM3231 Quantum Chemistry and Molecular Thermodynamics
CM3232 Physical Chemistry of the Solid State and Interfaces
CM3251 Nanochemistry
CM5223 Topics in Supramolecular Chemistry
EE3407 Analog Electronics
EE3408C Integrated Analog Design

EE4401 Optoelectronics
EE4433 Nanometer Scale Information Storage
ESP3206 Continuum Mechanics
ESP4302 Nanophotonics
ME4284 Micro Sensors and Micro Actuators
PC3233 Atomic and Molecular Physics I
PC3235 Solid State Physics I
PC3236 Computational Methods in Physics
PC3241 Solid State Devices
PC3274 Mathematical Methods in Physics II
PC4274 Mathematical Methods in Physics III
PC4240 Solid State Physics II
PC4253 Thin Film Technology
PC5205 Topics in Surface Physics
PC5212 Physics of Nanostructures

Computational Engineering Science Specialisation
Core modules
ESP3206 Continuum Mechanics
MA3227 Numerical Analysis II
PC3274 Mathematical Methods in Physics II
ME4291 Finite Element Analysis
Technical electives (choose 2)
BN4406 Biophonics and Bioimaging
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
MA2108 Mathematical Analysis
MA3220 Ordinary Differential Equations
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
PC4274 Mathematical Methods in Physics III
IE2110/MA3236 Operations Research / Non-linear Programming

Photonics and Optics Specialisation
Core modules
EE2023 Signals and Systems
PC3247 Modern Optics
ESP4302 Nanophotonics
EE4603 Biomedical Imaging Systems
Technical electives (choose 2)
BN4406 Biophonics and Bioimaging
BN5101 Engineering Principles in Medicine I
BN5205 Computational Biomechanics
CS3216 Software Development on Evolving Platforms

EE3206 Introduction to Computer Vision and Image Processing
EE3407 Analog Electronics
EE4212 Computer Vision
EE4213 Image Processing
EE4305 Introduction to Fuzzy/Neural Systems
EE4401 Optoelectronics
EE4604 Biological Perception in Digital Media
EE4605 Bio-Instrumentation & Signal Analysis
ESP3206 Continuum Mechanics
ESP4301 Charged Particle Optics
PC3243 Photonics
PC3274 Mathematical Methods in Physics II
PC4274 Mathematical Methods in Physics III

Energy Systems Specialisation
Core modules
ESP3401 Photovoltaic Devices and Systems
ME3221 Energy Conversion Processes
EE2022 Electrical Energy Systems
ESP4402 Transport Phenomena in Energy Systems
Technical electives (choose 2)
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
ESP3206 Continuum Mechanics
ESP5402 Nanomaterials for Energy Systems
ME3122 Heat Transfer
ME4223 Thermal Environmental Engineering
ME4225 Industrial Heat Transfer
ME4284 Micro Sensors and Micro Actuators
ME5207 Solar Energy Systems
PC3241 Solid State Devices
PC3274 Mathematical Methods in Physics II
PC4274 Mathematical Methods in Physics III
PC4253 Thin Film Technology

Recommended Semester Schedule

Table 3.2.6b: Recommended Semester Schedule for Engineering Science Students*(matriculated from AY2014/2015)*

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

GEK1549 Critical Thinking and Writing	4	MA1508 Linear Algebra with Applications	4
GE / SS / UE / Breadth	4	GE/ SS / UE / Breadth	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
ES2331 Communicating Engineering (UEM 1)	4	EE2022 / GE 2 Electrical Energy Systems (for ES Specialisation) / GE / SS / UE / Breadth	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**	
ESP3902 Major Design Project I	4	ESP3903 Major Design Project II	4
ESP3102 From Making Nano to Probing Nano	4	CM3296 Molecular Modelling: Theory and Practice	4
Nanoscience and Nanotechnology Elective 1	4	PC3251 Nanophysics	4
Nanoscience and Nanotechnology Elective 2	4	GE / SS / UE / Breadth	4
GE / SS / UE /Breadth	4	GE / SS / UE / Breadth	4
Sub-total	**20**	**Sub-total**	**20**
Semester 7		**Semester 8**	
ESP4901 Final Year Project (over 2 semesters)	6	ESP4901 Final Year Project (over 2 semesters)	6
PC4259 Surface Physics	4	HR2002 Human Capital in Organisations	3
EG2401 Engineering Professionalism	3	GE / SS / UE / Breadth	4
GE / SS / UE / Breadth	4	GE / SS / UE / Breadth	4
Nanoscience and Nanotechnology Elective 3	4		
Nanoscience and Nanotechnology Elective 4	4		
Sub-total	**19**	**Sub-total**	**17**

Computational Engineering Science Specialisation

Modules	MCs	Modules	MCs
Semester 5		Semester 6	

ESP3902 Major Design Project I	4	ESP3903 Major Design Project II	4
ESP3206 Continuum Mechanics	4	MA3227 Numerical Analysis II	4
PC3274 Mathematical Methods in Physics II	4	Computational Engineering Science Elective 2	4
Computational Engineering Science Elective 1	4	GE / SS / UE / Breadth	4
GE / SS / UE / Breadth	4	GE / SS / UE / Breadth	4
Sub-total	20	Sub-total	20
Semester 7		Semester 8	
ESP4901 Final Year Project (over 2 semesters)	6	ESP4901 Final Year Project (over 2 semesters)	6
ME4291 Finite Element Analysis	4	HR2002 Human Capital in Organisations	3
EG2401 Engineering Professionalism	3	GE / SS / UE / Breadth	4
GE / SS / UE / Breadth	4	GE / SS / UE / Breadth	4
Sub-total	17	Sub-total	17

Photonics and Optics Specialisation

Modules	MCs	Modules	MCs
Semester 5		**Semester 6**	
ESP3902 Major Design Project I	4	ESP3903 Major Design Project II	4
EE2023 Signals and Systems	4	Photonics and Optics Elective 2	4
PC3247 Modern Optics	4	GE / SS / UE / Breadth	4
Photonics and Optics Elective 1	4	GE / SS / UE / Breadth	4
GE / SS / UE / Breadth	4	GE / SS / UE / Breadth	4
Sub-total	**20**	**Sub-total**	**20**
Semester 7		**Semester 8**	
ESP4901 Final Year Project (over 2 semesters)	6	ESP4901 Final Year Project (over 2 semesters)	6
ESP4302 Nanophotonics	4	EE4603 Biomedical Imaging Systems	4
EG2401 Engineering Professionalism	3	HR2002 Human Capital in Organisations	3
GE / SS / UE / Breadth	4	GE / SS / UE / Breadth	4
Sub-total	**17**	**Sub-total**	**17**

Energy Systems Specialisation

Modules	MCs	Modules	MCs
Semester 5		Semester 6	
ESP3902 Major Design Project I	4	ESP3903 Major Design Project II	4
ESP3401 Photovoltaic Devices and Systems	4	ME3221 Energy Conversion Processes	4
Energy Systems Elective 1	4	Energy Systems Elective 2	4

GE / SS / UE / Breadth	4	GE / SS / UE / Breadth	4
GE / SS / UE / Breadth	4	GE / SS / UE / Breadth	4
Sub-total	20	Sub-total	20
Semester 7		Semester 8	
ESP4901 Final Year Project (over 2 semesters)	6	ESP4901 Final Year Project (over 2 semesters)	6
EG2401 Engineering Professionalism	3	ESP4402 Transport Phenomena in Energy Systems	4
GE / SS / UE / Breadth	4	HR2002 Human Capital in Organisations	3
GE / SS / UE / Breadth	4	GE / SS / UE / Breadth	4
Sub-total	17	Sub-total	17

3.2.7 Bachelor of Engineering (Environmental Engineering)

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.

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 12 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 (for A-level or equivalent students matriculated in AY2014/2015)

Modular Requirements	MCs
University Level Requirements	20
General Education Modules (GEM) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives	20
Programme Requirements	
Faculty Requirements	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
ES2331 Communicating Engineering	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
Environmental Engineering Major Requirements	
Foundation Requirements	24
MA1505 Mathematics I	4
MA1506 Mathematics II	4
PC1431 Physics IE	4
CE2409 Computer Applications in Civil Engineering	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**
CE2112 Soil Mechanics	4
CE2155 Structural Mechanics and Materials	4
CE3132 Water Resources Engineering	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
ESE Design and Project Modules	**12**
ESE4501 Design Project	4
ESE4502R B.Eng Dissertation	8
ESE Elective Modules	12
3 Technical Electives (from Table 3.2.7b)	
Industrial Engagement[3]	12
Total	162

[1] BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.

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

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

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

Table 3.2.7b: Technical Elective Modules*

Department of Civil and Environmental Engineering

ESE4301 Wastewater Biotechnology
ESE4401 Water & Wastewater Engineering 2
ESE4403 Membrane Tech in Env Applns
ESE4404 Bioenergy
ESE4405 Urban Water Engineering & Management
ESE4406 Energy and the Environment
ESE4407 Environmental Forensics
ESE4408 Environmental Impact Assessment
ESE4409 Environmental Applications of Adsorption
ESE5201 Combustion Pollution Control
ESE5202 Air Pollution Control Technology
ESE5203 Aerosol Science and Technology
ESE5204 Toxic & Hazardous Waste Management
ESE5205 Sludge and Solid Waste Management
ESE5301 Environmental Biological Principles
ESE5401 Water Quality Management
ESE5402 Industrial Wastewater Control
ESE5403 Water Reclamation & Reuse
ESE5404 Biological Treatment Processes
ESE5405 Water Treatment Processes
ESE5406 Membrane Treatment Process and Modelling
ESE5601 Environmental Risk Assessment
ESE5602 Environmental Management Systems
ESE5603 Pollution Minimisation and Prevention
CE4231 Earth's Climate: Science & Modelling
CE4247 Treatment Plant Hydraulics
CE5307 Wave Hydrodynamics and Physical Oceanography
CE5603 Engineering Economics & Project Evaluation
CE5883A Topics in Hydraulic & Water Resources

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

Dept of Chemical and Biomolecular Engineering

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

Dept of School of Design and Environment

LX5104 Environmental Law

Recommended Semester Schedule

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

Table 3.2.7b: Recommended Semester schedule for EVE Students (Cohort AY2014/2015 onwards)

Modules	MCs	Modules	MCs

Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE	4	GEK1549 Critical Thinking and Writing	4
ESE1001 Environmental Engineering Fundamentals	4	CE2134 Hydraulics	4
CE2409 Computer Applications in Civil Engineering	4	CM1502 General and Physical Chemistry for Engineers	4
EG1109 Statics and Mechanics of Materials	4	CE2155 Structural Mechanics and Materials$^{\Delta}$, or LSM1401 Fundamentals of Biochemistry $^{\Delta}$	4
ES1102* English for Academic Purposes	-		
Sub-total	20	Sub-total	20

* Students who have not passed or even been exempted from the Qualifying English Test at the time of admissions to the Faculty, will have to read ES1000 and/or ES1102. This will be decided by CELC. GEK1549 must be read and it can be used to fulfil GEM A.

Modules	MCs	Modules	MCs
Semester 3		Semester 4	
CE2112 Soil Mechanics $^{\Delta}$,or CN2121 Chemical Engineering Thermodynamics $^{\Delta}$,or LSM1401 Fundamentals of Biochemistry $^{\Delta}$,or CM2142 Analytical Chemistry $^{\Delta}$	4	LSM1401 Fundamentals of Biochemistry $^{\Delta}$,or CM2142 Analytical Chemistry $^{\Delta}$,or AR2723 Strategies for Sustainable Architecture $^{\Delta}$,or CE3132 Water Resources Engineering $^{\Delta}$	4
CE2183 Construction Project Management	4	ESE2401 Water Science & Technology	4
CE2407 Engineering and Uncertainty Analysis	4	2 x GE/SS/Breadth Module	8
ESE2001 Environmental Processes	4	UE 1	4
ES2331 Communicating Engineering	4	UE 2	4
Sub-total	20	Sub-total	24

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

Modules	MCs	Modules	MCs
Semester 5		Semester 6	
ESE3101 Solid and Hazardous Waste Mgmt	4	Industrial Engagement	12
ESE3201 Air Quality Management	4	UE 3	4
ESE3301 Environmental Microbiological Principles	4	UE 4	4
ESE3401 Water & Wastewater Engineering 1	4		
Technical Elective Module 1	4		
Sub-total	**20**	**Sub-total**	**20**

Semester 7		Semester 8	
ESE4501 Design Project	4	ESE4502R B.Eng Dissertation (Cont'd)	4
ESE4502R B.Eng. Dissertation	4	HR2002 Human Capital in Organizations	3
Technical Elective Module 2	4	EG2401 Engineering Professionalism	3
Technical Elective Module 3	4	UE 5	4
GE/SS/Breadth Module	4	GE/SS/Breadth Module	4
Sub-total	20	Sub-total	18

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

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

Modules	MCs	Modules	MCs
Semester 3		**Semester 4**	
MA1301 Introductory Mathematics *(can count towards UEM4)* *If exemption is given, read MA1505*	4	MA1505 Mathematics I	4
EG1109 Statics and Mechanics	4	ESE2401 Water Science and Technology	4
ESE1001 Environmental Engineering Fundamentals	4	CM1502 General and Physical Chemistry for Engineers*	4
ESE2001 Environmental Processes	4	GEK1549 Critical Thinking and Writing (GEM A)	4
PC1431 Physics IE *	4	Breadth module	4
ES1102** English for Academic Purposes	-	UE 5	4
Sub-total	20	Sub-total	24

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

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

Note:

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

Semester 5		Semester 6	
MA1506 Mathematics II	4	CE2155* Structural Mechanics and Materials (Pre-Req: EG1109), or CM2142* Analytical Chemistry (Pre-Req: CM1101), or AR2723* Strategies for Sustainable Architecture, or LSM1401* Fundamentals of Biochemistry	4
CE2112* Soil Mechanics (Pre-Req: EG1109), or LSM1401* Fundaments of Biochemistry, or CN2121* Chemical Engineering Thermodynamics (Pre-Req: CN1111 and CM1502), or CM2142* Analytical Chemistry (Pre-Req: CM1101 waived if pass CM1502)	4	CE2134 Hydraulics	4
ESE3401 Water and Wastewater Engineering 1	4	Technical Elective Module 1	4
CE2183 Construction Project Management	4	Free Elective Module 2	4
Free Elective Module 1	4	Free Elective Module 3	
Singapore Studies	4		
Sub-total	24	Sub-total	**20**

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

Semester 7		Semester 8	
ESE3101 Solid & Hazardous Waste Management	4	ESE4502 BEng Dissertation*(cont'd)*	4
ESE3201 Air Quality Management	4	CE2155* Structural Mechanics and Materials (Pre-Req: EG1109), or CE3132 Water Resources Engineering (Pre-Req: CE2134), or AR2723* Strategies for Sustainable Architecture, or CM2142* Analytical Chemistry (Pre-Req: CM1101), or LSM1401* Fundamentals of Biochemistry	4
ESE3301 Environmental Microbiological Principles	4	EG2401 Engineering Professionalism	3
ESE4501 Design Project	4	Technical Elective Module 2	4
ESE4502 BEng Dissertation	4	Technical Elective Module 3	4
CE2407 Engineering and Uncertainty Analysis *(if not taken in earlier semesters)*	4		
Sub-total	**24**	Sub-total	**19**

Note:

- The above schedule can be revised in the event of timetabling constraints.
- Polytechnic graduates admitted into BEng programmes with the (12MC) Industrial Engagement requirement, may take the 3-month internship (6MC via EG3602) and/or 'Free Elective' modules in lieu of the 12 MC for EG3601. Students can consider taking their Free Elective module/s during Special Terms.

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

3.2.8 Bachelor of Engineering (Industrial & Systems Engineering)

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.

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 3.2.8d. 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) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty[+]	8
Unrestricted Electives	20
Programme Requirements	
Faculty Requirements	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
ES2331 Communicating Engineering (Breadth/UE)	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
Foundation Requirements	23/24
MA1505 Mathematics I	4
MA1506 Mathematics II	4

Basket of Science Modules **	3/4
CS1010E Programming Methodology	4
ST1131 Introduction to Statistics	4
ST2131 Probability	4
ISE Major Requirements	87
CS1020E Data Structures and Algorithms	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
IE3101 Statistics for Engineering Applications	4
IE3110 Simulation	5
ISE Design and Project Modules	
IE3100M Systems Design Project	12
IE4100R B.Eng. Dissertation	8
ISE Electives (See Table 3.2.8d)	24
EG3602 Vacation Intership Programme[3]	**6**
Total	160/161

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

[1] BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.

[2] 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.

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

Table 3.2.8b: List of Science 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
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 3.2.8- c: 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 Algorithms
	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 column)
- at least one module from (A), one module from (B), and one 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.

Recommended Semester Schedule

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

Table 3.2.8d: Recommended Semester Schedule

Modules	MCs	Modules	MCs
MA1505 Mathematics I	4	MA1506 Mathematics II	4
Basket of Science Modules (click to view table)	3/4	IE2140 Engineering Economy	4
CS1010E Programming Methodology	4	GEK1549 Critical Thinking and Writing	4
ST1131[+] Introduction to Statistics	4		
GE/SS/UEM/Breadth	4	ST2131[+] Probability	4
		GE/SS/UEM/Breadth	4
Sub-total	19/20	Sub-total	20

[+] Refer to Faculty of Science curriculum.

Modules	MCs	Modules	MCs
Semester 3		Semester 4	
IE2110 Operations Research I	4		
IE2101 Introduction to Systems Thinking	4	IE2130 Quality Engineering I	4
CS1020E Data Structures and Algorithms	4	IE2150 Human Factors Engineering	4
ES2331 Communicating Engineering	4	IE3110 Simulation	5
IE2100 Probability Models with Applications	4	GE/SS/Breadth/UE	4
		GE/SS/Breadth/UE	4
Sub-total	20	Sub-total	21

Modules	MCs
Special Term	
[#]	

EG3602#	Vacation Internship Programme	6

EG3602 Vacation Internship Programme may be read in the Special Term after Semester 4 or 6.

Modules		MCs	Modules		MCs
Semester 5			Semester 6		
IE3100M	Systems Design Project	6	IE3100M	Systems Design Project (Cont'd)	6
IE3101	Statistics for Engineering Applications	4	IE4xxx	ISE Electives Module 2	4
IE4xxx	ISE Electives Module 1	4	HR2002	Human Capital in Organizations	3
GE/SS/Breadth/UE		4	GE/SS/Breadth/UE		4
GE/SS/Breadth/UE		4	GE/SS/Breadth/UE		4
Sub-total		22	Sub-total		21

Modules		MCs	Modules		MCs
Semester 7			Semester 8		
IE4100R	B.Eng. Dissertation	6	IE4100R	B.Eng. Dissertation (Cont'd)	2
IE4xxx	ISE Electives Module 4	4	IE4xxx	ISE Electives Module 4	4
EG2401	Engineering Professionalism	3	IE4xxx	ISE Electives Module 5	4
GE/SS/Breadth/UE		4	IE4xxx	ISE Electives Module 6	4
Sub-total		17	Sub-total		14

3.2.9 Bachelor of Engineering (Materials Science and Engineering)

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.

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) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Modules	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives	20
Programme Requirements	
Faculty Requirements:	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
ES2331 Communicating Engineering[#] (Breadth/UE)	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
Foundation Requirements:	**23**
MA1505 Mathematics I	4
MA1506 Mathematics II	4
PC1432 Physics IIE*	4
EG1108 Electrical Engineering	3
CS1010E Programming Methodology	4
Materials Science & Engineering Major Requirements	
MSE Core Modules[#]	**56**
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
3rd Year Materials Laboratory		-
MSE Design and Project Modules		16
MLE4101	B.Eng. Dissertation (over two semesters)	12
MLE4102	Design Project	4
MSE Electives		**15**
EG3601	**Industrial Attachment Programme[3]**	**12**
Total		**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 PC1432.

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

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

1 BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.

2 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.

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

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
BN3301 Introduction to Biomaterials##
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

*** Bridging Module: Students without A-level pass in Chemistry must read CM1417 Fundamentals of Chemistry as a prerequisite for CM1121 or CM1501.
Students who wish to do the specialization in the Polymeric and Biomedical Materials specialization are recommended to take BN3301 Introduction to Biomaterials.

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 and PC1413 Physics IE are 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
MA1501 Organic Chemistry for Engineers or CM1121 Basic Organic Chemistry ***	4	PC1432 Physics IIE **	4
GEK1549 Critical Thinking and Writing	4	CS1010E Programming Methodology	4
Singapore Studies Module	4	EG1108 Electrical Engineering	3

GE/UE (CM1417 ***)		4	ES2331	Communicating Engineering	4
ES1102	English for Academic Purposes	-			
Sub-total		20	Sub-total		19
Semester 3			Semester 4		
MLE2101	Structure of Materials	4	MLE2103	Phase Transformation and Kinetics	4
MLE2102	Thermodynamics and Phase Diagrams	4	MLE2104	Mechanical Properties of Materials	4
Breadth ###	ES2331 Communicating Engineering	4	MLE2105	Electronic Properties of Materials	4
GE/UE		4	MLE3101	Materials Characterisation	4
GE/UE		4	GE/UE		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 Programme ++	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
HR2002	Human Capital in Organizations	3	GE/UE		4
GE/UE		4	GE/UE		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 PC1432.

*** Bridging Module:

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

++ EG3601 Industrial Attachment is compulsory for direct entry students.

Students admitted from AY2012/2013 are required to read ES2331 Communicating Engineering. Pre-requisite of this

module is GEK1549.

Students who qualify and were earlier invited by Office of Undergraduate Programmes to read ES1501X Academic Expository

Writing (eg. ES1501A or ES1501B) can read this module in lieu of ES1531 and ES2331.

Students who wish to do the specialization in the Polymeric and Biomedical Materials specialization are recommended to take BN3301 Introduction to Biomaterials.

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
GEK1549 Critical Thinking and Writing	4	EG1108 Electrical Engineering	3
Singapore Study Module	4	ES2331 Communicating Engineering	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
MLE2101 Structure of Materials	4	MLE2104 Mechanical Properties of Materials	4
MLE2102 Thermodynamics and Phase Diagrams	4	MLE2105 Electronic Properties of Materials	4
Breadth ES2331 Communicating Engineering#	4	MLE3101 Materials Characterisation	4
GE/UE	4	GE/UE	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 Programme++	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

HR2002	Human Capital in Organizations	3	GE/UE	4
GE/UE		4	GE/UE	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 PC1432.

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

++ EG3601 Industrial Attachment is compulsory for direct entry students

Students admitted from AY2012/2013 are required to read ES2331 Communicating Engineering. Pre-requisite of this module is ES1531. Students who qualify and were earlier invited by Office of Undergraduate Programmes to read ES1501X Academic Expository Writing (eg. ES1501A or ES1501B) can read this module in lieu of GEK1549 and ES2331.

Students who wish to do the specialization in the Polymeric and Biomedical Materials specialization are recommended to take BN3301 Introduction to Biomaterials.

3.2.10 Bachelor of Engineering (Mechanical Engineering)

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
- Energy and Sustainability
- Offshore Oil & Gas Technology

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

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 at http://www.eng.nus.edu.sg/ugrad/SP_minors.html.

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.

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
- Energy and Sustainability
- Offshore Oil & Gas Technology

- To qualify for a specialisation, a student must pass at least four modules from the chosen area of specialisation and any other requirements as given in Table 3.2.10c. Students in a specialisation programme are required to do their final-year dissertation (8MCs) in an area related to the specialisation. For updated information on Specialisation programmes, please refer http://www.me.nus.edu.sg/current-students/program-overview/specialisations/specialisations-from-2013

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 AY2014/15 onwards)

Students are advised to refer to Department of Mechanical Engineering website at http://www.me.nus.edu.sg for latest updated information on B.Eng.(ME) Curriculum.

MODULAR REQUIREMENTS	MCs
University Requirements	20
General Education Modules (GEM) with at least one from Group B: Humanities & Social Sciences	8
Singapore Studies (SS) Module	4
Breadth: Modules Outside Student's Faculty	8
Unrestricted Electives**	20
Programme Requirements	
Faculty Requirements	10
(GEK1549 or equivalent) Critical Thinking & Writing[1]	-
ES2331 Communicating Engineering	4
HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3
ES1102 English[2]	-
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	35
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)	8
ME Electives		
Technical Electives (from Table 3.2.10b)		12
EG3601 Industrial Attachment Programme[3]		**12**
Total		161

[1] BEng students are required to read a Critical Thinking & Writing module and a Communications module. GEK1549 Critical Thinking & Writing, which also satisfies the General Education requirement (Group A) and ES2331 Communicating Engineering would meet these requirements. Alternatively, students can read ES1501X Academic Expository Writing in place of both GEK1549 and ES2331. USP/UTRP/RVRC students should refer to their respective programmes for USP/UTRP/RVRC modules to be read in place of GEK1549 and/or ES2331.

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

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

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
ME4235 Introduction to Aeroelasticity

Manufacturing
ME3261 Computer aided Design and Manufacturing
ME3263 Design for Manufacturing and Assembly
ME4261 Tool Engineering
ME4262 Automation in Manufacturing
ME4263 Fundamentals of Product Development
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

Others
ME3000 Independent Study 1
ME3001 Independent Study 2

Table 3.2.10c: Technical Electives Modules for ME Specialisations

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

Aeronautical Engineering
Students taking Aeronautical Engineering Specialisation are required to select TWO modules from Group A and TWO modules from Group B and present their FYP in a poster session.

Group A
ME3232 Compressible Flow
ME4235 Introduction to Aeroelasticity
ME4241 Aircraft Performance, Stability and Control

Group B
ME4212 Aircraft Structures
ME4233 Computational Methods in Fluids Mechanics
ME4234 Experimental Methods in Fluid Mechanics
ME4291 Finite Element Analysis

Automotive Engineering
Students taking Automotive Engineering Specialisation are required to select at least THREE modules from Group A and another ONE from either Groups.

Group A
ME4214 Vehicle Dynamics
ME4227 Internal Combusion Engine
ME4264 Automobile Design and Engineering
ME4265 Automotive Body and Chassis Engineering

Group B
ME3251 Materials for Engineers
ME3261 Computer aided Design and Manufacturing
ME3263 Design for Manufacturing and Assembly
ME4213 Vibration Theory and Application
ME4254 Materials in Engineering Design
ME4255 Materials Failure
ME4262 Automation in Manufacturing

Energy and Sustainability
Students taking Energy and Sustainability specialisation are required to take at least FOUR modules from the list below and present their FYP in a poster session
ME3221 Energy Conversion Processes
ME4223 Thermal Environmental Engineering
ME4225 Industrial Heat Transfer
ME4226 Energy and Thermal Systems Analysis
ME4227 Internal Combustion Engines
ME5207◊ Solar Energy Systems
ESP3401 Photovoltaic Devices & Systems
ESP4402 Transport Phenomena in Energy Systems

Offshore Oil and Gas Technology
Students taking Offshore Oil and Gas Technology are required to take ALL modules in Group A and at least another TWO modules from Group B.

Group A
GE3244 Fundamentals in Petroleum Geoscience (Fulfil Breadth/UEM requiremetns)
ME4105 Offshore Oil and Gas Technology

Group B
ME3211 Mechanics of Solids
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

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

Sample Semester Schedule

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

Table 3.2.10d: Sample Semester Schedule for ME students (matriculating from AY14/15 onwards)

Modules	MCs	Modules	MCs
Semester 1		Semester 2	
MA1505 Mathematics I	4	MA1506 Mathematics II	4
PC1431 Physics IE	4	GEK1549 Critical Thinking and Writing	4
CS1010E Programming Methodology	4	EG1108 Electrical Engineering	3
EG1109 Statics and Mechanics of Materials	4	ES2331 Communicating Engineering	4
SS[1]	4	ME2103 Engineering Visualisation and Modelling	3
Sub-total	20	Sub-total	18
Semester 3	**MCs**	Semester 4	**MCs**
		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	ME3112 Mechanics of Machines	4
ME3162 Manufacturing Processes	4	Breadth 1[1]	4
GE[1]	4		
Sub-total	22	Sub-total	23
Semester 5	**MCs**	Semester 6	**MCs**
EG3601 Industrial Attachment Programme	12	HR2002 Human Capital in Organizations	3
EG2401 Engineering Professionalism	3	ME2142 Feedback Control Systems	4
ME3101 Mechanical Systems Design I	4	ME3102 Mechanical System Design II	4
		ME3122 Heat Transfer	4
		ME Technical Elective 1	4
		UE 1 [1]	4
Sub-total	19	Sub-total	23
Semester 7	**MCs**	Semester 8	**MCs**
ME4101A B.Eng. Dissertation	4	ME4101A B.Eng. Dissertation	4
ME Technical Elective 2	4	ME Technical Elective 3	4
Breadth 2[1]	4	UE 4[1]	4
UE 2[1]	4	UE 5[1]	4
UE 3[1]	4		
Sub-total	20	Sub-total	16
Total MCs			161

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

Please note that this semester schedule is only a sample, you can customized your own schedule taking into considerations the semester the modules are offered and the pre- and co-requisites of a module.

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

Year 2					
Semester 3		**MCs**	**Semester 4**		**MCs**
MA1301	Introductory Mathematics[1]	4	MA1505	Mathematics I	4
PC1431	Physics IE	4	ME2101	Fundamentals of Mechanical Design	4
ME2151	Principles of Mechanical Engineering Materials	3	ME2103	Engineering Visualisation and Modelling	3
ME2113	Mechanics of Materials I	4	ME2143	Sensors and Actuators	4
GEK1549	Critical Thinking and Writing (GEM A)[3]	4	ME2114	Mechanics of Materials II	3
ES1xxx	English[4]	-			
Sub-Total		**19**	**Sub-Total**		**19**
Year 3					
Semester 5		**MCs**	**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	ME3112	Mechanics of Machines	4
ME3101	Mechanical Systems Design I	4	ME Technical Elective 1		4
ME3162	Manufacturing Processes	4	Breadth 2[2]		4
Sub-Total		23	Sub-Total		23
Year 4					
Semester 7		**MCs**	**Semester 8**		**MCs**
ME4101	B.Eng. Dissertation	4	ME4101A	B.Eng. Dissertation (cont'd)	4
ME3122	Heat Transfer	4	ME Technical Elective 3		4
ME Technical Elective 2		4	Free Elective 3		4
Free Elective 2		4	UE 1[2]		4
SS*		4	UE 2[2]		4
Sub-Total		**20**	**Sub-Total**		**20**
Total					**123**

1 MA1301 will be counted towards Free Elective.
2 These ULR modules (GEM, SS, UEM, Breadth) can be read in any semester. Breadth modules are strictly modules read outside the student's faculty.
3 GEK1549 is compulsory, to be graded (eg. cannot s/u) and has to be counted toward GEM A requirement. For more details, please refer to the section on English Modules at http://www.eng.nus.edu.sg/ugrad/MS_timetable.html.
4 Either ES1000 and/or ES1102 depending on the results of your QET and decided by CELC.

Please note that this semester schedule is only a sample, you can customized your own schedule taking into considerations the semester the modules are offered and the pre- and co-requisites of a module.

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 Programme should not be less than 24 MCs. Where there exists a substantial equivalence in the modules, departments may grant double counting of MCs from the major requirements (up to a maximum of 8 MCs) towards the MCs requirement in the Minor Programme. 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/programmes/minor.html

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

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

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

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

Requirements:

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

Biomedical Engineering Option	Life Science Option[+]	Engineering Electives Option
	LSM1102 Molecular Genetics	CE3143 Wastewater Microbiology
BN3401 Biomedical Electronics & Systems	LSM1104 General Physiology	CE4257 Linear Finite Element Analysis
BN3402 Bio Analytical Methods in Bioengineering	LSM1202[+] Human Anatomy	CN4208 Biochemical Engineering
BN4201 Musculoskeletal Biomechanics	LSM1401* Fundamentals of Biochemistry	CN4210 Membrane Science and Engineering
BN4202 Biofluid Dynamics	LSM2101 Metabolism and Regulation	CN4241R Engineering Principles for Drug Delivery

BN4203 Rehabilitation Engineering	LSM2102 Molecular Biology	EE3101 Digital Signal Processing
BN4301 Principles of Tissue Engineering	LSM2103 Cell Biology	EE3206 Intro to Computer Vision and Image Processing
BN4402 Electrophysiology	LSM2241 Introductory Bioinformatics	EE4605 Bio-Instrumentation and Signal Analysis
BN4403 Cellular Bioengineering	LSM2202A Experimental Molecular and Cell Biology	EE4601 Sensors for Biomedical Applications
BN4404 Biomicroelectromechanical Systems – BioMEMs	LSM3241 Bioinformatics and Biocomputing	EE4602 Bioelectronics
BN4406 Biophotonics and Bioimaging	PY1105 Physiology I	EE4603 Biomedical Imaging Systems
		ME4233 Computational Methods in Fluid Mechanics
		ME4253 Biomaterials Engineering
		ME4291 Finite Elements Analysis

* Students reading LSM1401 are NOT permitted to read LSM1101 and vice versa.
+ No more than three Level-1000 modules should be read.

3.3.2 Minor in Engineering Materials

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

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

The objectives of this multidisciplinary minor programme are as follows:

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

Requirements

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

Biomedical and Polymeric Materials
BN3301 Introduction to Biomaterials

BN4301 Principles of Tissue Engineering
CN4203 Polymer Engineering
CM3264 Petroleum and Industrial Organics
CM4262 Advanced Materials Characterisation Techniques
CM4264 Speciality Polymers: Synthesis, Characterisation and Applications
CM4265 Polymer Blends and Composites
MLE3104 Polymeric and Composite Materials
MLE4202 Selected Advanced Topics on Polymers
MLE4203 Polymeric Biomedical Materials
ME4253 Biomaterials Engineering

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

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

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

3.3.3 Minor in Systems Engineering

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

Students opting for this minor should have a suitable mathematics and statistics background.
- MA1505 – Mathematics I or equivalent; and MA1506 Mathematics II or equivalent

and

- ST1131- Introduction to Statistics or its equivalent

Eligibility

Students must meet the following criteria to be eligible to apply:
- Completed first year of study
- Matriculation not beyond the end of the 5th semester of study
- Must have a CAP score of at least 3.5

Requirements

The minor in Systems Engineering will be awarded on satisfactory completion of the following 6 modules (24 MCs):
1. ST2131 – Probability
2. IE2100 – Probability Models with Applications
3. IE2101 – Introduction to Systems Design
4. IE2110 – Operations Research I
5. IE2140 – Engineering Economy
6. IE3101- Statistics for Engineering Applications

3.3.4 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, Minor in Managment or Minor in Technopreneurship programmes are not eligible to apply for the Minor in MOT Programme. More details of the programme can be found at: http://www.eng.nus.edu.sg/etm/programmes/minor.html.

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.

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

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

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

In addition, student will have to choose one of the following two modules:

EE3031 Innovation & Enterprise I
TR3001 New Product Development
MT4003 Engineering Product Development

3.4 Enhancement Programmes

Students can personalize their educational experience to meet their own individual goals through the Faculty of Engineering's Enhancement programmes with options in engineering innovation, management & entrepreneurship, cutting-edge research, internships or even to pursue their own interests with peers on self-initiated projects/activities.

Students will generally receive academic credits via Unrestricted Electives upon successful completion of the particular enhancement programme except for those undertaking compulsory internships or industrial-attachments to satisfy their engineering discipline's programme requirements.

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

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 an overseas company 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 the IAP. Students may wish to register with the Faculty 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.

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 will have to submit a progress reports for continual assessment by their Mentors .

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

3.4.3 Technopreneurship and Incubation Programme

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

The overall learning objectives of the Technopreneurship and Incubation Programme (TIP) are:

- To enthuse and prepare students, by classroom and experiential learning, for a career in technology-based entrepreneurship.

- To educate students on how to start up and incubate companies.
- To provide the necessary resources for students to “incubate” their ideas.To assist students to link up with companies/contacts that may be useful to their business ideas.
- The TIP comprises two parts, namely EG1603 and EG2603:

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

The first TIP module is setup as a competition to emulate the competitive nature of industry and intensify the learning. Students will engage in a 2-day Technopreneur bootcamp at the start of the course and will apply their newly acquired knowledge and skills to real-life problem statements by writing a business plan that includes a real (technical) solution with validated business models. Students will receive advice from mentors as they develop their solution and business models. They are expected to present their final business plan to a panel of judges at the end of the course.

EG2603 TIP Product & Business Plan Development (2 MCs)

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

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.

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.

3.4.6 EG2606A/B Independent Work (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.

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: ES1531 Critical Thinking and Writing, SSAxxxx Singapore Studies, and HR2002 Human Capital in Organisations. 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/ and http://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 programme provides an opportunity for Faculty of Engineering students to tap into the Georgia Institute of Technology's (Georgia Tech) educational programme. The modules conducted under this programme involve participation of faculty members and students from both NUS and Georgia Tech. Students will benefit from the exposure to a different kind of academic experience and also the cross-cultural exchanges that can take place through the interaction with the Georgia Tech students and faculty members. The 12-week programme is conducted from May to July, of which six weeks will be hosted in Singapore and the remaining six weeks in China. Students participate in several site visits and programme sponsored field trips. Below are the possible modules (subject to yearly review) offered under the NUS module code and title which credits can be earned.

- IE4220 Supply Chain Modeling
- IE4243 Decision Modeling and Risk Analysis
- IE4249 Selected Topics to Engineering Management

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)

- 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)

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

3.5.5 Double Major Programmes

3.5.5.1 Second 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.

To apply, students must fulfill the following criteria:

- completed at least one semester of study;
- apply no later than the 3rd semester of their study;
- have a CAP score of at least 3.5;
- If they apply in the 2nd semester of their study, they must have completed at least two (2) Management Major (Technology) modules*
- If they apply in the 3rd semester of their study, they must have completed at least four (4) Management Major (Technology) modules*

Note:
* The Management Major (Technology) module(s):

- cannot be S/U module(s)
- exclude(s) Substituting module(s) or module(s) map back from SEP
- include(s) the Management Major (Technology) module(s) that they are enrolled in at the time of application

(Students who have withdrawn from the Double (Second) Major in Management (Technology) will not be re-admitted.)

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.

Out of the 48 MCs, up to 16 MCs may be approved substituting modules taken while on student exchange programme (on the condition that the modules taken are graded modules at partner universities). In addition, another 8 MCs may be substituting modules offered by other faculties in NUS (see Substituting modules: http://bschool.nus.edu.sg/Portals/0/images/BBA/docs/equivalentbbamodules.xls).

Students may use up to a maximum of 8 MCs of their management major (Tec) programme modules to double count towards other programmes.

(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/FNA1002/ FNA1002XFinancial Accounting MKT1003 /MKT1003X Principles of Marketing MT3001 Systems Thinking and Engineering TR2202 Technological Innovation TR3001 New Product Development or MT4003 Engineering Product Development MT4002 Technology Management Strategy	24
(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: <u>Technopreneurship (Biz):</u> TR2201 Entrepreneurial Marketing <u>Decision Sciences (Biz):</u> DSC3219 Quality Management or IE2130 Quality Engineering I DSC3201 Supply Chain Management DSC3202 Purchasing and Materials Management <u>Quantitative Finance (Biz):</u> FIN3118/ Financial Risk Management FNA3118 <u>Management (Biz):</u> MNO2311 Leadership in Organisation MNO3303 Organisational Effectiveness <u>Marketing (Biz):</u> MKT3418 Product and Brand Management <u>Applied Mathematics(FoS/FASS):</u> EC4311 Mathematical Economics II MA3253 Inventory & Queuing Models MA4260 Model Building in Operations Research <u>Systems Engineering (FoE/SDE):</u> IE2110 Operations Research I IE2140 Engineering Economy PF3101 Project Scheduling & Control <u>Management of Technology (FoE):</u> MT5003 Creativity and Innovation MT5005 IP Law for Engineers & Scientists <u>Management of Information Technology (SoC):</u> CS2250 Fundamentals of Information Systems	24

	CS3251 Technology Strategy and Management CS3253 Management of Information Systems	
12 Modules		48 MCs

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

For more details, please refer to: http://bba.nus.edu/majorminor_major_mgmttech.html.

3.5.5.2 Second Major in Systems Engineering Programme

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

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

- They must have completed their first year of study;
- They must apply no later than the 5th semester of their study;
- They must have a CAP score of at least 3.5

Applications should be submitted to the ISE Dept. Selection for admission will be on a competitive basis and subjected to the ISE Dept's approval as well as availability of quota.

Students opting for the Major in Systems Engineering should have a suitable mathematics and statistics background. They should read the following modules:

1. MA1505 Mathematics I or equivalent;
2. MA1506 Mathematics II or equivalent; and
3. ST1131 Introduction to Statistics or its equivalent.

To fulfill the requirements of the Major in Systems Engineering, students are required to complete 48 MCs (12 modules).

Students may use up to a maximum of 8 MCs of their Major in Systems Engineering modules to double count towards other programmes.

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

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

Students who complete the 24 MCs listed in Section (A) will be awarded a Minor in Systems Engineering if they do not wish to complete all the requirements for the Major in Systems Engineering.

1. Completion of the following six compulsory modules:

    - ST2131 Probability
    - IE2100 Probability Models with Applications
    - IE2101 Introduction to Systems Design
    - IE2110 Operations Research I
    - IE2140 Engineering Economy

- IE3101 Statistics for Engineering Applications

2. Completion of at least two modules from the following:

- IE3110 Simulation
- IE4210 Operations Research II
- IE4240 Project Management
- IE5203 Decision Analysis
- IE5404 Large Scale Systems Engineering

3. Completion of at most four modules from the following:

Service Systems:
IE5213 Service Innovation and Management
*ISE B.Eng. 4 standing or higher
IE5214 Infocomm Systems Project Management
* ISE B.Eng. 4 standing or higher

Transportation and Infrastructure Systems:
CE5804 Global Infrastructure Project Management
TP5025 Intelligent Transportation Systems
*CE4 standing or higher
TP5026 Transport Management & Policy
*CE4 standing or higher
TP5027 Transport & Freight Terminal Management
*CE4 standing or higher
TP5028 Intermodal Transportation Operations
*CE4 standing or higher

Chemical Process Systems:
CN4205R Process Systems Engineering
*CN3121, CN4111
CN4227R Advanced Process Control
*CN3121
CN4245R Data Based Process Characterization
*CN3121 or equivalent
CN5111 Optimization of Chemical Processes
*Linear algebra and numerical methods at undergraduate level
CN5181 Computer-Aided Chemical Engineering
CN5185 Batch Process Engineering

Control Systems:
EE4305 Introduction to Fuzzy/Neural Systems
*EE2010 for EE & CPE students
ME4246 Linear Systems
*ME2142

Systems Based Projects:
BN3101 Biomedical Engineering Design
EE3001 Project
*Level 3 standing

* Pre-requisite(s)

For the purpose of the Major in Systems Engineering, students will use their standing in their home programmes as fulfillment of the pre-requisites for modules that require ISE B.Eng. 4 standing or higher provided that they have completed the 24 MCs of compulsory modules (Section A).

For queries on the Major in Systems Engineering, please email isebox1@nus.edu.

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

4 Undergraduate Education (Part-time Programmes)

4.1 Bachelor of Technology Programme

Overview

AY2014/2015, 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. (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.

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. Applicants must have at least two years of relevant working experience. 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 or undergo bridging units to determine their suitability in coping with the demanding B.Tech. courses.

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

- 8 MCs of University Level Requirements (ULR),
- 20 MCs of Programme Requirements, and
- 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.

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.

Study Schedule and Candidature Period

Each of the four 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 (Semesters 1 and 2) in each Academic Year, the B.Tech. Programme also runs a 10-week Special Term during the period, 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 18 MCs of modules during a normal semester and 2 modules 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. 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 results in greater benefit from their studies and perhaps a better honours degree, it might be worthwhile to do so as the benefits are lifelong.

Leave of Absence

If for medical or other reasons, a student is unable to register for modules and attend classes satisfactorily during any semester,he/she 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 after this deadline will have to pay the administrative fee.

Other Academic Matters

Students are advised to read carefully other relevant information presented in 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

4.1.1 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.

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.

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.
- The limit on the number of Level-1000 modules to be counted towards fulfillment of graduation requirements is 60 MCs (including exemption modules of 28 MCs for polytechnic diploma holders).
- 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
CN4122E Process Synthesis and Simulation	3
CN4123E Design Project	7
CN4122E Process Synthesis and Simulation	**3**
CN4123E Design Project	**7**
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
CN4242E	Optimization of Chemical Processes	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.

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
	CN4122E Process Synthesis and Simulation (3)
Sem 4-2	CN4123E* Design Project (7)
	Elective Module 3 (4)
	TG3001* Industrial Practice (12)
Sem 4-3	CN4123E* Design Project (7)
	TG3001* Industrial Practice (12)

+ 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
	CN4122E Process Synthesis and Simulation (3)
Sem 4-2	CN4123E* Design Project
	Elective Module 2 (4)
	TG3001* Industrial Practice
Sem 4-3	CN4123E * Design Project - (7)
	TG3001* Industrial Practice (12)
Sem 5-1	Elective Module 3 (4)
	University Level Requirements 3+ (4)
	University Level Requirements 4+ (4)

+ 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.

4.1.2 Bachelor of Technology (Electronics Engineering)

The Bachelor of Technology in Electronics Engineering, a part-time undergraduate programme 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. The programme 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. 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 electronic engineer's career.

In order to prepare graduates for the rapidly evolving landscape of Electronics Engineering and to upgrade polytechnic graduates into professional engineers, the B.Tech. degree programme curriculum is specially designed to provide its graduates with a headstart in the rapidly advancing fields. The B.Tech. (EE) programme comprises of three components – a strong core in mathematics, computing and engineering; technical competence through a minimum of breadth and depth modules; and general education. The core provides knowledge and skills considered essential for electronics 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 many 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 and professionalism to make our graduates educated members of the global community.

The B.Tech. (Electronics Engineering) is accredited by the Engineering Accreditation Board (EAB) of Singapore for students graduating in AY2013/14 till AY2017/18. Via the accreditation from the EAB, all signatories in the Washington Accord recognize the substantial equivalence of our programmes in satisfying the academic requirements for the practice of engineering at the professional level in many countries including Canada, United States of America, United Kingdom, Hong Kong, New Zealand, Australia and others.

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.
- have a good understanding of the principles and applications of advanced mathematics, including probability and statistics, differential and integral calculus, linear algebra and complex variables.

Degree Requirements

Candidates must satisfy the following requirements for the degree of B.Tech. (Electronics Engineering):

- Complete a minimum of 120 MCs with a CAP ≥ 2.0 by taking modules in accordance with Table 4.1g.
- The limit on the number of Level-1000 modules to be counted towards fulfillment of graduation requirements is 60 MCs (including exemption modules of 28 MCs for polytechnic diploma holders).
- 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 (64 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	5
EE2021E Devices & Circuits	4
EE2023E Signals & Systems	4
EE2024E Programming for Computer Interfaces	5
EE2031E Circuit and Systems Design Lab	3
EE2032E Signals and Communications Design Lab	3
EE3031E Innovation & Enterprise I	4
TE4001 B.Tech. Dissertation	12
Major Requirements - Elective Modules (24 MCs)	

Selected from the modules listed in Table 4.1h	24
UNRESTRICTED ELECTIVE MODULES (UEMs)	**12**
Total	**120**

[+] 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
EE3731E Signal Processing Methods	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
EE3731E Signal Processing Methods	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
EE3013E Labview for Electrical Engineers	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

* 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, two electives from the following list (EE3013E, EE3104E, EE3131E, EE3331E, EE3431E, EE3408E, EE3501E, EE3731E and TE3201) and one other elective which may be any level 3 (breadth) or 4 (depth) module. Of the 24 MCs of technical electives, at least one module must be from the following list (EE3013E, EE3207E, EE3208E, EE3407E, EE3408E, EE3501E, EE4415E and TE3801). 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.

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 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
Sem 1-1	University Level Requirements 1+ (4)
	TG1401 Engineering Mathematics I (4)
	EE1001E Emerging Technologies in EE (4)
Sem 1-2	TE2002 Engineering Mathematics II (4)
	EE2020E Digital Fundamentals (5)
	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 (5)
	EE2021E Devices & Circuits (4)
Sem 2-2	EE2011E Engineering Electromagnetics (4)
	EE2031E Circuits and Systems Design Lab (3)
	EE2023E Signals & Systems (4)
Sem 2-3	TG2415 Ethics in Engineering (4) / University Level Requirements 3+ (4)
Sem 3-1	Elective 1 (4)
	Elective 2 (4)
	TG3001* Industrial Practice
	EE2032E Signals and Communications Design Lab (3)
	EE3031E Innovation & Enterprise I (4)

Sem 3-2	Elective 3 (4)
	Elective 4 (4)
	TG3001* Industrial Practice
Sem 3-3	TG2415 Ethics in Engineering (4)/ University Level Requirements 4+ (4)
	TG3001* Industrial Practice (12)
Sem 4-1	Elective 5 (4)
	TE4001* B.Tech. Dissertation
Sem 4-2	Elective 6 (4)
	TE4001* B.Tech. Dissertation (12)
Sem 4-3	University Level Requirements 4+ (4)

+ 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 (5)
	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 (5)
	EE1001E Emerging Technologies in EE (4)
Sem 2-2	TE2003 Advanced Mathematics for Engineers (4)
	EE2011E Engineering Electromagnetics (4)
	EE2023E Signals and Systems (4)
Sem 2-3	University Level Requirements 2+ (4)
Sem 3-1	EE2021E Devices & Circuits (4)
	EE2032E Signals and Communications Design Lab (3)
	Elective 1 (4)
	TG3001* Industrial Practice
Sem 3-2	EE3031E Innovation & Enterprise I (4)
	EE2031E Circuits and Systems Design Lab (3)
	Elective 2 (4)
	TG3001* Industrial Practice

Sem 3-3	TG2415 Ethics in Engineering (4)/ University Level Requirements 3+ (4)
	TG3001* Industrial Practice (12)
Sem 4-1	Elective 3 (4)
	Elective 4 (4)
	University Level Requirements 4+ (4)
Sem 4-2	Elective 5 (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)
	Elective 6 (4)

+ 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.

4.1.3 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. . The B.Tech. (Industrial & Management Engineering) is accredited by the Engineering Accreditation Board (EAB) of Singapore for students graduating in AY2012/13 till AY2016/17.

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 Programme Educational Objectives of the B.Tech. (Industrial and Management Engineering) programme are as follows:

- 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 at the national and global context.

The Student Learning Outcomes for the B.Tech. (Industrial and Management Engineering) Programme are :

Outcome (a) - Core: Apply knowledge of mathematics, science and engineering to the solution of complex engineering problems
Outcome (b) - Experimental Design: Design and conduct experiments, analyse, interpret data and synthesise valid conclusions
Outcome (c) - System Design: Design a system, component, or process, and synthesise solutions to achieve desired needs
Outcome (d) - Breadth and Depth: Identify, formulate, research through relevant literature review, and solve engineering problems reaching substantiated conclusions
Outcome (e) - Knowledge Application and Transfer: 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
Outcome (f) - Communications: Communicate effectively
Outcome (g) - Attitude: Recognize the need for, and have the ability to engage in life-long learning
Outcome (h) - Awareness: Understand the impact of engineering solutions in a societal context and to be able to respond effectively to the needs for sustainable development
Outcome (i) - Professional Relations: Function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management
Outcome (j) - Professional Ethics: Understand professional, ethical and moral responsibility

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.
The limit on the number of Level-1000 modules to be counted towards fulfillment of graduation requirements is 60 MCs (including exemption modules of 28 MCs for polytechnic diploma holders).
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 4.1I		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 4.1I: 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.

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
	Elective 4 (4)

Sem 4-2	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)
	TG2415 Ethics in Engineering (4)

Sem 4-2	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.

4.1.4 Bachelor of Technology (Mechanical Engineering)

The Bachelor of Technology in Mechanical Engineering [B.Tech. (Mechanical Engineering)] programmes offered by the Department of Mechanical Engineering follows 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) course for five years starting with students graduating in AY2013/14. This means that all B.Tech. (Mechanical Engineering) graduates for AY2013/14 to AY2017/18 will have their degrees fully accredited by EAB. Singapore became a signatory of the Washington Accord in June 2006. Under the Washington Accord, degrees accredited by Singapore's Engineering Accreditation Board will be mutually recognized by other signatory countries which include Australia, Canada, Japan, Korea, Malaysia, New Zealand, UK and USA.

The programme educational objectives of the B.Tech. (Mechanical Engineering) programme are as follows:

- To prepare graduates with the knowledge and competency for careers in and related to Mechanical Engineering
- To prepare graduates to become leaders in fields related to Mechanical Engineering
- To enable graduates to understand their role as engineers and their impact on society in both national and global contexts.

The Student Learning Outcomes for the B.Tech. (Mechanical Engineering) Programme are the abilities 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 life-long 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 multi-disciplinary teams and understand the fundamental precepts of effective project management
- Understand professional, ethical and moral responsibility

Degree Requirements

From the AY2007/08 intake onwards, candidates must satisfy the following requirements for the degree of B.Tech.

(Mechanical Engineering):

- To complete a minimum of 120 MCs with a CAP ≥ 2.0 by taking modules in accordance with Table 4.1o.
- The limit on the number of Level-1000 modules to be counted towards fulfillment of graduation requirements is 60 MCs (including exemption modules of 28 MCs for polytechnic diploma holders).
- 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 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 ELECTIVE 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 Engineering)*

Module Code and Title		MCs
ME3291E	Numerical Methods in Engineering	4
ME3211E	Mechanics of Solids	4
ME3233E	Unsteady Flow in Fluid Systems	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
TM4264	Fundamentals of Automotive Engineering	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.

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)
Sem 3-2	TM3101 Mechanical Systems Design (6)
	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.

5 Graduate Education

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

We believe it is just as important to infuse our students with a spirit of enterprise and the 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 and selected Indian Institute of Technology, (IIT).

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

5.1 Research Programmes

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

Overview

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

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

- Biomedical Engineering
- Chemical & Biomolecular Engineering
- Civil 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:

- Interactive & Digital Media Institute (IDMI)
- NUS Nanoscience and Nanotechnology Initiative (NUSNNI)
- Solar Energy Research Institute of Singapore (SERIES)
- 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)

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 programmes.
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.

Research Methodology & Ethics module

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

Overview

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

Degree Requirements

Coursework element

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

Joint Supervision

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

Oral Defence Examination

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

Conferment

Conferment of the joint degree will be by the candidate's home university. Only one certificate is awarded jointly by both universities.

The degree awarded to all successful candidates is identical except that a candidate may use the title of either Ph.D. (NUS-IIT) or Ph.D. (IIT-NUS) with his/her home university mentioned first.

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

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.

Degree Requirements

Coursework element

The prevailing requirements for coursework/education plan for each student of each university shall apply. Candidates would spend at least two semesters at the partner university , 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

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.

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

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.

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.

5.2 Coursework Programmes

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

Coursework programmes leading to the Master of Science (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)

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.

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
CN5192 Future Fuel Options: Prospects and Technologies
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
CN5555 Chemical Engineering Project

Compulsory Modules

EE5101R Linear Systems
EE5103R Computer Control Systems
MCH5206 Instrumentation and Sensors

Elective Modules for Specialization (at least 3 modules)

EE4302 Advanced Control Systems
EE4306 Distributed Autonomous Robotic Systems
EE4307 Control Systems Design and Simulation

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
MCH5002 Applications of Mechatronics

Other Recommended Elective Modules

EE5301 Adaptive Signal Processing OR
EE5137R Stochastic Processes

EE5903 Real-Time Systems
EE5904R Neural Networks
CN5115 Distillation Dynamics and Control
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
EE5132 Wireless and Sensor Networks
EE5133 Statistical Signal Processing Techniques
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
EE6130 Information and Coding Theory
EE6135 Digital Communications
EE6136 Advanced Optical Communications
EE6140 Underwater Communications Systems

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
EE5904R Neural Networks
EE5907R Pattern Recognition
EE5734 Interactive System Design Research Methods
EE6231 Reconfigurable Computing

CS5241* Speech Processing
CS5248* Systems Support for Continuous Media
CS5272* Embedded Software Design
CS5342* Multimedia Computing and Applications
CS5343* Advanced Computer Animation

* Conditions apply to M.Sc. students registered from August 2011 onwards. A maximum two (2) of the above listed CS modules can be taken and counted towards fulfilling the elective requirements of the specialization in Computer Engineering. In the event that a student opts out from this specialization, any CS modules that had been taken from this list would no longer be considered as part of the related-module degree requirements, and if necessary, the student would then have to take additional modules to meet the degree requirements.

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
EE5439 Micro/Nano Electromechanical Systems
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)

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 to four graduate modules equivalent to 12 to 16 MCs per semester and attend lectures three to four evenings per week.

A candidate needs to complete a programme of study consisting of one core module and at least nine elective modules. Some modules 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 theDepartment of Civil & Environmental Engineering . Candidates may, as part of the ten-module requirement for the MSc and subject to approval by the Department of Civil & Environmental Engineering, take up to two modules not

exceeding 10 MCs that are from other departments.

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 the Department of Civil & Environmental Engineering.

Core Modules
ESE5001 Environmental Engineering Principles

Elective Modules
ESE5002 Physical and Process Principles
ESE5003 Environmental Chemical Principles
ESE5004 Research Project
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)

1. **To complete the following core module**

ESE5001 Environmental Engineering Principles

2. **At least 7 modules from the following**

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

3. **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 Programme but a maximum of two modules of

the ten required modules may be from other Department/Faculties, including the following modules (subject to approval of Environmental Engineering Programme):

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)

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.

Degree Requirements

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

To satisfy graduation requirements, a candidate must obtain a minimum Cumulative Average Point (CAP) of 3.0 (equivalent to an average of Grade B-) for the best 40 MCs, inclusive of seven core modules and three elective modules. In addition, the grade point for each of the seven core modules must be at least 2.5 (Grade C+). A student is allowed one re-take for at most two core modules if the grade point obtained is less than 2.5 (Grade C+).

Core Modules

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

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

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

Note 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 (Hydraulic Engineering and Water Resources Management)

Overview

The M.Sc. (Hydraulic Engineering and Water Resources Management), M.Sc. (HEWRM), programme is hosted by the Department of Civil and Environmental Engineering. The programme accepts both full-time and part-time students.

Degree Requirements

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

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

In addition, a student must obtain a minimum Cumulative Point Average (CAP) of 3.0 (equivalent to an average of Grade B-) for the best modules equivalent to 40 MCs (inclusive of core modules, where required). Furthermore, the grade point obtained for each of the 6 core modules must be at least 2.5 (equivalent to Grade C+). If this is not met, a student is allowed to re-take once, up to 2 core modules within the given programme time frame. The better grade will be used to compute the CAP.

Core Modules

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

Elective Modules

CE5313 Groundwater Hydrology
CE5603 Engineering Economics and Project Evaluation
CE5710 Design of Floating Structures
CE5711 Offshore Moorings and Risers
ESE5001 Basic Environmental Science and Engineering
ESE5601 Environmental Risk Assessment
ESE5602 Environmental Management Systems
ESE5405 Water Treatment Processes
ESE5901 Environmental Technology
IE5203 Decision Analysis
PP5257 Water Policy and Governance
PP5294 Dynamic Modelling of Public Policy Systems

5.2.7 Master of Science (Industrial & Systems Engineering)

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.

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 at the Faculty of Engineering website for details.

Table 5.2. 7.2a: Modules in Master of Science (Industrial & Systems Engineering)

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

Systems Engineering and Methodologies
IE5107 Material Flow Systems
IE5108 Facility Layout and Location
IE5202 Applied Forecasting Methods
IE5203 Decision Analysis
IE5206 Energy and Sustainability: A Systems Approach
IE5401 Industrial Logistics
IE5402 Introduction to Systems Engineering and Architecture
IE5403 Systems Engineering Case Studies
IE5404 Large Scale Systems Engineering
IE5405 Inventory Systems
IE5407 Flexibility In Engineering Systems Design
IE5409 Topics in Systems Engineering
IE5504 Systems Modelling and Advanced Simulation
IE5506 Computer Based Decision Systems
IE5508 Applied Systems Optimization

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 graduating CAP = 3.5 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.

    1. IE5901 Independent Study in L&OR (4 MCs) to be completed in one semester.
    2. 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 graduating CAP = 3.5 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.

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

5.2.8 Master of Science (Intellectual Property Management)

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.

Degree Requirements

A full-time or part-time candidate for the degree of M.Sc. in IP Management must successfully complete a programme of study consisting of the following two key components:

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

For graduation:

1. Must successfully complete the GCIP programme with a minimum satisfactory performance level
2. For the MOT programme, must obtain a minimum CAP of 3.0 (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/ Management of Technological Innovation
BMA5115
MT5008/ Corporate Entrepreneurship
BMA5404
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/ Systems Engineering Project Management; (or
IE5208 Systems Approach to Project Management)
MT5900 MOT Project (8 MCs)

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

5.2.9 Master of Science (Management of Technology)

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.

A student may choose to graduate with ONE of the following:
- M.Sc. (Management of Technology) ; or
- M.Sc. (Management of Technology) with specialization in Innovation & Entrepreneurship (offered from Semester 1, AY2014/2015)

Degree Requirements

To qualify for the degree of M.Sc. (Management of Technology), a full-time or part-time candidate must successfully complete a programme of study of at least 40 MCs, which consists of the following:
(a) At least 16 MCs from the list of core modules
(b) The remaining MCs can be obtained from both the lists of core and/or elective modules, to make up a total of 40 MCs. Subject to the approval of the Programme Manager for M.Sc. (MOT), students may be allowed to take up to 8 MCs

outside the prescribed curriculum, in lieu of the required modules to complete the M.Sc. degree.

In addition, a student must obtain a minimum CAP of 3.0 (B-) for the best modules equivalent to 40 MCs.

Core Modules
All the following core modules are 4 MCs each.
MT5001 IP Management
MT5002 Management of Industrial R&D
MT5003 Creativity and Innovation
MT5007/ Management of Technological Innovation
BMA5115
MT5011 Finance for Engineering & Technology Management#
MT5012 Marketing of High-Technology Products and Innovations
IE5003 Cost Analysis and Engineering Economy#
IE5208 Systems Approach to Project Management^
SDM5004 Systems Engineering Project Management^

Elective Modules

Unless otherwise indicated, the elective modules below span different relevant areas and are 4 MCs each.
MT5004 User centred Engineering & Product Development
MT5005 IP Law for Engineers and Scientists
MT5006 Strategic & New Product Development*
MT5008/ Corporate Entrepreneurship
BMA5404
MT5009 Analyzing Hi-Technology Opportunities
MT5010 Technology Intelligence & IP Strategy
MT5013 Global Innovation Management
MT5014 Systems Approach to Tech and Innov Mgt
MT5015 The Financial and Business Aspects of Intellectual Property (IP)
MT5016 Business Models for Hi-Tech Products
MT5017 Integrative Design Thinking Workshop
MT5880A Topics in Management of Technology – Techno-Economics Systems
MT5880B Topics in Management of Technology – Institutional Innovation
MT5880C Topics in MOT – Disruptive Technologies and Value Innovation
MT5900 MOT Research Project (8 MCs)
MT5901 Management Practicum (2 MCs)
MT5902 Management Extended Practicum
MT5911 Venture FundingMT5912 Frugal Innovation
MT5913 TechLaunch – Experiential Entrepreneurship
MT5920 Enterprise Development
MT5921 Market Gaps – A Search for Innovation Opportunities
MT6001 Research in Tech & Innovation Management@
BMA5004A Management & Organization (2 MCs)
BMA5010A Managing Operations (2 MCs)
BMA5108 Technopreneurship
IE5121 Quality Planning and Management*
IE5203 Decision Analysis
IE5211 New Product Management

IE5401 Industrial Logistics
SDM5001 Systems Architecture
SDM5002 Systems Engineering
SDM5003 Knowledge Management
PP5220 National Science & Technology Policy

PP5293 Ruling the Net: IT and Policy Making

* # ^ Modules with the same symbol are mutually exclusive.
@ Module is meant for students who are interested to do research and want to contribute to the knowledge of Technology & Innovation Management.

M.Sc. (Management of Technology) with specialization in Innovation & Entrepreneurship

To be eligible for the specialization, students must successfully complete a programme of study of at least 40 MCs and achieve a
minimum CAP of 3.0, which consists of the following:

6 Compulsory Core Modules
MT5001 IP Management
MT5003 Creativity and Innovation
MT5007/BMA5115 Management of Technological Innovation
MT5011 Finance for Engineering & Technology Management
MT5008/BMA5404 Corporate Entrepreneurship
MT5920 Enterprise Development

Set 1 Electives (Choose any 2)
MT5902 Management Extended Practicum
MT5912 Frugal Innovation
MT5913 TechLaunch – Experiential Entrepreneurship
MT5921 Market Gaps – A Search for Innovation Opportunities

Set 2 Electives (Choose any 2)
MT5002 Management of Industrial R&D
MT5004 User-centred Engineering & Product Development
MT5010 Technology Intelligence & IP Strategy
MT5911 Venture Funding

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

5.2.10 Master of Science (Materials Science and Engineering)

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 Processing Engineering
CN5162 Advanced Polymeric Materials

CN5251 Membrane Science and Technology
CE5604 Advanced Concrete Technology
EE5207 Tribology and Mechanics of Magnetic Storage Systems
EE5208 Applied Engineering Magnetics
EE5431R Fundamentals of Nanoelectronics
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
ME6505 Engineering Materials in Medicine
ME6508 Atomistic Simulations of Materials
ME6604 Modelling of Machining Processes
MLE5102 Mechanical Behaviours 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
MLE5208 Mechanical Properties of Solid Films
MLE5210 Modelling and Simulation of Materials\
MLE6101 Thermodynamics and Kinetics of Materials
MLE6103 Structures 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.

5.2.11 Master of Science (Mechanical Engineering)

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

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 five 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
ME6602 Topics in Manufacturing
ME6604 Modelling of Machining Processes
ME6605 Abrasive and Non-Conventional Processes
ME6606 Computer Aided Product Development

5.2.12 Master of Science (Offshore Technology)

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.

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:

1. At least 28 MCs from the list of modules in Offshore Technology below.
2. 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.

To be eligible for the M.Sc. (Offshore Technology) with specialisation in Subsea Engineering, students must successfully complete a programme of study consisting of at least 40 MCs (with a minimum CAP of 3.0) which are made up of at least 28 MCs from the list of Modules in Offshore Technology. Of the 28 MCs, at least 20 MCs must be from the following specific modules identified from the list of Modules in Offshore Technology:

Modules for Specialisation in Subsea Engineering
OT5102 Oil & Gas Technology (4 MCs) (Compulsory)
OT5301 Subsea Systems Engineering (4 MCs) [Compulsory unless the student has taken this module in the B.Eng. (Mechanical Engineering) programme]
OT5205 Offshore Pipelines (4 MCs)
OT5302 Flow Assurance (4 MCs)
OT5303 Subsea Control (4 MCs)
OT5304 Subsea Construction & Operations Support (4 MCs)
OT5882 Topics in Subsea Engineering (4 MCs)
OT5001 Independent Study Module (8 MCs), relating to Subsea Engineering

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.

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

Elective modules
CE4257 Linear Finite Element Analysis,
CE4258 Structural Stability and Dynamics
CE5105 Analytical & Numerical Methods in Foundation Engineering
CE5308 Coastal Engineering and Sediment Transport
CE5509 Advanced Structural Steel Design
CE5514 Plate and Shell Structures
CE5603 Engineering Economics and Project Evaluation
CE5702 CE Reliability Analysis & Design
CE5804 Global Infrastructure Project Management
CE6003 Numerical Methods in Engineering Mechanics
CE6006 Advanced Finite Element Analysis

CE6101 Geotechnical Constitutive Modelling
ME5105 Shock and Vibration Control
ME5201 Thermal Systems Design
ME5362 Advanced Fluid Transients Computation and Modelling
ME5402 Advanced Robotics
ME5602 Manufacturing Systems Engineering
ME5708 Pressure Surges in Oil & Gas Flow Systems
SH5204 Safety Engineering

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

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/cee/programmes/MSc_ot.html

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

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.

Degree Requirements

The Master of Science (Safety, Health and Environmental Technology) course, or M.Sc. (SHE), is hosted by the Department of Chemical and Biomolecular Engineering. The programme accepts both full time and part time students. To qualify for the M.Sc. (SHE) degree with or without an area of specialization, a candidate must successfully complete a programme of study consisting of at least 40 Modular Credits (MCs). In addition, a student must obtain a minimum CAP of 3.0 (Grade B-) for the best modules equivalent to 40 MCs (inclusive of compulsory modules, where required). A student may choose to graduate with one of the following:

- M.Sc. (SHE)

- M.Sc. (SHE) with specialization in Industrial Hygiene
- M.Sc. (SHE) with specialization in Process Safety

Programme course modules are presented in the following four groups

Foundation Modules

SH5000 Basic Sciences for SHE
SH5002 Fundamentals in Industrial Safety
SH5003 Fundamentals in Environmental Protection
SH5004 Fundamentals in Industrial Hygiene
SH5101 Industrial Toxicology
SH5108 Chemical Hazard Management

Core Modules in Industrial Hygiene

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

Core Modules in Process Safety

SH5201 Hazard Identification and Evaluation
SH5202 Quantified Risk Analysis
SH5203 Emergency Planning
SH5204 Safety Engineering
SH5205 Incident Management
SH5206 Human Factors in Process Safety
SH5401 SHE and Quality Management Systems OR
ESE5602 Environmental Management Systems

Elective Modules

SH5103 Advanced Industrial Hygiene
SH5402 Advanced SHE Management
SH5403 Independent Study
SH5404 Safety Health and Environmental Project
ESE5202 Air Pollution Control Technology
ESE5204 Toxic and Hazardous Waste Management
ESE5205 Sludge and Solid Waste Management
ESE5402 Industrial Wastewater Control
ESE5403 Water Reclamation & Reuse
ESE5603 Pollution Minimization and Prevention
SH5880 Topics in Industrial Hygiene
SH5881 Topics in Process Safety
SH5882 Topics in Environment Protection

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

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

below.

MSc SHE without specialisation

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

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

M.Sc. (SHE) with specialization in Industrial Hygiene

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

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

M.Sc. (SHE) with specialization in Process Safety

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

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

5.2.14 Master of Science (Supply Chain Management)

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.

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 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.ise.nus.edu.sg/scm_modules/index.html

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 4211G Service Design
DSC 4212 Managerial Decision Analysis
DSC 5211C Quantitative Risk Management
IE 5001 Operations Planning and Control I
IE 5002 Applied Engineering Statistics
IE 5107 Material Flow Systems
IE 5108 Facility Layout and Location
IE5202 Applied Forecasting Methods
IE 5401 Industrial Logistics
IE5403 Systems Engineering Case Studies
IE 5405 Inventory Systems
LI 5201 Special Topics in Logistics

5.2.15 Master of Science (Systems Design & Management)

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.

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:

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

For graduation, a student:

1. >> Must obtain a minimum CAP of 3.0 (B-) for the best modules equivalent to 40 MCs; and
2. Must obtain at least 40 MCs of which at least 30 MCs must be at a graduate level within the subject or in related disciplines and the remaining credits may be from other levels in the same or other disciplines subject to the approval of the Programme Manager.

Modules

The proposed programme consists of four core modules (total of 16 MCs) and a list of electives drawn from existing modules taught by 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.

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

Systems application

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

5.2.16 Master of Science (Transportation Systems and Management)

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.

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 at least 32 Modular Credits (MCs) from modules in Lists A and B below. The remaining two modules (8 MCs) to satisfy the degree requirements may be selected from relevant level 5000 and level 6000 modules offered by the Department of Civil and Environmental Engineering or other graduate programmes of Faculty of Engineering, subject to the approval of M.Sc. (TSM) Programme Management, which also include the modules in aforementioned Lists A and B. In addition, a student must obtain a minimum CAP of 3.0 (Grade B-) for the best modules equivalent to 40 MCs (inclusive of compulsory modules, where required). A Student may choose to graduate with the following degrees:

- 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

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

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

Another 16 MCs can be obtained from List B:

List B – **Electives modules** (minimum choose any 4 modules)
BMA5004A Management and Organisation (2MCs)
BMA5101 Industry and Competitive Analysis
CE5204 Pavement Design and Rehabilitation
CE5603 Engineering Economics and Project Evaluation
CE5705 Transportation and Construction Safety Management
CE5804 Global Infrastructure Project Management
CE6001 Operations & Management of Infrastructure Systems
CE6002 Analysis of Civil Engineering Experiments
IE5001 Operations Planning and Control I
IE5107 Material Flow Systems
IE5121 Quality Planning and Management
IE5202 Applied Forecasting Methods
IE5203 Decision Analysis
IE5401 Industrial Logistics
IE5404 Large Scale Systems Engineering
TP5026 Transportation Management and Policy

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

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

5.3 Special 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.
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.eng.nus.edu.sg/cee/programmes/DDP/ProgramDetails.html

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 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 student intakes 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

Note: The terms for the President's Graduate Fellowship, NUS Research Scholarship, Tuition Fee Allowance are being reviewed. Revised terms of the scholarships may be implemented from the August 2014 intake onwards.

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.