



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

UNDERGRADUATE ACADEMIC HANDBOOK

SESSION 2023/2024



FACULTY OF SCIENCE

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**UNDERGRADUATE ACADEMIC HANDBOOK
Session: 2023/2024**

<http://science.utm.my>

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Attention

All information in this version of the guide is true at time of publishing. The Faculty of Science reserves the right to make amendments to the guide as needed without prior announcement. This Academic Guide is a reference for students from the 2023/2024 Session intake and remains valid until the end of their study. The synopses of courses offered by the Faculty of Science are only available in English, as per the language used in their instruction.

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السَّلَامُ عَلَيْكُمْ وَرَحْمَةُ اللَّهِ وَبَرَكَاتُهُ and Salam Sejahtera,

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

On behalf of the staff of the Faculty of Science, it gives me great pleasure to welcome the new students to Universiti Teknologi Malaysia (UTM) and the Faculty of Science. My heartfelt congratulations on your admission to the Bachelor of Science programs offered by the Faculty of Science, UTM. I believe that you will use this opportunity wisely to acquire the knowledge, skills, experience, and friendship.

The Undergraduate Academic Handbook contains information on the programmes, courses, and curriculum for the Bachelor of Science programmes offered by the Faculty of Science, which is applicable to students admitted in the 2023/2024 session. This handbook is designed to assist you with the practices of the University regarding academic matters and general administration. It serves as a useful guide in planning your studies as well as a reference for understanding the structure of courses or programs offered by the Faculty of Science. We wish you a rewarding educational experience at the Faculty of Science. All the best!

On behalf of the Faculty of Science, I would like to take this opportunity to extend my sincere gratitude to all who were involved in the publication of the 2023/2024 Undergraduate Academic Handbook.

Wassalam

Associate Professor Dr. Shafinaz Shahir
Dean
Faculty of Science, UTM

FACULTY OF SCIENCE'S MANAGEMENT TEAM

The Faculty of Science is headed by a Dean, assisted by two Deputy Deans, three Assistant Deans, four Directors, one Information Technology Manager, one Laboratory Manager, one Deputy Registrar and two Assistant Registrars.

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At present, the faculty consists of four departments:

- i. Department of Biosciences
- ii. Department of Chemistry
- iii. Department of Mathematical Sciences
- iv. Department of Physics

Currently, the Faculty has 167 highly qualified and experienced academic staff, assisted by 121 dedicated and hardworking supporting staff.

In terms of facilities and equipment, the faculty has 4 lecture halls, 25 lecture rooms. As for laboratories, there are 43 laboratories under the management of the Bioscience Department, 69 laboratories under the Chemistry Department, 3 computer laboratories under the Mathematical Science Department and 43 laboratories and 2 workshops under the management of Physics Department. These laboratories and workshops are used for teaching purposes as well as scientific research projects.

BACKGROUND OF UNIVERSITI TEKNOLOGI MALAYSIA

Universiti Teknologi Malaysia (UTM) was first established on the 14th of March 1972 under the name of Institut Teknologi Kebangsaan (ITK). On the 1st of April 1975, the name was changed to Universiti Teknologi Malaysia. Although UTM was considered as a new university then, as a technical institution, it had existed since 1925 by the name of Kuala Lumpur Technical School. The School initially trained technicians for the Public Works Department and was later opened to other civil servants in 1930.

In 1946, the government upgraded the status of the Technical School to a Technical College. However, the construction of the college only started in 1951 at Jalan Gurney, Kuala Lumpur and completed in 1955.

In 1960, the Technical College began to offer engineering courses on a professional level. Students pursuing these courses were required to sit for professional examinations conducted by the Institution of Civil Engineers, Institution of Mechanical Engineers and the Institution of Electrical Engineers, United Kingdom.

Degree courses were first offered in 1969, when the Planning Committee for Higher Learning recognized the college as a university-level technical institute. On the 14th of March 1972, His Majesty Yang Di Pertuan Agong proclaimed the establishment of Institut Teknologi Kebangsaan, which was later renamed Universiti Teknologi Malaysia. The university was recognized as a technical university focusing on technology, with Bahasa Malaysia as the medium of instruction.

Currently, UTM's main campus is located on land spanning 1,120 hectares in Skudai, Johor. It is situated about 18 km from Johor Bahru City centre. The branch campus is located at UTM International Campus, Jalan Semarak, Kuala Lumpur. The move from the original campus at Jalan Semarak, Kuala Lumpur, to the main campus in Skudai began in 1985 and proceeded in stages. At present, the Skudai campus houses 9 faculties and 3 faculties in UTM International Campus, Kuala Lumpur, as follows:

- a. Faculty of Science
- b. Faculty of Mechanical Engineering
- c. Faculty of Civil Engineering
- d. Faculty of Electrical Engineering
- e. Faculty of Chemical & Energy Engineering
- f. Faculty of Computing
- g. Faculty of Built Environment and Surveying
- h. Faculty of Humanities and Social Sciences
- i. Faculty of Management
- j. Azman Hashim International Business School
- k. Razak Faculty of Engineering, Technology, and Informatics
- l. Malaysia-Japan International Institute of Technology (MJIT)

In June 2010, UTM received recognition and status as a Research University (RU).

PHILOSOPHY, VISION, MISSION, AND MOTTO OF UTM

PHILOSOPHY

The divine law of Allah is the foundation of knowledge. In line with His Will, UTM strives with total commitment to attain excellence in science, technology and engineering for the well-being and prosperity of mankind

Hukum Allah adalah dasar kepada ilmu. Seajar dengan kehendak-Nya, UTM komited secara menyeluruh dan bersepadu demi mencapai kecemerlangan dalam sains, teknologi dan kejuruteraan untuk kemakmuran dan kesejahteraan sejagat

VISION

A Premier University Providing World-Class Education and Research
Universiti Terkemuka Menyediakan Perkhidmatan Pendidikan dan Penyelidikan Bertaraf Dunia

MISSION

To Develop Holistic Talents and Prosper Lives Through Knowledge and Innovative Technologies

Untuk Membangun Bakat Holistik dan Mensejahtera Kehidupan Menerusi Ilmu dan Inovasi Teknologi

CORE VALUES

Integrity

Integriti

Synergy

Sinergi

Excellence

Kecemerlangan

Sustainability

Kelestarian

MOTTO

“KERANA TUHAN UNTUK MANUSIA”

In the Name of God for Mankind

THE CHRONOLOGICAL DEVELOPMENT OF FACULTY OF SCIENCE

Year	Event
1972	<ul style="list-style-type: none">• The Science Service Unit teaches Physics, Chemistry and Mathematics for the Engineering Faculties of Institut Teknologi Kebangsaan (ITK).• The Centre for Science and Humanities Studies, consisting of four departments (Physics, Chemistry, Mathematics and Humanities) was established.• A Diploma of Science and Education was initiated in cooperation with the Ministry of Education, Malaysia.
1978	<ul style="list-style-type: none">• The split of the Centre of Science and Humanities Studies resulted in the formation of the Centre of Science Studies (PPS), which consisted of 3 Departments (Physics, Chemistry and Mathematics).
1978	<ul style="list-style-type: none">• The Diploma of Science with Education was renamed as the Integrated Science with Education Course (ISP).
1979	<ul style="list-style-type: none">• Enrolment of the first batch of undergraduate students for the Bachelor of Science with Education program (SSP).
1980	<ul style="list-style-type: none">• The Department of Computer Science was established and placed under PPS.
1981	<ul style="list-style-type: none">• The Centre for Science Studies (PPS) was upgraded and renamed as the Faculty of Science (FS).
1982	<ul style="list-style-type: none">• The Education Department and the Department of Technical Science were transferred from the Centre of Humanities Studies into the Faculty of Science.
1983	<ul style="list-style-type: none">• The Bachelor of Computer Science Programme was initiated.
1984	<ul style="list-style-type: none">• The Department of Computer Science separated from the Faculty of Science to form an independent faculty.
1986	<ul style="list-style-type: none">• The Bachelor of Science in Technology with Education (Civil, Electrical, Mechanical) was established.
1987	<ul style="list-style-type: none">• The Bachelor of Industrial Science (SSI) course was started. The programmes offered were Industrial Chemistry, Industrial Physics and Industrial Mathematics.
1988	<ul style="list-style-type: none">• The Faculty of Science moved to Skudai.

Year	Event
	<ul style="list-style-type: none"> The Bachelor of Computer Science with Education (SPK) was initiated, followed by the Diploma in Education.
1989	<ul style="list-style-type: none"> The Faculty officially started its postgraduate program in Chemistry, Physics and Mathematics
1992	<ul style="list-style-type: none"> The Faculty started the Bachelor of Science in Technology with Education (Living Skills) Course
1989	<ul style="list-style-type: none"> The Faculty officially started its postgraduate program in Chemistry, Physics and Mathematics.
1992	<ul style="list-style-type: none"> The Faculty started the Bachelor of Science in Technology with Education (Living Skills) course.
1994	<ul style="list-style-type: none"> The Department of Education and the Department of Science and Technical Education were dissolved following the establishment of the Faculty of Education. Three departments remained in the Faculty of Science: The Departments of Chemistry, Physics and Mathematics.
1997	<ul style="list-style-type: none"> The Faculty started offering the Bachelor of Industrial Science (Biology) programme.
1998	<ul style="list-style-type: none"> The Faculty started offering the Bachelor of Industrial Science (Material Physics) programme.
1999	<ul style="list-style-type: none"> The Faculty started offering the Bachelor of Industrial Science (Health Physics) programme.
2000	<ul style="list-style-type: none"> The Biology Department was established in the Faculty.
2002	<ul style="list-style-type: none"> The Faculty of Science began offering a special programme known as the Excellent Scientists Programme (Pure Physics, Chemistry and Mathematics).
2003	<ul style="list-style-type: none"> The enrolment of students for the Undergraduate Programme was limited to only post-matriculation, post-STPM and diploma holders only.
2005	<ul style="list-style-type: none"> The Faculty began offering Undergraduate Degree Programmes in Pure Sciences (Biology, Chemistry, Physics and Mathematics).
2010	<ul style="list-style-type: none"> Enrolment of students for the Bachelor of Science (Material Physics) and Bachelor of Science (Health Physics) was stopped.
2012	<ul style="list-style-type: none"> The Department of Mathematics was renamed the Department of Mathematical Sciences.

Year	Event
2018 till Present	<ul style="list-style-type: none">• UTM Synergy 4.0• The Bioscience Department previously from the Faculty of Biosciences and Medical Engineering merged together with the Faculty of Science.

VISION, MISSION, MOTTO, PHILOSOPHY AND OBJECTIVES OF FACULTY OF SCIENCE

VISION

To be a world-renowned faculty in the advancement of science and mathematics

MISSION

To lead in the development of holistic talents and knowledge through learning and teaching, research, and innovation for universal well-being

MOTTO

“WHERE GREAT MINDS ARE NURTURED”

PHILOSOPHY

The Faculty of Science is committed to provide the pillar of strength through fundamental knowledge for the advancement and sustainability of other disciplines for UTM to continue soaring high.

OBJECTIVES

(Educational Goals)

1. To provide quality academic programmes in science and mathematics to meet both local and global education needs.
2. To facilitate the dissemination of knowledge in science and mathematics through innovative and effective teaching and learning.
3. To produce competent and versatile graduates guided by high moral and ethical values.
4. To undertake frontier and transformative research and development in biology, chemistry, physics, and mathematics.
5. To engage in interdisciplinary and collaborative research.
6. To provide an environment conducive to the exchange of knowledge, views, and innovative ideas.
7. To contribute to the advancement of knowledge through scholarly publications.
8. To engage in scientific based smart partnership and global networking.
9. To contribute to the generation of the nation's wealth through research and innovation.
10. To contribute to the improvement of the quality of life, protection of the environment and conservation of natural resources.

BUSINESS, STATEMENT OF OPPORTUNITY, CORE COMPETENCIES, CLIENT CHARTER

BUSINESS

To conduct teaching/learning, research, and consultancy activities in the field of Science and Mathematics.

STATEMENT OF OPPORTUNITY

1. Capitalizing on the staff expertise in realizing a culture of intellectual excellence to attract high quality students.
2. Maximizing smart partnership and professional networking with public and private sectors to enhance research, students' internship, and graduate employability.
3. Optimizing the usage of state-of-the-art facilities to conduct Faculty's programs, research activities, consultation work, and professional development programs.
4. Implementing market driven academic programs ensures quality graduates and employers' satisfaction.
5. Support visionary leadership drives innovative and transformative ideas in achieving management excellence thus increasing the Faculty's academic ranking.

CORE COMPETENCIES

1. Conducting quality teaching and learning in science and mathematics through creative and innovative techniques.
2. Designing science and mathematics-based programs in line with local and global trends and needs.
3. Undertaking frontier research in science and mathematics.
4. Engaging in interdisciplinary and collaborative research.
5. Producing scholarly publications consistently.
6. Providing scientific consultancy and advisory services.

CLIENTS CHARTER

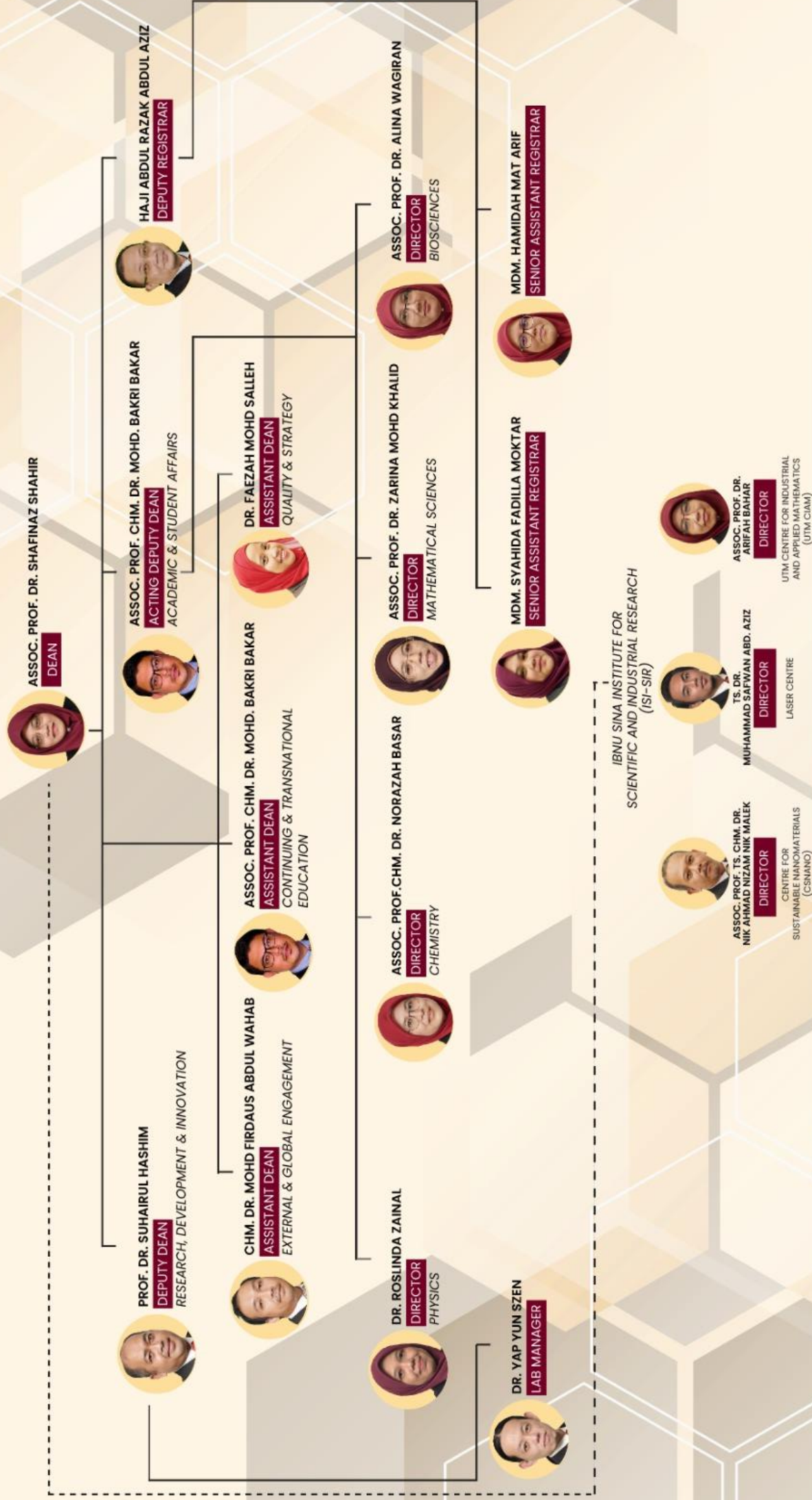
The Faculty of Science is committed to:

1. Design quality academic programmes which are market-driven, adaptable to the nation's needs and can inculcate ethical values to the students.
2. Fulfil academic duties with full responsibility and dedication in accordance with the standards, rules and regulations as stipulated by the University.

3. Execute fair and just assessment in the evaluation of students' academic performance.
4. Provide well-equipped laboratories and regularly maintained facilities conducive to laboratory work and research.
5. Provide professional guidance, supervision and efficient management in laboratory work and research.
6. Provide training and consultation towards the improvement of skills and professionalism.
7. Practise a friendly, open and caring attitude, always ready to provide necessary assistance related to the Faculty's core business.
8. Provide assistance within five (5) minutes of arrival to all clients at the Faculty's service counter.
9. Ensure a safe and healthy working environment in the faculty.

ORGANISATIONAL STRUCTURE

Faculty of Science



...where great minds are nurtured

UNDERGRADUATE PROGRAMMES AND ADMISSION REQUIREMENTS

UNDERGRADUATE PROGRAMMES OFFERED

The Faculty of Science offers eight (8) undergraduate programmes as of the 2023/2024 Academic Session. The programmes are: -

No.	Program Name	Program Code	Credits Norm to Graduate
1	Bachelor of Science (Chemistry) with Honours	SSCAH	129
2	Bachelor of Science (Industrial Chemistry) with Honours	SSCCH	129
3	Bachelor of Science (Mathematics) with Honours	SSCEH	129
4	Bachelor of Science (Industrial Mathematics) with Honours	SSCMH	129
5	Bachelor of Science (Physics) with Honours	SSCZH	128
6	Bachelor of Science (Industrial Physics) with Honours	SSCFH	128
7	Bachelor of Science Biology with Honours	SSCYH	128
8	Bachelor of Science Biotechnology with Honours	SSCTH	122

GENERAL ENTRANCE REQUIREMENTS

The general entrance requirements into the Bachelor of Science programmes are based on the candidate's qualification in the 'Sijil Tinggi Pelajaran Malaysia (STPM)', or 'Sijil Matrikulasi Kementerian Pelajaran Malaysia' or diploma, or the equivalent. The detailed entrance requirements can be obtained from the UTM's Prospectus or website (<http://www.utm.my/admission.utm.my>). Candidates with a certified Diploma and other certified qualifications may be considered for credit transfer.

COURSE STRUCTURE AND GENERAL COURSE HANDLING

COURSE STRUCTURE

The Bachelor of Science curriculum was designed to provide relevant and up-to-date combinations of core and elective courses. The curriculum was devised with the intentions to strengthen the fundamentals of Science and Mathematics in the early stage of the programme. Students must also undergo Industrial Training/Research Training for 1 semester. Apart from that, the Bachelor of Industrial Science students are required to take 3 management courses minimum.

Credit distribution for the Bachelor of Science Programmes is summarized by the following tables: -

a. Bachelor of Science (Pure) Programme: -

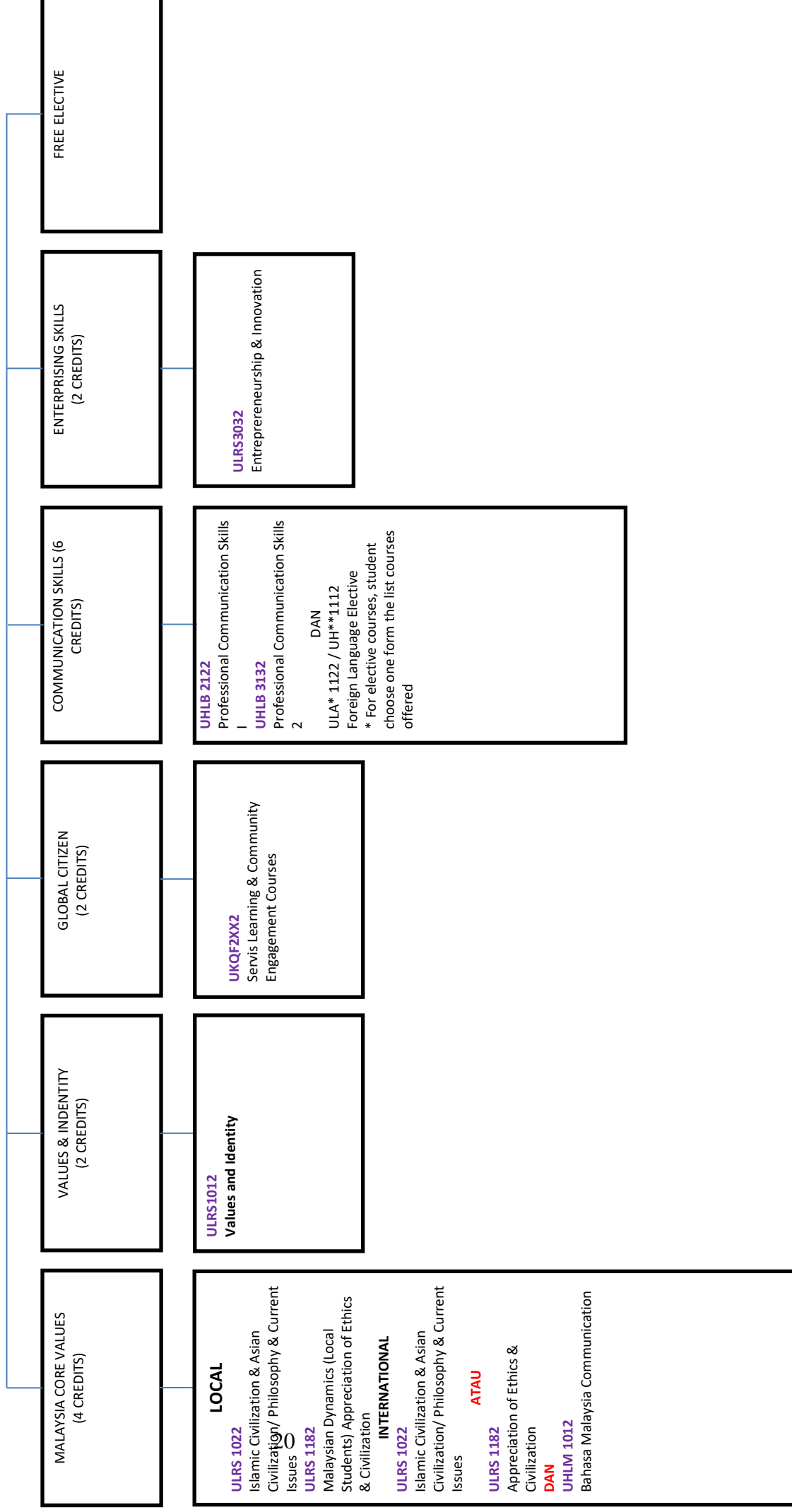
No.	Classification	SSCZH		SSCAH		SSCEH		SSCYH	
		Credit	%	Credit	%	Credit	%	Credit	%
1	Fundamentals in Science and Mathematics	15	59	3	59.7	24	59.7	7	61.8
2	Programme Core	61		74		53		72	
3	Programme Electives	33	26	33	25.6	33	25.6	30	23.4
4	Compulsory University Courses								
	a. Humanities	6	15	6	14.7	6	14.7	6	14.8
	b. Language	6		6		8		6	
	c. Co-Curriculum	2		2		2		2	
	d. Entrepreneurship	2		2		2		2	
	e. Free Elective	3		3		3		3	
	Total	128	100	129	100	129	100	128	100

b. Bachelor of Science (Industrial) Programme: -

No.	Classification	SSCFH		SSCCH		SSCMH		SSCTH	
		Credit	%	Credit	%	Credit	%	Credit	%
1	Fundamentals in Science and Mathematics	12	59	3	59.7	24	59.7	7	67
2	Programme Core	64		74		53		75	
3	Programme Electives	33	26	33	25.6	33	25.6	21	17
4	Compulsory University Courses								
	a. Humanities	6	15	6	14.7	6	14.7	6	16
	b. Language	6		6		6		6	
	c. Co-Curriculum	2		2		2		2	
	d. Entrepreneurship	2		2		2		2	
	e. Free Elective	3		3		3		3	
	Total	128	100	129	100	129	100	122	100

GENERAL COURSE STRUCTURE

UNIVERSITY GENERAL COURSE
(TOTAL CREDITS = 16 CREDITS + 3 ELECTIVE CREDITS)



BACHELOR OF SCIENCE (PHYSICS) WITH HONOURS (SSCZH)

1. Awarding Institution		Universiti Teknologi Malaysia		
2. Teaching Institution		Universiti Teknologi Malaysia		
3. Programme Name		Bachelor of Science (Physics) with Honours		
4. Final Award		Bachelor of Science (Physics) with Honours		
5. Programme Code		UT6441001(SSCZH)		
6. Professional or Statutory Body of Accreditation		Kementerian Pengajian Tinggi		
7. Language(s) of Instruction		Bahasa Malaysia and English		
8. Mode of Study (Conventional, Distance Learning, etc)		Conventional		
9. Mode of Operation (Franchise, Self-governing, etc)		Self-governing		
10. Study Scheme (Full Time/Part Time)		Full Time		
11. Study Duration		Minimum: 4 years Maximum: 6 years		
Type of Semester	No. of Semesters		No. of Weeks per Semester	
	Full Time	Part Time	Full Time	Part Time
Normal	8	10	18	20
Short	4	5	8	10
12. Entry Requirement	<p>Minimum Entry Requirements for STPM/ Matriculation/ Foundation/ Diploma & Equivalent Holders:</p> <p>University General Entry Requirements:</p> <ul style="list-style-type: none"> • Passed the Malaysian Certificate of Examination (SPM) or equivalent with a credit in Bahasa Melayu / Bahasa Malaysia ; and • Passed the Malaysian Higher School Certificate (STPM) with at least C Grade (CGPA 2.00) in General Paper and C Grade (CGPA 2.00) in any two of the taken subject in the STPM ; or Passed in Malaysian Matriculation Certificate / Foundation with minimum CGPA of at least 2.00 ; or Passed in STAM Qualification for at least Jekyll level ; or • Obtained an UA/ILKA/US or other equivalent Diploma approved by the Government of Malaysia and the University Senate (special programme entry requirements according to the types of programmes offered); and • Attained a minimum Band 2 in Malaysia University English Test (MUET). The validity period for MUET is FIVE (5) years from the date of the MUET result; or Band 5.5 in IELTS / Score of 500 in TOEFL PBT/ Score of 59 in TOEFL IBT. <p>Program Entry Requirements: STPM/Matriculation/Foundation Holders</p> <p>First Year Admission</p> <ul style="list-style-type: none"> • Obtained at least CGPA 2.80 at STPM/ Matriculation/ Foundation level; and • Obtained at least Grade B (CGPA 3.00) in Physics at STPM/ Matriculation/ Foundation level; and • Obtained at least Grade B- (CGPA 2.67) in any ONE (1) of the following subjects: Additional Mathematics, Chemistry, Biology; and • Passed with credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level or equivalent; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET) or at least Band score of 6.0 in the International English Language Testing System (IELTS). <p>Diploma Holders</p>			

	<ul style="list-style-type: none"> • Obtained a Diploma from UTM or any other institutions approved by the Government of Malaysia and related to the applied course with CGPA of at least 3.00; or • Other equivalent qualifications approved by the Government of Malaysia and the University Senate and related to the applied course with CGPA of at least 3.00; or • Candidates who obtained a CGPA less than 3.00 but have at least TWO (2) years working experience in related field are eligible to apply; and • Passed with credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level; or • Obtained at least Grade C in any of Mathematics subjects at the Diploma level; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET).
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13. Programme Educational Objectives (PEO)

The objectives of the Bachelor of Science (Industrial Physics) program are to provide knowledge, skills, and attributes needed for a successful career.

PEO 1 A competent, innovative, productive, and talented physicist for industrial and research needs.

PEO 2 A professional with appropriate soft-skills.

PEO 3 Positive attitude, integrity, and high responsibility to the community and global citizens.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
PEO1	✓	✓	✓				✓				
PEO2				✓	✓	✓					
PEO3								✓	✓	✓	✓

14. Programme Learning Outcomes (PLO)

Code	Intended Learning Outcomes	Learning and Teaching Methods	Assessment
(a) Technical Knowledge and Competencies			
PLO1 Knowledge and Understanding (KW)	Describe advanced and comprehensive, theoretical and technical knowledge and demonstrate relevant skills in physics	Lectures, tutorials, directed reading, active learning	Examinations, quizzes, tests, assignments.
PLO2 Cognitive Skills (CG)	Demonstrate intellectual independence in the application of knowledge within physics by applying critical, analytical and evaluation skills.	Lectures, tutorials, projects group/individual), directed reading, computer-based exercises, active learning	Examinations, quizzes, tests, computing output, presentations, and reports.
PLO3 Practical Skills (PS)	Attest skills and knowledge on a range of approaches in the field of physics and the ability to review, make adjustments and supervise related practices and processes concerning fields of specialization and industry.	FYUP, industrial training, service learning	Project presentations, project reports, industrial training reports.

PLO7 Numeracy Skills (NS)	Devise procedures on numerical and graphical information to make the right conclusions and decisions.	Active learning, projects	Oral presentations, project reports and peer evaluation.
b) Generic Skills			
PLO4 Interpersonal Skills (IPS)	Work together with different people in diverse learning and working communities as well as other groups locally and internationally.	Active learning, projects (Final year undergraduate project (FYUP), group/individual), industrial training	Oral presentations, project reports, industrial training reports.
PLO5 Communication Skills (CS)	Convey ideas both in written or oral forms using appropriate and different forms of presentation, confidently accurately and coherently in the appropriate context in a well-structured manner to a diversity of audiences.	Active learning, projects (FYUP, group/individual), industrial training	Written assignments, oral presentations, project reports, learning portfolio.
PLO6 Digital Skills (DS)	Use a broad range of information, media and technology applications to support study and/or work.	Active learning, projects (FYUP, group/individual), professional development courses, industrial training.	Written assignments, oral presentations, project reports and learning portfolio.
PLO8 Leadership, Autonomy and Responsibility (LAR)	Exhibit independence and professionalism in managing responsibilities within broad organizational needs.	Active learning, group projects, service learning and industrial training	Oral presentations, project reports, service learning and industrial training reports.
PLO9 Personal Skills (PRS)	Engage effectively in self-directed lifelong learning and professional pathways.	FYUP, co-curricular activities, group work, industrial training	FYUP reports, learning portfolio and industrial training report.
PLO10 Entrepreneurial Skills (ENT)	Relate entrepreneurial competency within given tasks and job scopes.	Lectures, assignments, case studies, seminar, workshop, co-curricular activities, group work	Written assignments, oral presentations and group reports.
PLO11 Ethics and Professionalism Skills (ETS)	Adhere to ethical codes and act professionally within the working environments.	FYUP, industrial training, lectures, immersive experiential learning	Research proposal, FYUP reports and industrial training report.

15. Classification of Courses

No.	Classification	Credit Hours	Percentage (%)
i.	Faculty Core	15	11.7
ii.	Programme Core	61	47.7
iii.	Programme Electives	33	25.8
iv	Compulsory University Courses		
	a) General Courses	8	14.8
	b) Languages	6	

	c) Entrepreneurship	2	
	d) Free Elective	3	
	Total	128	100
No	Classification	Credit Hours	Percentage (%)
A	Physics Courses		
	a) Lectures	95	74.2
	b) Laboratory/Workshop	6	4.7
	c) Research Training	5	3.9
	d) Undergraduate projects	6	4.7
	Total credit hours for Part A	112	87.5
B	University general courses		
	a) Humanities	6	4.7
	b) Languages	6	4.7
	c) Co-curriculum	2	1.5
	d) Entrepreneurship	2	1.5
	e) Free Elective	3	
	Total credit hours for Part B	16	12.5
	Total credit hours for Part A and B	128	100
16. Total Credit Hours to Graduate		128 credit hours	

17. Programme Structures and Features, Curriculum and Award Requirements

The course is offered on full-time mode and is based on a two semester academic session with several courses being delivered and assessed in each semester. Assessment is based on final examination and coursework conducted throughout the semester.

Award requirements:

To graduate, students should:

- Attain a total of not less than 128 credit hours with minimum CPA of 2.0.
- Pass industrial training.
- Complete and pass the final year undergraduate project.

YEAR 1

SEMESTER 1			SEMESTER 2		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
UHLM 1012	Malay Language for Communication 2	2	ULRS 1012	Value and Identity (Nilai dan Jati Diri)	2
ULRS 1182	Appreciation of Ethics and Civilizations *	2	SSCP 1163	Sound, Wave and Optics	3
SSCP 1143	Mechanics	3	SSCP 1223	Modern Physics	3
SSCP 1153	Electricity and Magnetism	3	SSCM 1523	Linear Algebra	3
SSCP 1811	Practical Physics I	1	SSCM 1033	Mathematical Methods II	3
SSCM 1023	Mathematical Methods I	3	SSCP 1821	Practical Physics II	1
SSCP 1102	Introduction to Physics Program	2	UHLB 1112	English Communication Skills**	2
Total credit hours		14 (16*)	Total credit hours		15 (17**)

* International students choose ONE only (ULRS 1182 or UHS 1022)
 ** Only for students with MUET below band 4 (Pre-requisite for UHLB 2122)

YEAR TWO

SEMESTER 3			SEMESTER 4		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
UHLB 2122	Professional Communication Skills 1	2	ULRF 2XX2	Service Learning & Community Engagement Course	2
ULRS 1022	Philosophy and Current Issues*	2	XXXX XXX3	Elective course	3
SSCP 2313	Basic Electronics	3	SSCP 2113	Thermodynamics	3
SSCP 2333	Computer Programming	3	SSCP 2413	Solid State Physics	3
SSCP 2811	Practical Physics III	1	SSCP 2613	Mathematical Physics	3
SSCP 2213	Nuclear Physics	3	SSCP 2821	Practical Physics IV	1
SSCM 1703	Differential Equations I	3			
Total credit hours		17	Total credit hours		15

YEAR THREE

SEMESTER 5			SEMESTER 6		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
ULRS 1032	Entrepreneurship & Innovation	2	UHLB 3132	Professional Communication Skills 2	2
SSCM 3503	Complex Variables	3	UHLX 1XX2	Foreign Language for Communication	2
SSCP 3123	Classical Mechanics	3	SSCP 3821	Practical Physics VI	1
SSCP 3811	Practical Physics V	1	SSCP 3643	Quantum Mechanics I	3
SSCP 3113	Electromagnetism	3	SSCP 3333	Computational Physics	3
SSCP 3133	Thermal and Statistical Physics	3			
			Electives (Choose 9 Credits)		
			SSCP 3143	Relativity	3
			SSCP 3523	Modern Optics	3
			SSCP 3153	Elementary Particle	3
			SSCP 3163	Energy and Environmental Physics	3
Total credit hours		15	Total credit hours		17

SEMESTER 3		
SHORT SEMESTER		Credit hours
SSCU 3905	Research Training (HW)	5
Total credit hours		5

YEAR FOUR

SEMESTER 7		
Course code	Course name	Credit hours
SSCU 4904	Undergraduate Project I	2
Elective (Choose 12 credits)		
SSCP 4163	Astrophysics	3
SSCP 4323	Electronics and Instrumentation	3
SSCP 4333	Signal Processing	3
SSCP 4413	Semiconductor Physics	3
SSCP 4423	Condensed Matter Physics	3
Total credit hours		14

SEMESTER 8		
Course code	Course name	Credit hours
SSCU 4924	Undergraduate Project II	4
Elective (Choose 12 credits)		
SSCP 4173	Quantum Mechanics II	3
SSCP 4213	Advanced Nuclear Physics	3
SSCP 4433	Magnetism	3
SSCP 4453	Low Temperature Physics and Superconductivity	3
Total credit hours		16

18. Mapping of Programme Learning Outcomes to Courses

COURSES OFFERED		LEARNING OUTCOMES										
		Knowledge and Understanding	Cognitive Skills	Practical Skills	Interpersonal Skill	Communication Skills	Digital Skills	Numeracy Skills	Leadership, Autonomy and Responsibility	Personal Skills	Entrepreneurial Skills	Ethics and Professionalism Skills
Code	Course Name	P L O 1	P L O 2	P L O 3	P L O 4	P L O 5	P L O 6	P L O 7	P L O 8	P L O 9	P L O 10	P L O 11
Core Courses												

SSCP 1102	Introduction To Physics Programme	✓		✓						✓		
SSCP 1143	Mechanics	✓	✓									
SSCP 1153	Electricity and Magnetism	✓	✓									
SSCP 1163	Sound, Wave and Optics	✓	✓									
SSCP 1223	Modern Physics	✓	✓									
SSCP 1811	Practical Physics I	✓	✓	✓	✓							
SSCP 1821	Practical Physics II	✓	✓	✓	✓							
SSCP 2113	Thermodynamics	✓	✓		✓							
SSCP 2213	Nuclear Physics	✓	✓						✓			
SSCP 2313	Basics Electronic	✓	✓					✓				
SSCP 2333	Computer Programming	✓	✓	✓				✓				
SSCP 2413	Solid State Physics	✓	✓		✓							
SSCP 2613	Mathematical Physics	✓	✓							✓		
SSCP 2811	Practical Physics III	✓	✓	✓		✓						
SSCP 2821	Practical Physics IV	✓	✓	✓		✓						
SSCP 3113	Electromagnetism	✓	✓		✓							
SSCP 3133	Thermal And Statistical Physics	✓	✓			✓						
SSCP 3811	Practical Physics V	✓	✓	✓					✓			
SSCP 3333	Computational Physics	✓	✓	✓			✓					
SSCP 3821	Practical Physics VI	✓	✓	✓		✓			✓			
SSCM 3503	Complex Variables	✓	✓					✓				
SSCP 3123	Classical Mechanics	✓	✓				✓					
SSCP 3643	Quantum Mechanics I	✓	✓				✓					
SSCM 1023	Mathematical Methods I	✓	✓									
SSCM 1523	Linear Algebra	✓	✓									
SSCM 1033	Mathematical Methods II	✓	✓									
SSCM 1703	Differential Equations I	✓	✓					✓				

SSCU 4902	Undergraduate Project I	✓	✓				✓			✓		✓
SSCU 4904	Undergraduate Project II	✓	✓	✓		✓				✓		✓
SSCU 3915	Research Training	✓	✓	✓	✓	✓			✓	✓		✓
TOTAL		30	29	11	6	6	4	4	4	5	0	3
Electives Courses												
SSCP 3143	Relativity	✓	✓		✓							
SSCP 3153	Elementary Particle	✓	✓				✓					
SSCP 3163	Energy and Environmental Physics	✓	✓							✓		
SSCP 3523	Modern Optics	✓	✓		✓							
SSCP 4163	Astrophysics	✓	✓	✓					✓			
SSCP 4323	Electronics and Instrumentation	✓	✓	✓	✓							
SSCP 4333	Signal Processing	✓	✓	✓					✓			
SSCP 4413	Semiconductor Physics	✓	✓					✓				
SSCP 4423	Condensed Matter Physics	✓	✓		✓							
SSCP 4173	Quantum Mechanics II	✓	✓			✓						
SSCP 4213	Advanced Nuclear Physics	✓	✓				✓					
SSCP 4433	Magnetism	✓	✓					✓				
SSCP 4453	Low Temperature Physics and Superconductivity	✓	✓					✓				
TOTAL		13	13	3	4	1	2	3	2	1	0	0
Core University Courses												
ULRS 1022	Philosophy and Current Issues	✓								✓		✓
UHL M 1012	Malay Language for Communication 2					✓						
UHM S 1182	Appreciation of Ethics and Civilizations	✓					✓					✓
ULRS 1012	Value and Identity									✓		✓
UBS 1032	Introduction to Entrepreneurship										✓	
UHL 2122	Professional Communication Skills 1					✓						

ULRI 2XX	Service Learning & Community Engagement Courses				✓					✓		✓
UHL B 313 2	Professional Communication Skills					✓						
UHL 1XX	Foreign Language For Communication					✓						
TOTAL		2	0	0	1	4	7	0	0	4	4	5

19. Programme Uniqueness

- The program is specially tailored to suit the current industrial needs.
- This program allows students to do their industrial placement at local or foreign companies.
- Established links with local and international industries.
- The program allows students to transfer credit of certain equivalence courses offered by other universities locally and overseas.
- Our laboratories are equipped with state of the art facilities and instruments.

20. Career Prospects and Career Path

This program prepares graduate to pursue carriers in various industries such as industrial supervisor, human resource manager, instrumentation services manager, quality control and production engineer, professional engineers and Occupational Health Officers. In public sectors, the graduate may pursue career as Science Officer, Research Scientist, Meteorologist and etc.

21. Cross Campus Program

Students are given the opportunity to enrol certain courses at participating institutions either locally or abroad. The grades and credits of up to 1/3 of the total credits of the curriculum are transferable.

22. UTM Professional Skills Certificate

UTM has designed its own UTM Professional Skills Certificate programme to enhance the knowledge and skills of its students. It provides students with value-added courses so that they will have a competitive-edge when they enter the employment market. Students are given the opportunity to enrol in this programme offered by UTM SPACE.

23. Facilities Available

A: Laboratories:

1. Material Characterization laboratory
2. Material Preparations laboratory
3. Crystal Growth laboratory
4. Teaching Laboratory: Optics 1
5. Teaching Laboratory: Optics 2
6. Teaching Laboratory: Optics 3
7. PCB Laboratory
8. Teaching Laboratory: Instrumentation 1
9. Teaching Laboratory: Instrumentation 2
10. Teaching Laboratory: Instrumentation 3
11. Teaching Laboratory: Instrumentation 4
12. Applied Optics Laboratory 1
13. Applied Optics Laboratory 2
14. Applied Optics Laboratory 3

15. Sputtering Laboratory
16. Thin Film Laboratory
17. Atomic Force Scanning Microscope (AFM) Laboratory
18. Teaching Laboratory: Material Physics 1
19. Teaching Laboratory: Material Physics 2
20. Teaching Laboratory: Nuclear Physics
21. Astrophysics Laboratory
22. Electronic Workshop
23. General Workshop
24. Tensile Testing Room
25. Non-destructive Testing Laboratory
26. Material Analysis Laboratory
27. Furnaces Room

B: List of instruments

1. Single crystal growth apparatus
2. UV-VIS Spectrophotometer
3. CNC machine
4. Photoluminescence Spectrometer
5. Ellipsometer
6. High Temperature Furnace
7. Differential Thermal Analyzer(DTA)
8. Vickers Hardness Equipment
9. General mechanical testing machine
10. Hyper pure Germanium Detector
11. Atomic Force Microscope (AFM)
12. Rapid Thermal Process (RTP)
13. Tensile Machine
14. Corrosion Machine

24. Support for Students and Their Learning

- One week induction programme for orientation and introductory study skills
- Student Handbook (online)
- Extensive library and other learning resources and facilities.
- Online resources: e-learning, UTMACAD, e-portfolio
- Students are assigned to academic advisors to assist them in education planning.

25. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning Mechanisms for Review and Evaluation of Teaching, Learning, Assessment, the Curriculum and Outcome Standards

- a) Students performance in terms of:
 - Kedudukan Bersyarat (KS)/ Kedudukan Baik (KB)
 - Cumulative Grade Point Average (CGPA)
 - Grade Point Average (GPA)
 - Graduate on time (GOT)
 - Completion rate
- b) Employability
 - Alumni survey
 - Market survey
- c) Lecturer's performance
 - Teaching evaluation by students (e-PPP)
 - Annual staff appraisal (e-LPPT)
- d) Curriculum review
 - Faculty academic committee
 - Industrial training survey

- Continuous Quality Improvement (CQI) report
- External examiner reports
- Survey of Course Outcome (SCO) by students
- Graduate employability report
- Exit Survey

e) Delivery system

- Academic Quality Assurance Committee
 - i. Audit report
 - ii. MQA standard

26. Regulation of Assessment

a) Summary of marks, grades and their evaluation points

Marks	Grade	Evaluation Point
90-100	A+	4.00
80-89	A	4.00
75-79	A-	3.67
70-74	B+	3.33
65-69	B	3.00
60-64	B-	2.67
55-59	C+	2.33
50-54	C	2.00
45-49	C-	1.67
40-44	D+	1.33
35-39	D	1.00
30-34	D-	0.67
00-29	E	0.00

b) Role of External Examiners (Visiting Examiners)

Visiting Examiners are appointed by the Faculty Academic Committee to

- review and evaluate program curriculum,
- review and evaluate assessment procedure and methods,
- make necessary recommendations to the Academic Committee.

27. Assessment Tools

Measurement Tools	Learning Outcomes											Duration	Action by
	P L O 1	P L O 2	P L O 3	P L O 4	P L O 5	P L O 6	P L O 7	P L O 8	P L O 9	P L O 10	P L O 11		
Survey of course outcome (SCO)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Course assessment report (CAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Exit survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of final semester	Faculty
Industrial training survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	End of training	Faculty
Employer Survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	Once a year	Faculty

BACHELOR OF SCIENCE (INDUSTRIAL PHYSICS) WITH HONOURS (SSCFH)

1. Awarding Institution		Universiti Teknologi Malaysia		
2. Teaching Institution		Universiti Teknologi Malaysia		
3. Programme Name		Bachelor of Science (Industrial Physics) with Honours		
4. Final Award		Bachelor of Science (Industrial Physics) with Honours		
5. Programme Code		UT6440001 (SSCFH)		
6. Professional or Statutory Body of Accreditation		Ministry of Higher Education		
7. Language(s) of Instruction		Bahasa Malaysia and English		
8. Mode of Study (Conventional, Distance Learning, etc)		Conventional		
9. Mode of Operation (Franchise, Self-governing, etc)		Self-governing		
10. Study Scheme (Full Time/Part Time)		Full Time		
11. Study Duration		Minimum: 4 years Maximum: 6 years		
Type of Semester	No. of Semesters		No. of Weeks per Semester	
	Full Time	Part Time	Full Time	Part Time
Normal	8	10	18	20
Short	4	5	8	10
12. Entry Requirement	<p>Fulfil all university requirements and the following program requirements:</p> <p>STPM/Matriculation/Foundation Holders:</p> <ul style="list-style-type: none"> • Obtained at least CGPA 2.80 at STPM/ Matriculation/ Foundation level; and • Obtained at least Grade B (CGPA 3.00) in Physics at STPM/Matriculation/Foundation level; and • Obtained at least Grade B- (CGPA 2.67) in any ONE (1) of the following subjects: Additional Mathematics, Chemistry, Biology; and • Passed with credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level or equivalent; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET) or at least Band score of 6.0 in the International English Language Testing System (IELTS). <p>Diploma Holders:</p> <ul style="list-style-type: none"> • Obtained a Diploma from UTM or any other institutions approved by the Government of Malaysia and related to the applied course with CGPA of at least 3.00; or • Other equivalent qualifications approved by the Government of Malaysia and the University Senate and related to the applied course with CGPA of at least 3.00; or • Candidates who obtained a CGPA less than 3.00 but have at least TWO (2) years working experience in related field are eligible to apply; and • Passed with credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level; or • Obtained at least Grade C in any of Mathematics subjects at the Diploma level; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET). <p>The detailed entry requirements can be obtained from the UTM Prospectus or website (http://admission.utm.my).</p>			

13. Programme Educational Objectives (PEO)

The objectives of the Bachelor of Science (Industrial Physics) program are to provide knowledge, skills, and attributes needed for a successful career. It is therefore anticipated that graduates of the program will

1. Become competent, innovative, productive, and talented physicists for industrial and research needs.
2. Become a professional with appropriate soft-skills.
3. Have a positive attitude, integrity, and high responsibility to the community and global citizen.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
PEO1	✓	✓	✓				✓				
PEO2				✓	✓	✓					
PEO3								✓	✓	✓	✓

14. Programme Learning Outcomes (PLO)

Code	Intended Learning Outcomes	Learning and Teaching Methods	Assessment
(a) Technical Knowledge and Competencies			
PLO1 Knowledge and Understanding (KW)	Relate comprehensive fundamental concept and theoretical knowledge in multi-disciplinary field of applied physics.	Lectures, tutorials, directed reading, active learning	Examinations, quizzes, tests, assignments.
PLO2 Cognitive Skills (CG)	Apply fundamental laws and principles of physics using various methods to solve related problems in applied physics.	Lectures, tutorials, projects group/individual), directed reading, computer-based exercises, active learning	Examinations, quizzes, tests, computing output, presentations, and reports.
PLO3 Practical Skills (PS)	Demonstrate technical and experimental skills using advance and specific equipment in the field of applied physics.	FYUP, industrial training, service learning	Project presentations, project reports, industrial training reports.
PLO7 Numeracy Skills (NS)	Construct procedures based on numerical and graphical information to make the right decisions in the scopes of physics applications.	Active learning, projects	Oral presentations, project reports and peer evaluation.
b) Generic Skills			
PLO4 Interpersonal Skills (IPS)	Work together in various local and international working communities.	Active learning, projects (Final year undergraduate project (FYUP), group/individual), industrial training.	Oral presentations, project reports, industrial training reports.
PLO5 Communication Skills (CS)	Convey ideas through verbal and non-verbal forms in accurate, appropriate, and	Active learning, projects (FYUP, group/individual), industrial training	Written assignments, oral presentations, project reports, learning portfolio.

	confident manner to diverse audiences, especially within the working communities.		
PLO6 Digital Skills (DS)	Use a broad range of information, media and technology applications in various tasks.	Active learning, projects (FYUP, group/individual), professional development courses, industrial training.	Written assignments, oral presentations, project reports and learning portfolio.
PLO8 Leadership, Autonomy and Responsibility (LAR)	Exhibit independence and professionalism in managing responsibilities within broad organizational needs.	Active learning, group projects, service learning and industrial training	Oral presentations, project reports, service learning and industrial training reports.
PLO9 Personal Skills (PRS)	Engage effectively in self-directed lifelong learning and professional pathways.	FYUP, co-curricular activities, group work, industrial training	FYUP reports, learning portfolio and industrial training report.
PLO10 Entrepreneurial Skills (ENT)	Relate entrepreneurial competency within given tasks and job scopes.	Lectures, assignments, case studies, seminar, workshop, co-curricular activities, group work	Written assignments, oral presentations and group report.
PLO11 Ethics and Professionalism Skills (ETS)	Adhere to ethical codes and act professionally within the working environments.	FYUP, industrial training, lectures, immersive experiential learning	Research proposal, FYUP reports and industrial training report.

15. Classification of Courses			
No.	Classification	Credit Hours	Percentage (%)
i.	Programme Core	79	61.7
ii.	Programme Electives	33	25.8
iii.	University General Courses		
	a) General Courses Cluster	6	4.7
	b) Languages	8	6.3
	c) Entrepreneurship	2	1.5
	Total	128	100
No	Classification	Credit Hours	Percentage (%)
A	Physics Courses		
	a) Lectures	95	74.2
	b) Laboratory/Workshop	6	4.7
	c) Industrial Training	5	3.9
	d) Final Year Undergraduate projects	6	4.7
	Total credit hours for Part A	112	87.5
B	University General Courses		
	a) General Courses Cluster	6	4.7
	b) Languages	8	6.3
	c) Entrepreneurship	2	1.5
	Total credit hours for Part B	16	12.5
	Total credit hours for Part A and B	128	100
16. Total Credit Hours to Graduate		128 credit hours	

17. Programme Structures and Features, Curriculum and Award Requirements

The course is offered on full-time mode and is based on a two semester academic sessions with several courses being delivered and assessed in each semester. Assessment is based on final examination and coursework conducted throughout the semester.

Award requirements:

To graduate, students should:

- Attain a total of not less than 128 credit hours with minimum CPA of 2.0.
- Pass industrial training.
- Complete and pass the final year undergraduate project.

YEAR 1

SEMESTER 1			SEMESTER 2		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
SSCP 1102	Introduction to Physics Program	2	SSCP 1163	Sound, Wave and Optics	3
SSCM 1023	Mathematical Methods I	3	SSCP 1223	Modern Physics	3
SSCP 1143	Mechanics	3	SSCM 1523	Linear Algebra	3
SSCP 1153	Electricity and Magnetism	3	SSCM 1033	Mathematical Methods II	3
SSCP 1811	Practical Physics I	1	SSCP 1821	Practical Physics II	1
ULRS 1182	Appreciation of Ethics and Civilizations	2	ULRS 1012	Value and Identity	2
UHLM 1012	Malay Language for Communication 2 * (International Students) * International students	2	UHLB 1112	English Communication Skills**	2
Total credit hours		14 (16*)	Total credit hours		15 (17**)

* International students choose ONE only (ULRS 1182 or UHIS 1022)

** Only for students with MUET band less than 4 (Pre-requisite for UHLB 2122)

YEAR TWO

SEMESTER 3			SEMESTER 4		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
SSCP 2313	Basic Electronics	3	SSCP 2113	Thermodynamics	3
SSCP 2333	Computer Programming	3	SSCP 2413	Solid State Physics	3
SSCP 2213	Nuclear Physics	3	SSCP 2613	Mathematical Physics	3
SSCM 1703	Differential Equations	3	SSCP 2821	Practical Physics IV	1
SSCP 2811	Practical Physics III	1	XXXX XXXX	Free Elective	3

ULRS 1022	Philosophy and Current Issues	2
UHLB 2122	Professional Communication Skills 1	2
Total credit hours		17

UKQF 2XX2	Service learning & Community Engagement Course	2
Total credit hours		15

YEAR THREE

SEMESTER 5		
Course code	Course name	Credit hours
SSCP 3323	Advanced Electronics	3
SSCP 3113	Electromagnetism	3
SSCP 3133	Thermal and Statistical Physics	3
SSCP 3811	Practical Physics V	1
ULRS 3032	Entrepreneurship & Innovation	2
Electives (Choose 3 Credits)		
SHAC 1023	Financial Accounting	3
SHAD 1033	Principles of Management	3
Total credit hours		17

SEMESTER 6		
Course code	Course name	Credit hours
SSCP 3343	Instrumentation and Data Acquisition	3
SSCP 3613	Quantum Mechanics	3
SSCP 3821	Practical Physics VI	1
UHLX 1112	Foreign Language for Communication	2
UHLB 3122	Professional Communication Skills 2	2
Electives (Choose 6 Credits)		
SHAF 1013	Principles of Marketing	3
SHAD 1043	Organizational Behaviours	3
SSCP 3433	Quality Control	3
Total credit hours		16

SEMESTER 3		
SHORT SEMESTER		Credit hours
SSCU3905	Industrial Training (HW)	5
Total credit hours		5

YEAR FOUR

SEMESTER 7		
Course code	Course name	Credit hours
SSCU 4902	Undergraduate Project I	2
Elective (Choose 12 credits)		
Group A		
SSCP 4123	Non-destructive Testing and Evaluation	3
SSCP 4133	Industrial Electronics	3

SEMESTER 8		
Course code	Course name	Credit hours
SSCU 4904	Undergraduate Project II	4
Elective (Choose 12 credits)		
Group A		
SSCP 4013	Data Processing	3
SSCP 4303	Process Control	3

SSCP 4143	Electronics Circuit Simulation	3	SSCP 4353	Ultrasonic Techniques	3
SSCP 4383	Signal Processing	3	SSCP 4363	Electronics Testing and Maintenance	3
SSCP 4393	Computer Interfacing	3	SSCP 4373	Communication Electronics	3
Group B			Group B		
SSCP 4223	Radiation Detection	3	SSCP 4253	Medical Physics	3
SSCP 4233	Radiation Protection	3	SSCP 4263	Occupational Health and Safety	3
SSCP 4243	Applied Radiation Physics	3	SSCP 4273	Nuclear Energy	3
SSCP 4293	Radiation Dosimetry	3	SSCP 4283	Environmental Radiation Protection	3
SSCP 4913	Radiobiology	3	SSCP 4203	Medical Radiation Protection	3
Group C			Group C		
SSCP 4623	Material Science	3	SSCP 4463	Corrosion Sciences	3
SSCP 4633	Ceramic and Amorphous Material	3	SSCP 4473	Spectroscopy and Material Analysis	3
SSCP 4643	Polymer Science	3	SSCP 4483	Semiconductor Devices	3
SSCP 4603	Vacuum and Thin Film Technology	3	SSCP 4443	Magnetic Material	3
SSCP 4493	Metallurgy	3	SSCP 4403	Microscopy and Material Analysis	3
Group D			Group D		
SSCP47 13	Introduction to Nonlinear Optics	3	SSCP45 53	Applied Optics	3
SSCP45 23	Laser Technology	3	SSCP45 63	Photonics	3
SSCP45 33	Fibre Optics Technology	3	SSCP45 73	Laser in Medicine	3
SSCP45 43	Optoelectronics	3	SSCP45 83	Photometry	3
SSCP35 23	Modern Optics	3	SSCP45 93	Solid State Laser Engineering	3
Total credit hours		14	Total credit hours		16

18. Mapping of Programme Learning Outcomes to Courses

COURSES OFFERED		LEARNING OUTCOMES										
		Knowledge and Understanding	Cognitive Skills	Practical Skills	Interpersonal Skill	Communication Skills	Digital Skills	Numeracy Skills	Leadership, Autonomy and Responsibility	Personal Skills	Entrepreneurial Skills	Ethics and Professionalism Skills
Code	Course Name	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
Core Courses												
SSCP 1102	Introduction To Physics Programme	✓		✓						✓		
SSCP 1143	Mechanics	✓	✓									
SSCP 1153	Electricity and Magnetism	✓	✓									
SSCP 1163	Sound, Wave and Optics	✓	✓									
SSCP 1223	Modern Physics	✓	✓									
SSCP 1811	Practical Physics I	✓	✓	✓	✓							
SSCP 1821	Practical Physics II	✓	✓	✓	✓							
SSCP 2113	Thermodynamics	✓	✓		✓							
SSCP 2213	Nuclear Physics	✓	✓						✓			
SSCP 2313	Basics Electronic	✓	✓					✓				
SSCP 2333	Computer Programming	✓	✓	✓				✓				
SSCP 2413	Solid State Physics	✓	✓		✓							
SSCP 2613	Mathematical Physics	✓	✓							✓		
SSCP 2811	Practical Physics III	✓	✓	✓		✓						

SSCP 2821	Practical Physics IV	✓	✓	✓		✓						
SSCP 3113	Electromagnetism	✓	✓		✓							
SSCP 3133	Thermal and Statistical Physics	✓	✓			✓						
SSCP 3811	Practical Physics V	✓	✓	✓					✓			
SSCP 3821	Practical Physics VI	✓	✓	✓		✓			✓			
SSCP 3323	Advanced Electronics	✓	✓		✓				✓			
SSCP 3343	Instrumentation and Data Acquisition	✓	✓	✓						✓		
SSCP 3613	Quantum Mechanics	✓	✓							✓		
SSCM 1023	Mathematical Methods I	✓	✓									
SSCM 1523	Linear Algebra	✓	✓									
SSCM 1033	Mathematical Methods II	✓	✓									
SSCM 1703	Differential Equations I	✓	✓					✓				
SSCU 4902	Undergraduate Project I	✓	✓				✓			✓		✓
SSCU 4904	Undergraduate Project II	✓	✓	✓		✓				✓		✓
SSCU 3905	Industrial Training	✓	✓	✓	✓	✓			✓	✓		✓
TOTAL		29	29	11	7	6	1	3	5	7	0	3
Electives Courses												
SSCP 3433	Quality Control	✓	✓		✓							
SSCP 4013	Data Processing	✓	✓	✓			✓					
SSCP 4123	Non-destructive Testing and Evaluations	✓	✓	✓		✓						
SSCP 4143	Electronics Circuit Simulation	✓	✓	✓			✓					
SSCP 4203	Medical Radiation Protection	✓	✓			✓						
SSCP 4223	Radiation Detection	✓	✓					✓				
SSCP 4233	Radiation Protection	✓	✓							✓		
SSCP 4253	Medical Physics	✓	✓						✓			
SSCP 4263	Occupational Health and Safety	✓	✓			✓						
SSCP 4273	Nuclear Energy	✓	✓					✓				
SSCP 4293	Radiation Dosimetry	✓	✓							✓		

SSCP 4303	Process Control	✓	✓			✓						
SSCP 4353	Ultrasonic Technique	✓	✓							✓		
SSCP 4363	Electronics Testing and Maintenance	✓	✓	✓						✓		
SSCP 4383	Signal Processing	✓	✓	✓				✓				
SSCP 4393	Computer Interfacing	✓	✓	✓						✓		
SSCP 4403	Microscopy and Materials Analysis	✓	✓	✓								✓
SSCP 4443	Magnetic Materials	✓	✓			✓						
SSCP 4463	Corrosion Sciences	✓	✓									
SSCP 4483	Semiconductor Devices	✓	✓							✓		
SSCP 4493	Metallurgy	✓	✓			✓						
SSCP 4523	Laser Technology	✓	✓		✓							
SSCP 4533	Fibre Optics Technology	✓	✓							✓		
SSCP 4543	Optoelectronics	✓	✓				✓					
SSCP 4553	Applied Optics	✓	✓							✓		
SSCP 4563	Photonics	✓	✓		✓							
SSCP 4573	Laser in Medicine	✓	✓						✓			
SSCP 4583	Photometric	✓	✓	✓		✓						
SSCP 4603	Vacuum And Thin Film Technology	✓	✓						✓			
SSCP 4623	Material Science	✓	✓					✓				
SSCP 4633	Ceramic and Amorphous Material	✓	✓							✓		
SSCP 4913	Radiobiology	✓	✓									✓
TOTAL		32	32	8	3	7	3	4	3	9	0	2
Management Elective Coures												
SHAD 1043	Organizational Behaviours	✓										✓
SHAC 1023	Financial Accounting	✓			✓	✓					✓	
SHAF 1013	Principles of Marketing	✓				✓					✓	
SHAD 1033	Principles of Management	✓										✓
TOTAL		4	0	0	1	2	0	0	0	0	0	2

Core University Courses												
ULRS 1022	Philosophy and Current Issues	✓								✓		✓
UHLM 1012	Malay Language for Communication 2					✓						
ULRS 1182	Appreciation of Ethics and Civilizations	✓								✓		✓
ULRS 1032	Entrepreneurship & Innovation										✓	
ULRS 1012	Value and Identity									✓		✓
UHLB 2122	Professional Communication Skills 1					✓						
UHLB 3122	Professional Communication Skills 2					✓	✓					
UKQF 2XX2	Service learning & Community Engagement Course				✓				✓	✓		
UHLX 1112	Foreign Language for Communication						✓					
TOTAL		2	0	0	1	3	2	0	1	4	1	3

19. Programme Uniqueness

- The program is specially tailored to suit the current industrial needs.
- This program allows student to do their industrial placement at local or foreign companies.
- Established links with local and international industries.
- The program allows student to do transfer credit of certain equivalence courses offered by other university locally and overseas.
- Our laboratories are equipped with state of the art facilities and instruments.

20. Career Prospects and Career Path

This program prepares graduate to pursue carriers in various industries such as industrial supervisor, human resource manager, instrumentation services manager, quality control and production engineer, professional engineers and Occupational Health Officers. In public sectors, the graduate may pursue carrier as Science Officer, Research Scientist, Meteorologist and etc.

21. Cross Campus Program

Students are given the opportunity to enrol certain courses at participating institutions either locally or abroad. The grades and credits of up to 1/3 of the total credits of the curriculum are transferable.

22. UTM Professional Skills Certificate

UTM has designed its own UTM Professional Skills Certificate programme to enhance the knowledge and skills of its students. It provides students with value-added courses so that they will have a competitive-edge when they enter the employment market. Students are given the opportunity to enrol in this programme offered by UTMSPACE, UTMXCITE, UTM Career Centre, Akademi Bahasa, UTM iLeaGue dan UTMCAEL. (More information can be obtained from <https://ileague.utm.my/utm-professional-skills-certificate-utm-psc/>).

23. Facilities Available

A: Laboratories:

1. Material Characterization laboratory
2. Material Preparations laboratory
3. Crystal Growth laboratory
4. Teaching Laboratory: Optics 1
5. Teaching Laboratory: Optics 2
6. Teaching Laboratory: Optics 3
7. PCB Laboratory
8. Teaching Laboratory: Instrumentation 1
9. Teaching Laboratory: Instrumentation 2
10. Teaching Laboratory: Instrumentation 3
11. Teaching Laboratory: Instrumentation 4
12. Applied Optics Laboratory 1
13. Applied Optics Laboratory 2
14. Applied Optics Laboratory 3
15. Sputtering Laboratory
16. Thin Film Laboratory
17. Atomic Force Scanning Microscope (AFM) Laboratory
18. Teaching Laboratory: Material Physics 1
19. Teaching Laboratory: Material Physics 2
20. Teaching Laboratory: Nuclear Physics
21. Astrophysics Laboratory
22. Electronic Workshop
23. General Workshop
24. Tensile Testing Room
25. Non-destructive Testing Laboratory
26. Material Analysis Laboratory
27. Furnaces Room

B: List of instruments

1. Single crystal growth apparatus
2. UV-VIS Spectrophotometer
3. CNC machine
4. Photoluminescence Spectrometer
5. Ellipsometer
6. High Temperature Furnace
7. Differential Thermal Analyzer (DTA)
8. Vickers Hardness Equipment
9. General mechanical testing machine
10. Hyper pure Germanium Detector
11. Atomic Force Microscope (AFM)
12. Rapid Thermal Process (RTP)
13. Tensile Machine
14. Corrosion Machine

24. Support for Students and Their Learning

- One week induction programme for orientation and introductory study skills
- Student Handbook (online)
- Extensive library and other learning resources and facilities.
- Online resources: e-learning, UTMACAD, e-portfolio
- Students are assigned to academic advisors to assist them in education planning.

25. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning Mechanisms for Review and Evaluation of Teaching, Learning, Assessment, the Curriculum and Outcome Standards

- a) Students performance in terms of:
- Kedudukan Bersyarat (KS)/ Kedudukan Baik (KB)
 - Cumulative Grade Point Average (CGPA)
 - Grade Point Average (GPA)
 - Graduate on time (GOT)
 - Completion rate
- b) Employability
- Alumni survey
 - Market survey
- c) Lecturer's performance
- Teaching evaluation by students (e-PPP)
 - Annual staff appraisal (e-LPPT)
- d) Curriculum review
- Faculty academic committee
 - Industrial training survey
 - Continuous Quality Improvement (CQI) report
 - External examiner reports
 - Survey of Course Outcome (SCO) by students
 - Graduate employability report
 - Exit Survey
- e) Delivery system
- Academic Quality Assurance Committee
 - i. Audit report
 - ii. MQA standard

26. Regulation of Assessment

- a) Summary of marks, grades and their evaluation points

Marks	Grade	Evaluation Point
90-100	A+	4.00
80-89	A	4.00
75-79	A-	3.67
70-74	B+	3.33
65-69	B	3.00
60-64	B-	2.67
55-59	C+	2.33
50-54	C	2.00
45-49	C-	1.67
40-44	D+	1.33
35-39	D	1.00
30-34	D-	0.67
00-29	E	0.00

- b) Role of Board of Study (BOS) which the members consist of the External Examiners, Industrial Advisory Panels and Alumni. They are appointed by the Faculty Academic Committee to:
- review and evaluate program curriculum,
 - review and evaluate assessment procedure and methods,
 - make necessary recommendations to the Academic Committee.

27. Assessment Tools

Measurement Tools	Learning Outcomes											Duration	Action by
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11		
Course Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Course assessment report (CAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Annual Program Assessment Report (APAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Faculty
Entry Survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	First semester first year	Faculty
Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of final semester	Faculty
Industrial Training Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	End of training	Faculty
Alumni Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty

BACHELOR OF SCIENCE (CHEMISTRY) WITH HONOURS (SSCAH)

1. Awarding Institution		Universiti Teknologi Malaysia		
2. Teaching Institution		Universiti Teknologi Malaysia		
3. Programme Name		Bachelor of Science (Chemistry) with Honours		
4. Final Award		Bachelor of Science (Chemistry) with Honours		
5. Programme Code		UT6442002 (SSCAH)		
6. Professional or Statutory Body of Accreditation		Ministry of Higher Education		
7. Language(s) of Instruction		Bahasa Malaysia and English		
8. Mode of Study (Conventional, Distance Learning, etc)		Conventional		
9. Mode of Operation (Franchise, Self-governing, etc)		Self-governing		
10. Study Scheme (Full Time/Part Time)		Full Time		
11. Study Duration		Minimum: 4 years Maximum: 6 years		
Type of Semester	No. of Semesters		No. of Weeks per Semester	
	Full Time	Part Time	Full Time	Part Time
Normal	8	12	18	20
Short	4	6	8	10
12. Entry Requirement	<p>Candidates should fulfil all the University requirements and the following program requirements:</p> <p>Programme Entry Requirements:</p> <p>STPM/Matriculation/Foundation Holders:</p> <ul style="list-style-type: none"> • Obtained a CGPA of at least 2.80 at STPM/Matriculation/Foundation level; and • Obtained at least Grade B (CGPA 3.00) in Chemistry at the STPM/Matriculation/Foundation level; and • Obtained at least Grade B- (CGPA 2.67) in any ONE (1) of the following subjects: Physics, Biology and Additional Mathematics or Mathematics; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level or equivalent; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET); and • Candidates have no physical disabilities (e.g., blind/colour blindness/paralysed which may cause difficulties in the lab work). <p>Diploma Holders:</p> <ul style="list-style-type: none"> • Obtained a Diploma from UTM or any other institutions approved by the Government of Malaysia and related to the applied course with a CGPA of at least 3.00; or • Other equivalent qualifications approved by the Government of Malaysia and the University Senate and related to the applied course with a CGPA of at least 3.00; or • Candidates who obtained a CGPA of less than 3.00 but have at least TWO (2) years working experience in the related field are eligible to apply; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level; or • Obtained at least Grade C in any Mathematics subject at the Diploma level; and 			

	<ul style="list-style-type: none"> Obtained at least a Band 2 in the Malaysian University English Test (MUET); and Candidates have no physical disabilities (e.g., blind/colour blindness/paralysed which may cause difficulties in the lab work). <p>International Candidates:</p> <p>Please check the entry requirements through the following website https://admission.utm.my/entry-requirements-ug-international/ The detailed entry requirements can be obtained from the UTM Prospectus or website (http://admission.utm.my).</p>
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13. Programme Educational Objectives (PEO)

The objectives of the BSc (Chemistry) with Honours program are to provide the knowledge, skills and attributes that should be achieved by the graduates for a successful career. It is therefore anticipated that, graduates of the program who are

1. knowledgeable and competent in undertaking research and development activities in the field of chemistry
2. efficient and innovative with distinctive leadership qualities and compliance to standards of ethical conduct demonstrate high standards of ethics, pure values and social responsibilities.
3. responsible in engaging and contributing professionally towards environmental well-being and sustainable community

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
PEO1	✓	✓	✓			✓	✓				
PEO2								✓		✓	✓
PEO3				✓	✓				✓		

14. Programme Learning Outcomes (PLO)

Code	Intended Learning Outcomes	Learning and Teaching Methods	Assessment
(a) Technical Knowledge and Competencies			
PLO1 Knowledge and Understanding (KW)	Construct comprehensive theoretical knowledge, technical and research skills in Chemistry.	Lectures, tutorials, active learning, laboratory works, research projects.	Examination, test, quiz, and laboratory report.
PLO2 Cognitive Skills (CG)	Design creative and innovative solutions to solve complex issues and problems in Chemistry.	Lectures, tutorials, active learning, laboratory works, research projects.	Examination, test, quiz, assignment, and laboratory report.
PLO3 Practical Skills (PS)	Modify instrumentation and analytical methods, procedures and processes in Chemistry.	Active learning, laboratory works, hands-on instrumentations, chemistry related software skills, research project, research training.	laboratory observation, group project, computer simulation, final year project report and research training supervisory report.
PLO7 Numeracy Skills (NS)	Interpret numerical, graphical and visual data for applications in Chemistry.	Lectures, tutorials, active learning, laboratory works.	Examination, test, quiz, and laboratory report.

PLO4 Interpersonal Skills (IPS)	Work together with different people in diverse working and learning communities locally and internationally.	Group projects, laboratory works, independent research, research training, research project.	Group assignment, laboratory report, research project report, research training report.
PLO5 Communication Skills (CS)	Confidently convey ideas both in written and oral forms using appropriate well- structured presentation methods to a diversity of audiences.	Independent research projects, research training.	Oral presentation, project report.
PLO6 Digital Skills (DS)	Integrate a wide range of digital technologies to enhance understanding in Chemistry.	Chemistry related software assignment, research project, research training.	Computer simulation, final year project report and research training supervisory report.
PLO8 Leadership, Autonomy and Responsibility (LAR)	Demonstrate leadership, autonomy and professionalism in managing responsibilities and making decisions within broad organizational parameters.	Group assignments.	Group assignment report.
PLO9 Personal Skills (PRS)	Engage effectively in self-directed lifelong learning and professional pathways.	Lecture, individual assignment, laboratory work, final year project and research training.	Laboratory report, individual assignment report, seminar presentation and final year project report
PLO10 Entrepreneurial Skills (ENT)	Develop entrepreneurial competency skills.	Assignments.	Assignment reports.
PLO11 Ethics and Professionalism Skills (ETS)	Build good ethics and professionalism related to science, technology and environmental issues.	Assignments.	Assignment reports.

15. Classification of Courses

No.	Classification	Credit Hours	Percentage (%)
i.	Faculty Core	3	2.3
ii.	Programme Core	74	57.4
iii.	Programme Electives	33	25.6
iv.	Compulsory University Courses		
	a) General Courses Cluster	8	
	b) Languages	6	14.7
	c) Entrepreneurship	2	
	d) Free Elective	3	
	Total	129	100
No	Classification	Credit Hours	Percentage (%)
A	Chemistry Courses		
	a) Lectures	80	62.0

	b) Laboratory	9	7.0
	c) Research Training	12	9.3
	d) Final Year Undergraduate Project	6	4.7
	Total credit hours for Part A	107	83.0
B	Related Courses		
	a) Mathematics	3	2.3
	b) Compulsory University Courses		
	1. Humanities		4.6
	2. Language	6	4.6
	3. Co-Curriculum	6	1.6
4. Entrepreneurship	2	1.6	
5. Free Elective	2	2.3	
	Total credit hours for Part B	22	17.0
	Total credit hours for Part A and B	129	100
16. Total Credit Hours to Graduate		129 credit hours	

17. Programme Structures and Features, Curriculum and Award Requirements

The course is offered on full-time mode and is based on two semester academic sessions with several courses being delivered and assessed in each semester. Assessment is based on final examination and coursework conducted throughout the semester.

Award requirements:

To graduate, students should:

- Attain a total of not less than 129 credit hours with minimum CPA of 2.0.
- Pass industrial training.
- Complete and pass the final year undergraduate project.

YEAR 1

SEMESTER 1			SEMESTER 2		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
UHLM 1012	Malay Language for Communication 2 (International Students only)	2	ULRS 1012	Value and Identity	2
ULRS 1182	Appreciation of Ethics and Civilizations*	2	SSCC 1203	Analytical Chemistry	3
SSCC 1633	Organic Chemistry I	3	SSCC 1861	Analytical Chemistry Practical I	1
SSCC 1821	Organic Chemistry Practical I	1	SSCC 1643	Organic Chemistry II	3
SSCC 1713	Main Group Elements	3	SSCC 1891	Organic Chemistry Practical II	1
SSCC 1851	Inorganic Chemistry Practical I	1	SSCC 1323	Information Literacy	3
SSCC 1313	Occupational Safety, Health and Environment	3	SSCM 1023	Mathematical Methods I	3
SSCC 1881	Basic Laboratory Skills	1			
Total credit hours		16	Total credit hours		16

* International students choose ONE only (ULRS 1182 or UHIS 1022)

** Only for students with MUET below band 4 (Pre-requisite for UHLB 2122)

YEAR TWO

SEMESTER 3		
Course code	Course name	Credit hours
UHLB 2122	Professional Communication Skills 1	2
ULRS 1022	Philosophy and Current Issues*	2
SSCC 2223	Spectrometric Methods of Analysis	3
SSCC 2871	Analytical Chemistry Practical II	1
SSCC 2413	Chemical Thermodynamics	3
SSCC 2831	Physical Chemistry Practical I	1
SSCC 2463	Quantum Chemistry	3
SSCC 2653	Polymer Chemistry	3
Total credit hours		18

SEMESTER 4		
Course code	Course name	Credit hours
ULRF 2XX2	Service Learning & Community Engagement Courses	2
SSCC 2713	Coordination Chemistry	3
SSCC 2851	Inorganic Chemistry Practical II	1
SSCC 2453	Chemical Kinetics and Electrochemistry	3
SSCC 2841	Physical Chemistry Practical II	1
SSCC 2213	Environmental Chemistry	3
SSCC 2473	Molecular Spectroscopy	3
SSCU 3622	Research Methodology and Information Retrieval (HW)	2
Total credit hours		18

*International Students Choose ONE Only

YEAR THREE

SEMESTER 5		
Course code	Course name	Credit hours
ULRS 3032	Entrepreneurship & Innovation	2
XXXX XXX3	Free Elective	3
Electives (choose 12 Credits)		
SSCC 3643	Application of Spectroscopy	3
SSCC 3243	Separation Methods	3
SSCC 3443	Chemical Reactions Process	3
SSCC 3373	Quality Management System	3
SSCC 3603	Medicinal Chemistry	3
SSCC 3773	Inorganic and Organometallic Polymers	3

SEMESTER 6		
Course code	Course name	Credit hours
UHLB 3132	Professional Communication Skills 2	2
UHLX 1XX2	Foreign Language for Communication	2
SSCU 3902	Undergraduate Project I	2
SSCC 3543	Modelling and Simulation	3
Electives (Choose 9 Credits)		
SSCC 3493	Surface and Colloid Chemistry	3
SSCC 3653	Organic Synthesis	3
SSCC 3433	Solid State Chemistry	3
SSCC 3563	Instrumentation Competency	3
SSCC 3363	Green Chemistry	3
SSCC 3003	Chemistry of Biomolecules	3

18. Mapping of Programme Learning Outcomes to Courses

COURSES OFFERED		LEARNING OUTCOMES										
		Knowledge and Understanding	Cognitive Skills	Practical Skills	Interpersonal Skill	Communication Skills	Digital Skills	Numeracy Skills	Leadership, Autonomy and Responsibility	Personal Skills	Entrepreneurial Skills	Ethics and Professionalism Skills
Code	Course Name	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
Core Courses												
SSCC 1633	Organic Chemistry I	✓	✓				✓					
SSCC 1821	Organic Chemistry Practical I	✓	✓	✓						✓		
SSCC 1713	Main Group Elements	✓	✓			✓						
SSCC 1851	Inorganic Chemistry Practical I	✓	✓	✓	✓							
SSCC 1313	Occupational Safety, Health and Environment	✓	✓									✓
SSCM 1023	Mathematical Methods I	✓	✓									
SSCC 1881	Basic Laboratory Skills	✓	✓	✓								✓
SSCC 1203	Analytical Chemistry	✓	✓					✓				
SSCC 1861	Analytical Chemistry Practical I	✓	✓	✓				✓				
SSCC 1643	Organic Chemistry II	✓	✓							✓		
SSCC 1891	Organic Chemistry Practical II	✓	✓	✓						✓		
SSCC 1323	Information Literacy	✓	✓				✓					
SSCC 2223	Spectrometric Methods of Analysis	✓	✓			✓						
SSCC 2871	Analytical Chemistry Practical II	✓	✓	✓								✓

SSCC 2413	Chemical Thermodynamics	✓	✓					✓				
SSCC 2831	Physical Chemistry Practical I	✓	✓	✓		✓						
SSCC 2463	Quantum Chemistry	✓	✓					✓				
SSCC 2653	Polymer Chemistry	✓	✓								✓	
SSCC 2713	Coordination Chemistry	✓	✓						✓			
SSCC 2851	Inorganic Chemistry Practical II	✓	✓	✓			✓					
SSCC 2453	Chemical Kinetics and Electrochemistry	✓	✓		✓							
SSCC 2841	Physical Chemistry Practical II	✓	✓	✓					✓			
SSCC 2213	Environmental Chemistry	✓	✓									✓
SSCC 2473	Molecular Spectroscopy	✓	✓							✓		
SSCC 3543	Modelling and Simulation	✓	✓				✓					
SSCU 3622	Research Methodology and Information Retrieval (HW)	✓	✓			✓	✓					✓
SSCU 3902	Undergraduate Project I	✓	✓			✓				✓		✓
SSCU 4904	Undergraduate Project II	✓	✓	✓		✓	✓	✓		✓		✓
SSCU 4928	Research Training (Practical)			✓	✓	✓	✓			✓		✓
SSCU 4924	Research Training (Report)	✓	✓			✓		✓				
Electives Courses												
SSCC 3643	Application of Spectroscopy	✓	✓							✓		
SSCC 3243	Separation Methods	✓	✓							✓		
SSCC 3443	Chemical Reactions Process	✓	✓							✓		
SSCC 3373	Quality Management System	✓	✓							✓		
SSCC 3603	Medicinal Chemistry	✓	✓							✓		
SSCC 3773	Inorganic and Organometallic Polymers	✓	✓							✓		
SSCC 3493	Surface and Colloid Chemistry	✓	✓		✓							
SSCC 3653	Organic Synthesis	✓	✓		✓							
SSCC 3433	Solid State Chemistry	✓	✓		✓							

SSCC 4263	Electroanalytical Chemistry	✓	✓							✓		
SSCC 3363	Green Chemistry	✓	✓		✓							
SSCC 3003	Chemistry of Biomolecules	✓	✓		✓							
SSCC 3763	Nanochemistry	✓	✓		✓							
SSCC 3733	Nuclear Chemistry	✓	✓		✓							
SSCC 4713	Energy Materials	✓	✓							✓		
SSCC 4693	Metabolism of Biomolecules	✓	✓							✓		
SSCC 4633	Heterocyclic Chemistry	✓	✓							✓		
SSCC 4113	Thermal Chemistry	✓	✓							✓		
SSCC 3563	Instrumentation Competency		✓	✓	✓							
SSCC 4533	Applications of Computer in Chemistry	✓	✓				✓					
SSCC 4723	Organometallic Chemistry	✓	✓							✓		
SSCC 4393	Special Topics in Chemistry	✓	✓							✓		
SSCC 5713	Advanced Inorganic Chemistry	✓	✓		✓							
SSCC 5413	Advanced Physical Chemistry	✓	✓							✓		
SSCC 5613	Advanced Organic Chemistry	✓	✓							✓		
SSCC 5203	Advance Analytical Chemistry	✓	✓							✓		
SSCC 5813	Forensic Analytical Instrumentation	✓	✓							✓		
SSCC 5823	Forensic Chemistry	✓	✓							✓		
XXXX XXXX	Free Elective											
University General Courses												
ULRS 1022	Philosophy and Current Issues	✓								✓		✓
ULRS 1182	Appreciation of Ethics and Civilizations	✓								✓		✓
UHLM 1012	Malay Language for Communication 2 (International Students only)					✓						
ULRS 1032	Entrepreneurship & Innovation										✓	
UHLB 2122	Professional Communication Skills 1					✓						

UHLB 3132	Professional Communication Skills 2					✓						
UHLX 1XX2	Foreign Language for Communication					✓						
ULRF 2XX2	Service Learning & Community Engagement Courses				✓					✓		✓
ULRS 1012	Value and Identity									✓		✓

19. Programme Uniqueness

- The program allows students to perform their research training at local or foreign organizations.
- Our laboratories are equipped with state-of-the-art facilities and instruments.
- The program is recognized by Malaysian Institute of Chemistry (IKM).
- Established links with local and international research institutions and industries.
- The program allows students to transfer credit of certain equivalence courses offered by other universities locally and overseas.

20. Career Prospects and Career Path

Graduates of this programme can work as

- Chemists or scientists in government research institutions such as MARDI, Malaysia Palm Oil Board (MPOB), RRI, PRSS, AMREC, SIRIM and Malaysia Nuclear Agency (MNA).
- Chemists or process engineers in private sectors such as in petrochemicals, rubber, palm oil, pharmaceuticals, textiles and dyes, cosmeceuticals, electronics, water treatment and food processing companies.
- Academics or researchers in higher learning institutions, following pursuance of their degree qualifications to Masters or Ph.D. levels.
- Quality control or quality assurance and marketing officers in agencies or industries in which sound knowledge of chemistry skills are required.

21. Cross Campus Program

Students are given the opportunity to enrol certain courses at participating institutions either locally or abroad. The grades and credits of up to 1/3 of the total credits of the curriculum are transferable.

22. UTM Professional Skills Certificate

UTM has designed its own UTM Professional Skills Certificate (UTM PSC) to enhance the knowledge and skills of its students. It provides students with value-added courses so that they will have a competitive-edge when they enter the employment market.

(More information can be obtained from <https://ileague.utm.my/utm-professional-skills-certificate-utm-psc/>)

23. Facilities Available

List of Facilities:

1. Research Laboratories
2. Glass Blowing Workshop
3. Biotechnology Laboratory
4. Macromolecule Laboratory
5. Chemical Store
6. Department of Chemistry Resource Centre
7. Students Activity Room
8. Students Computer Room

9. Inorganic Chemistry Laboratory 1 & 2
10. Physical Chemistry Laboratory 1 & 2
11. Organic Chemistry Laboratory 1 & 2
12. Analytical Chemistry Laboratory 1 & 2
13. Forensic Laboratory
14. Instrument Rooms

List of Instruments:

1. High Resolution Nuclear Magnetic Resonance Spectrometer
2. Solid State Nuclear Magnetic Resonance Spectrometer
3. Gas Chromatography-Mass Spectrometer System
4. Fourier Transform Infrared Spectrometers
5. Gel Permeation Chromatography
6. UV-Visible Spectrometers
7. Diffuse-Reflectance UV-Visible Spectrophotometer
8. High Performance Liquid Chromatography
9. Gas Chromatograph
10. Atomic Absorption Spectrometer
11. Scanning Electron Microscope
12. Field Emission Scanning Electron Microscope
13. Transmission Electron Microscope
14. Ion Chromatography
15. Capillary Electrophoresis Unit
16. Single point BET Surface Area Analyzer
17. Multipoint Surface Analyzer
18. Differential Scanning Calorimeter
19. Thermogravimetry Analyzer
20. Voltammetric System
21. Fluorescence Spectrometer
22. Surface Adsorption/Desorption System
23. Total Organic Carbon Analyzer
24. Flame Photometer
25. Electron Spin Resonance Spectrometer
26. X-Ray Diffraction Spectrometer
27. Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)

24. Support for Students and Their Learning

(a) Support Personnel

- Academic Advisor
- Counsellor
- Students Association (PESAT)

(b) Infrastructure support

- Internet access (Wireless)
- e-learning
- Digital library
- Cafeterias
- Health care centre
- Sports and recreational areas
- Smart classroom
- Students' activity room
- Reading Stations

(c) Financial support

- Perbadanan Tabung Pendidikan Tinggi Negara (PTPTN)
- MARA
- JPA and etc.

25. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning Mechanisms for Review and Evaluation of Teaching, Learning, Assessment, the Curriculum and Outcome Standards

- a) Students' performance in terms of:
 - Kedudukan Bersyarat (KS) / Kedudukan Baik (KB)
 - Cumulative Grade Point Average (CGPA)
 - Grade Point Average (GPA)
 - Graduate on time (GOT)
 - Completion rate
- b) Employability
 - Alumni survey
 - Employer survey
 - Market survey
- c) Lecturer's performance
 - Teaching evaluation by students (e-PPP)
 - Annual staff appraisal (e-LPPT)
- d) Curriculum review
 - Faculty academic committee
 - Industrial training survey
 - Continuous Quality Improvement (CQI) report
 - External examiner reports
 - Survey of Course Outcome (SCO) by students
 - Graduate employability report
 - Exit Survey
- e) Delivery system
 - Academic Quality Assurance Committee
 - i. Audit report
 - ii. MQA standard

26. Regulation of Assessment

a) Summary of marks, grades and their evaluation points

Marks	Grade	Evaluation Point
90-100	A+	4.00
80-89	A	4.00
75-79	A-	3.67
70-74	B+	3.33
65-69	B	3.00
60-64	B-	2.67
55-59	C+	2.33
50-54	C	2.00
45-49	C-	1.67
40-44	D+	1.33
35-39	D	1.00
30-34	D-	0.67
00-29	E	0.00

b) Role of Board of Study (BOS) which the members consist of the External Examiners, Industrial Advisory Panels and Alumni appointed by the Faculty Academic Committee are to:

- review and evaluate program curriculum,
- review and evaluate assessment procedure and methods,
- make necessary recommendations to the Academic Committee.

27. Assessment Tools

Measurement Tools	Learning Outcomes											Duration	Action by
	P L O 1	P L O 2	P L O 3	P L O 4	P L O 5	P L O 6	P L O 7	P L O 8	P L O 9	P L O 10	P L O 11		
Entry Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty
Course Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Course Assessment Report (CAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Annual Program Assessment Report (APAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty
Research Training Survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	Once a year	Faculty
Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of final semester	Faculty
Alumni Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty

BACHELOR OF SCIENCE (INDUSTRIAL CHEMISTRY) WITH HONOURS (SSCCH)

1. Awarding Institution		Universiti Teknologi Malaysia		
2. Teaching Institution		Universiti Teknologi Malaysia		
3. Programme Name		Bachelor of Science (Industrial Chemistry) with Honours		
4. Final Award		Bachelor of Science (Industrial Chemistry) with Honours		
5. Programme Code		UT6442001 (SSCCH)		
6. Professional or Statutory Body of Accreditation		Ministry of Higher Education		
7. Language(s) of Instruction		Bahasa Malaysia and English		
8. Mode of Study (Conventional, Distance Learning, etc)		Conventional		
9. Mode of Operation (Franchise, Self-governing, etc)		Self-governing		
10. Study Scheme (Full Time/Part Time)		Full Time		
11. Study Duration		Minimum: 4 years Maximum: 6 years		
Type of Semester	No. of Semesters		No. of Weeks per Semester	
	Full Time	Part Time	Full Time	Part Time
Normal	8	10	18	20
Short	4	5	8	10
12. Entry Requirement	<p>Fulfil all university requirements and the following program requirements:</p> <p>STPM/Matriculation/Foundation Holders:</p> <ul style="list-style-type: none"> • Obtained at least CGPA 2.80 at STPM, Matriculation or Foundation level; and • Obtained at least Grade B (CGPA 3.00) in Chemistry at the STPM, Matriculation or Foundation level; and • Obtained at least Grade B- (CGPA 2.67) in any ONE (1) of the following subjects: Biology, Physics and or Mathematics; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level or equivalent; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET). • Candidates have no physical disabilities (eg. blind/color blindness/paralysed which may cause difficulties in lab work). <p>Diploma Holders:</p> <ul style="list-style-type: none"> • Obtained a Diploma from UTM or any other institutions approved by the Government of Malaysia and related to the applied course with CGPA of at least 3.00; or • Other equivalent holders approved by the Government of Malaysia and the University Senate and related to the applied course with a CGPA of at least 3.00; or • Candidates who obtained a CGPA less than 3.00 but have at least TWO (2) years working experience in related field are eligible to apply; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level; or • Obtained at least Grade C in any of Mathematics subjects at Diploma level; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET). • Candidates have no physical disabilities (eg. blind/color blindness/paralysed which may cause difficulties in lab work). 			

The detailed entry requirements can be obtained from the UTM Prospectus or website (<http://admission.utm.my>).

13. Programme Educational Objectives (PEO)

The objectives of the B. Sc. (Industrial Chemistry) program are to provide the knowledge, skills and attributes that should be achieved by the graduates for a successful career. The graduate should be able to:

1. Knowledgeable, competent, efficient and responsive towards the challenges of chemical industries, social and environmental issues.
2. Effective in communication and innovative with distinctive leadership qualities that include adherence to standards of ethical conduct in a diverse working environment.
3. Contribute professionally to the society through awareness and sensitivity to their needs and aspirations.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
PEO1	✓	✓	✓			✓	✓				
PEO2								✓		✓	✓
PEO3				✓	✓				✓		

14. Programme Learning Outcomes (PLO)

Code	Intended Learning Outcomes	Learning and Teaching Methods	Assessment
(a) Technical Knowledge and Competencies			
PLO1 Knowledge and Understanding (KW)	Integrate comprehensive theoretical knowledge as well as technical and industrial skills in the field of chemistry.	Lectures, tutorials, directed reading, active learning	Examinations, quizzes, tests, assignments.
PLO2 Cognitive Skills (CG)	Construct solutions to issues or problems in the industry related to the field of chemistry.	Lectures, tutorials, projects (group/individual), directed reading, computer-based exercises, active learning	Examinations, quizzes, tests, computing output, presentations, and reports.
PLO3 Practical Skills (PS)	Utilize methods and procedures in practices and processes related to chemistry in industry.	FYUP, industrial training, service learning	Project presentations, project reports, industrial training reports.
PLO7 Numeracy Skills (NS)	Interpret numerical, graphical and visual data for applications in industrial chemistry.	Active learning, projects	Oral presentations, project reports and peer evaluation.
b) Generic Skills			
PLO4 Interpersonal Skills (IPS)	Work together with different people in diverse learning and working communities as well as other groups locally and internationally	Active learning, projects (Final year undergraduate project (FYUP), group/individual), industrial training	Oral presentations, project reports, industrial training reports.
PLO5 Communication Skills	Confidently convey ideas both in written and oral form using appropriate	Active learning, projects (FYUP,	Written assignments, oral presentations,

(CS)	well-structured presentation methods to a diverse audience.	group/individual), industrial training	project reports, learning portfolio.
PLO6 Digital Skills (DS)	Integrate a wide range of digital technologies to enhance understanding in chemistry.	Active learning, projects (FYUP, group/individual), professional development courses, industrial training	Written assignments, oral presentations, project reports and learning portfolio.
PLO8 Leadership, Autonomy and Responsibility (LAR)	Show professionalism, autonomy and leadership in managing responsibilities and making decisions within broad organizational parameters.	Active learning, group projects, service learning and industrial training	Oral presentations, project reports, service learning and industrial training reports.
PLO9 Personal Skills (PRS)	Engage effectively in lifelong learning and professional pathways independently.	FYUP, co-curricular activities, group work, industrial training	FYUP reports, learning portfolio and industrial training report.
PLO10 Entrepreneurial Skills (ENT)	Develop entrepreneurial competency skills.	Lectures, assignments, case studies, seminar, workshop, co-curricular activities, group work	Written assignments, oral presentations and group report.
PLO11 Ethics and Professionalism Skills (ETS)	Build good ethics and professionalism related to science, technology and environmental issues.	FYUP, industrial training, lectures, immersive experiential learning	Research proposal, FYUP reports and industrial training report.

15. Classification of Courses

No.	Classification	Credit Hours	Percentage (%)
i.	Faculty Core	3	2.3
ii.	Programme Core	74	57.4
iii.	Programme Electives	33	25.6
iv.	Compulsory University Courses		
	a) General Courses Cluster	8	
	b) Languages	6	14.7
	c) Entrepreneurship	2	
	d) Free Elective	3	
	Total	129	100
No	Classification	Credit Hours	Percentage (%)
A	Chemistry Courses		
	a) Lectures	74	57.3
	b) Laboratory	9	7.0
	c) Industrial Training	12	9.3
	d) Undergraduate Projects	6	4.7
	Total credit hours for Part A	101	78.3
B	Related Courses		
	a) Mathematics	3	2.3
	b) Management	6	4.7
	c) Compulsory University Courses		
	1. Humanities	6	4.7
2. Language	6	4.7	

	3. Co-Curriculum	2	1.6
	4. Entrepreneurship	2	1.6
	5. Free Elective	3	2.3
	Total credit hours for Part B	28	21.7
	Total credit hours for Part A and B	129	100
16. Total Credit Hours to Graduate		129 credit hours	

17. Programme Structures and Features, Curriculum and Award Requirements

The course is offered on full-time mode and is based on a two semester academic sessions with several courses being delivered and assessed in each semester. Assessment is based on final examination and coursework conducted throughout the semester.

Award requirements:

To graduate, students should:

- Attain a total of not less than 129 credit hours with minimum CPA of 2.0.
- Pass industrial training.
- Complete and pass the final year undergraduate project.

YEAR ONE

SEMESTER 1			SEMESTER 2		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
ULRS 1182	Appreciation of Ethics and Civilisations*	2	ULRS 1012	Value and Identity	2
UHLM 1012	Malay Language for Communication (International Students)	2	SSCC 1203	Analytical Chemistry	3
SSCC 1633	Organic Chemistry I	3	SSCC 1861	Analytical Chemistry Practical I	1
SSCC 1821	Organic Chemistry Practical I	1	SSCC 1643	Organic Chemistry II	3
SSCC 1713	Main Group Elements	3	SSCC 1891	Organic Chemistry Practical II	1
SSCC 1851	Inorganic Chemistry Practical I	1	SBSD 1033	Principles of Management	3
SSCC 1313	Occupational Safety, Health and Environment	3	SSCM 1023	Mathematical Methods 1	3
SSCC 1881	Basic Laboratory Skills	1			
Total credit hours		16	Total credit hours		16

* International students choose ONE only (ULRS 1182 or ULRS 1022)

** Only for students with MUET below band 4 (Pre-requisite for UHLB 2122)

YEAR TWO

SEMESTER 3			SEMESTER 4		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
ULRS 1022	Philosophy and Current Issues*	2	ULRF 2XX2	Service Learning & Community Engagement Courses	2

UHLB 2122	Professional Communication Skills 1	2	SSCC 2713	Coordination Chemistry	3
SSCC 2223	Spectrometric Methods of Analysis	3	SSCC 2851	Inorganic Chemistry Practical II	1
SSCC 2871	Analytical Chemistry Practical II	1	SSCC 2453	Chemical Kinetics and Electrochemistry	3
SSCC 2413	Chemical Thermodynamics	3	SSCC 2841	Physical Chemistry Practical II	1
SSCC 2831	Physical Chemistry Practical I	1	SSCC 2663	Polymer Processing	3
SSCC 2473	Molecular Spectroscopy	3	SSCU 2622	Research Methodology and Information Retrieval (HW)	2
SSCC 2233	Industrial Environmental Chemistry	3	SBSD 1043	Organizational Behaviour	3
Total credit hours		18	Total credit hours		18

*International students choose one only

YEAR THREE

SEMESTER 5		
Course code	Course name	Credit hours
ULRS 3032	Entrepreneurship & Innovation	2
XXXX XXXX	Free Elective	3
Electives (Choose 12 Credits)		
SSCC 3673	<i>Industrial Organic Chemistry</i>	3
SSCC 3203	<i>Extraction and Chromatographic Techniques</i>	3
SSCC 3373	<i>Quality Management System</i>	3
SSCC 3423	<i>Industrial Chemical Process</i>	3
SSCC 3333	<i>Petrochemistry</i>	3
SSCC 3293	<i>Radioanalytical Chemistry</i>	3
SSCC 3133	<i>Liquid Crystals</i>	3
Total credit hours		17

SEMESTER 6		
Course code	Course name	Credit hours
UHLB 3132	Professional Communication Skills 2	2
UHLX 1112	Communication in Foreign Language Elective	2
SSCU 3902	Undergraduate Project I	2
SSCC 3553	Computer-Aided Chemistry	3
Electives (Choose 9 Credits)		
SSCC 3253	<i>Food Analysis</i>	3
SSCC 3143	<i>Interfacial Chemistry</i>	3
SSCC 3573	<i>Industrial Instrumentation Competency</i>	3
SSCC 3273	<i>Forensic Science</i>	3
SSCC 3663	<i>Natural Products Chemistry</i>	3
SSCC 3013	<i>Organic Chemistry- Biomolecules</i>	3
SSCC 3753	<i>Catalytic Chemistry</i>	3
SSCC 3353	<i>Consumer Chemistry</i>	3
Total credit hours		18

YEAR FOUR

SEMESTER 7			SEMESTER 8		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
SSCU 4904	Undergraduate Project II	4	SSCU 4918	Industrial Training (Practical) (HW)	8
Elective (Choose 12 credits)			SSCU 4914	Industrial Training (Report)	4
SSCC 4783	<i>Bioinorganic Chemistry</i>	3			
SSCC 4023	<i>Spectroscopic Methods in Organic Chemistry</i>	3			
SSCC 4303	<i>Oleochemistry</i>	3			
SSCC 4383	<i>Special Topics in Industrial Chemistry</i>	3			
SSCC 4483	<i>Corrosion Chemistry</i>	3			
SSCC 4683	<i>Biotechnology</i>	3			
SSCC 4743	<i>Materials Chemistry</i>	3			
SSCC 4343	<i>Chemical Sensors</i>	3			
SSCC 5613	Advanced Organic Chemistry	3			
SSCC 5203	Advanced Analytical Chemistry	3			
SSCC 5713	Advanced Inorganic Chemistry	3			
SSCC 5413	Advanced Physical Chemistry	3			
SSCC 5813	Forensic Analytical Instrumentation	3			
SSCC 5823	Forensic Chemistry	3			
Total credit hours		16	Total credit hours		12

18. Mapping of Programme Learning Outcomes to Courses

COURSES OFFERED		LEARNING OUTCOMES										
		Knowledge and Understanding	Cognitive Skills	Practical Skills	Interpersonal Skill	Communication Skills	Digital Skills	Numeracy Skills	Leadership, Autonomy and Responsibility	Personal Skills	Entrepreneurial Skills	Ethics and Professionalism Skills
Code	Course Name	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
Core Courses												
SSCC 1633	Organic Chemistry I	√	√				√					
SSCC 1821	Organic Chemistry Practical I	√	√	√						√		
SSCC 1713	Main Group Elements	√	√			√						
SSCC 1851	Inorganic Chemistry Practical I	√	√	√	√							
SSCC 1313	Occupational Safety, Health and Environment	√	√									√
SSCM 1023	Mathematical Methods 1	√	√									
SSCC 1881	Basic Laboratory Skills	√	√	√								√
SSCC 1203	Analytical Chemistry	√	√					√				
SSCC 1861	Analytical Chemistry Practical I	√	√	√				√				
SSCC 1643	Organic Chemistry II	√	√							√		
SSCC 1891	Organic Chemistry Practical II	√	√	√						√		
SSCC 2223	Spectrometric Methods of Analysis	√	√			√						
SSCC 2871	Analytical Chemistry Practical II	√	√	√								√
SSCC 2413	Chemical Thermodynamics	√	√					√				

SSCC 2831	Physical Chemistry Practical I	√	√	√		√						
SSCC 3553	Computer-Aided Chemistry	√	√				√					
SSCC 2663	Polymer Processing	√	√								√	
SSCC 2713	Coordination Chemistry	√	√						√			
SSCC 2851	Inorganic Chemistry Practical II	√	√	√			√					
SSCC 2453	Chemical Kinetics and Electrochemistry	√	√		√							
SSCC 2841	Physical Chemistry Practical II	√	√	√					√			
SSCC 2233	Industrial Environmental Chemistry	√	√									√
SSCC 2473	Molecular Spectroscopy	√	√							√		
SBSD 1033	Principles of Management	√	√			√	√					
SBSD 1043	Organizational Behaviour	√	√			√	√					
SSCU 2622	Research Methodology and Information Retrieval (HW)	√	√			√	√					√
SSCU 3902	Undergraduate Project I	√	√			√				√		√
SSCU 4904	Undergraduate Project II	√	√	√		√	√	√		√		√
SSCU 4918	Industrial Training (Practical)			√	√	√	√			√		√
SSCU 4914	Industrial Training (Report)	√	√			√		√				
TOTAL		29	29	11	3	10	8	5	2	8	0	8
Electives Courses												
SSCC 3673	<i>Industrial Organic Chemistry</i>	√	√							√		
SSCC 3203	Extraction and Chromatographic Techniques	√	√							√		
SSCC 3423	<i>Industrial Chemical Process</i>	√	√							√		
SSCC 3373	Quality Management System	√	√							√		
SSCC 3333	<i>Petrochemistry</i>	√	√							√		
SSCC 3293	<i>Radioanalytical Chemistry</i>	√	√							√		
SSCC 3133	Liquid Crystals	√	√							√		
TOTAL (Choose 4)												

SSCC 3253	Food Analysis	√	√		√								
SSCC 3143	Interfacial Chemistry	√	√		√								
SSCC 3573	Industrial Instrumentation Competency		√	√	√								
SSCC 3273	Forensic Science	√	√		√								
SSCC 3663	Natural Products Chemistry	√	√		√								
SSCC 3013	Organic Chemistry-Biomolecules	√	√		√								
SSCC 3753	Catalytic Chemistry	√	√		√								
SSCC 3353	Consumer Chemistry	√	√		√								
TOTAL (Choose 3)													
SSCC 4783	Bioinorganic Chemistry	√	√							√			
SSCC 4023	Spectroscopic Methods in Organic Chemistry	√	√							√			
SSCC 4303	Oleochemistry	√	√							√			
SSCC 4383	Special Topics in Industrial Chemistry	√	√							√			
SSCC 4483	Corrosion Chemistry	√	√							√			
SSCC 4683	Biotechnology	√	√							√			
SSCC 4743	Materials Chemistry	√	√							√			
SSCC 4343	Chemical Sensors	√	√							√			
SSCC 5713	Advanced Inorganic Chemistry	√	√		√								
SSCC 5413	Advanced Physical Chemistry	√	√							√			
SSCC 5613	Advanced Organic Chemistry	√	√							√			
SSCC 5203	Advanced Analytical Chemistry	√	√							√			
SSCC 5813	Forensic Analytical Instrumentation	√	√							√			
SSCC 5823	Forensic Chemistry	√	√							√			
TOTAL (Choose 4)													
TOTAL		11	11	0	3	0	0	0	0	4	4	0	0
Core University Courses													
ULRS 1182	Appreciation of Ethics and Civilisations	√									√		√
UHLM 1012	Malay Language for Communication 2					√							

ULRS 1012	Value and Identity									√		√
ULRS 1022	Philosophy and Current Issues	√								√		√
ULRF 2**2	Service Learning & Community Engagement Courses				√					√		√
UHLB 2122	Professional Communication Skills 1					√						
ULRS 3032	Entrepreneurship & Innovation										√	
UHLB 3132	Professional Communication Skills 2					√						
UHLX 1112	Communication in Foreign Language Elective					√						
TOTAL		2	0	0	1	4	0	0	0	4	1	4

19. Programme Uniqueness

- The program is specially tailored to suit the current industrial needs.
- This program allows students to do their industrial placement at local or foreign companies.
- This program is recognized by professional body; Malaysian Institute of Chemistry.
- Established links with local and international industries.
- The program allows students to transfer credit of certain equivalence courses offered by other universities locally and overseas.
- Our laboratories are equipped with state of the art facilities and instruments.

20. Career Prospects and Career Path

Graduates of this programme can work as

- Chemists or scientists in government research institutions such as MARDI, Malaysia Palm Oil Board (MPOB), RRI, PRSS, AMREC, SIRIM, Jabatan Kimia Malaysia and Malaysian Nuclear Agency (Nuclear Malaysia).
- Chemists or process engineers in private sectors such as in petrochemicals, rubber, palm oil, pharmaceuticals, textiles and dyes, cosmeceuticals, electronics, water treatment and food processing companies.
- Academics or researchers in higher learning institutions, following pursuance of their degree qualifications to Masters or PhD levels.
- Quality control or quality assurance and marketing officers in agencies or industries in which sound knowledge of chemistry skills are required.

21. Cross Campus Program

Students are given the opportunity to enrol certain courses at participating institutions either locally or abroad. The grades and credits of up to 1/3 of the total credits of the curriculum are transferable.

22. UTM Professional Skills Certificate

UTM has designed its own UTM Professional Skills Certificate programme to enhance the knowledge and skills of its students. It provides students with value-added courses so that they will have a competitive-edge when they enter the employment market. Students are given the

opportunity to enrol in this programme offered by UTM SPACE, UTMXCITE, UTM Career Centre, Akademi Bahasa, UTM iLeaGue and UTMCAEL.

(More information can be obtained from <https://ileague.utm.my/utm-professional-skills-certificate-utm-psc/>)

23. Facilities Available

List of Facilities:

1. Inorganic Chemistry Laboratory 1 & 2
2. Physical Chemistry Laboratory 1 & 2
3. Organic Chemistry Laboratory 1 & 2
4. Analytical Laboratory 1, 2, & 3
5. Instrument Rooms (10)
6. Research Laboratories (10)
7. Glass Blowing Workshop
8. Biotechnology Laboratory
9. Macromolecule Laboratory
10. Chemical Store
11. Department of Chemistry Resource Center
12. Students Activity Room
13. Students Computer Room
14. Computer Laboratories
15. Smart Classrooms
16. Resource Centre
17. Lecture Halls

List of Instruments

1. Nuclear Magnetic Resonance Spectrometer
2. Solid State Nuclear Magnetic Resonance Spectrometer
3. Gas Chromatography-Mass Spectrometer System
4. Fourier Transform Infrared Spectrometers
5. Gel Permeation Chromatography
6. UV-Visible Spectrometers
7. Diffuse-Reflectance UV-Visible Spectrophotometer
8. High Performance Liquid Chromatography
9. Gas Chromatograph
10. Atomic Absorption Spectrometer
11. Scanning Electron Microscope
12. Field Emission Scanning Electron Microscope
13. Transmission Electron Microscope
14. Ion Chromatograph
15. Capillary Electrophoresis Unit
16. Single Point BET Surface Area Analyzer
17. Multipoint Surface Analyzer
18. Differential Scanning Calorimeter
19. Thermogravimetry Analyzer
20. Voltammetric System
21. Fluorescence Spectrometer
22. Surface Adsorption/Desorption System
23. Total Organic Carbon Analyzer
24. Flame Photometer
25. Electron Spin Resonance Spectrometer
26. X-Ray Diffraction Spectrometer
27. Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)
28. Glove Box

24. Support for Students and Their Learning

- One week induction programme for orientation and introductory study skills
- Student Handbook (online)
- Extensive library and other learning resources and facilities.
- Online resources: e-learning, UTMACAD, e-portfolio
- Students are assigned to academic advisors to assist them in education planning.

25. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning Mechanisms for Review and Evaluation of Teaching, Learning, Assessment, the Curriculum and Outcome Standards

- a) Students performance in terms of:
 - Kedudukan Bersyarat (KS)/ Kedudukan Baik (KB)
 - Cumulative Grade Point Average (CGPA)
 - Grade Point Average (GPA)
 - Graduate on time (GOT)
 - Completion rate
- b) Employability
 - Alumni survey
 - Market survey
- c) Lecturer's performance
 - Teaching evaluation by students (e-PPP)
 - Annual staff appraisal (e-LPPT)
- d) Curriculum review
 - Faculty academic committee
 - Industrial training survey
 - Continuous Quality Improvement (CQI) report
 - External examiner reports
 - Survey of Course Outcome (SCO) by students
 - Graduate employability report
 - Exit Survey
- e) Delivery system
 - Academic Quality Assurance Committee
 - i. Audit report
 - ii. MQA standard

26. Regulation of Assessment

Summary of marks, grades and their evaluation points

Marks	Grade	Evaluation Point
90-100	A+	4.00
80-89	A	4.00
75-79	A-	3.67
70-74	B+	3.33
65-69	B	3.00
60-64	B-	2.67
55-59	C+	2.33
50-54	C	2.00
45-49	C-	1.67
40-44	D+	1.33
35-39	D	1.00
30-34	D-	0.67
00-29	E	0.00

b) Role of Board of Study (BOS) which the members consist of the External Examiners, Industrial Advisory Panels and Alumni. They are appointed by the Faculty Academic Committee to

- review and evaluate program curriculum,
- review and evaluate assessment procedure and methods,
- make necessary recommendations to the Academic Committee.

27. Assessment Tools

Measurement Tools	Learning Outcomes											Duration	Action by
	P L O 1	P L O 2	P L O 3	P L O 4	P L O 5	P L O 6	P L O 7	P L O 8	P L O 9	P L O 10	P L O 11		
Entry Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty
Course Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Course Assessment Report (CAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Annual Program Assessment Report (APAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty
Research Training Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓			Once a year	Faculty
Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of final semester	Faculty
Alumni Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty

BACHELOR OF SCIENCE (MATHEMATICS) WITH HONOURS (SSCEH)

1. Awarding Institution		Universiti Teknologi Malaysia		
2. Teaching Institution		Universiti Teknologi Malaysia		
3. Programme Name		Bachelor of Science (Mathematics) with Honours		
4. Final Award		Bachelor of Science (Mathematics) with Honours		
5. Programme Code		UT6461001 (SSCEH)		
6. Professional or Statutory Body of Accreditation		Ministry of Higher Education		
7. Language(s) of Instruction		Bahasa Malaysia and English		
8. Mode of Study (Conventional, Distance Learning, etc)		Conventional		
9. Mode of Operation (Franchise, Self-governing, etc)		Self-governing		
10. Study Scheme (Full Time/Part Time)		Full Time		
11. Study Duration		Minimum: 4 years Maximum: 6 years		
Type of Semester	No. of Semesters		No. of Weeks per Semester	
	Full Time	Part Time	Full Time	Part Time
Normal	8	10	18	20
Short	4	5	8	10
12. Entry Requirement	<p>Fulfill all university requirements and the following program requirements:</p> <p>STPM/Matriculation/Foundation Holders:</p> <ul style="list-style-type: none"> • Obtained at least CGPA 2.80 at STPM, Matriculation or Foundation level; and • Obtained at least Grade B (CGPA 3.00) in Pure Mathematics at the STPM, Matriculation or Foundation level; and • Obtained at least Grade B- (CGPA 2.67) in any ONE (1) of the following subjects: Physics, Chemistry and Biology; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level or equivalent; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET). <p>Diploma Holders:</p> <ul style="list-style-type: none"> • Obtained a Diploma from UTM or any other institutions approved by the Government of Malaysia and related to the applied course with CGPA of at least 3.00; or • Other equivalent holders approved by the Government of Malaysia and the University Senate and related to the applied course with a CGPA of less than at least 3.00; or • Candidates who obtained a CGPA less than 3.00 but have at least TWO (2) years working experience in related field are eligible to apply; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level; or • Obtained at least Grade C in any of Mathematics subjects at Diploma level; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET). <p>The detailed entry requirements can be obtained from the UTM Prospectus or website (http://admission.utm.my).</p>			

13. Programme Educational Objectives (PEO)

The objectives of the BSc (Mathematics) with Honours program are to provide the knowledge, skills and attributes that should be achieved by the graduates for a successful career. It is therefore anticipated that, graduates of the program will become

1. knowledgeable and competent in undertaking research and development activities in the field of mathematics.
2. Efficient and innovative, with distinctive leadership characteristics and adherence to ethical principles.
3. Responsible for the involvement and professional contribution towards social well-being.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
PEO1	/	/	/				/				
PEO2					/	/		/	/	/	
PEO3				/							/

14. Programme Learning Outcomes (PLO)

Code	Intended Learning Outcomes	Learning and Teaching Methods	Assessment
(a) Technical Knowledge and Competencies			
PLO1 Knowledge and Understanding (KW)	Demonstrate advanced and comprehensive theoretical and technical knowledge, and relevant skills in mathematical and statistical disciplines.	Lectures, tutorials, directed reading, active learning.	Examinations, quizzes, tests, assignments.
PLO2 Cognitive Skills (CG)	Demonstrate intellectual independence, to manage and resolve complex problems with creative and innovative solutions, to a range of approaches in the field of mathematics and statistics.	Lectures, tutorials, projects (group/individual), directed reading, computer-based exercises, active learning.	Examinations, quizzes, tests, computing output, presentations, and reports.
PLO3 Practical Skills (PS)	Attest skills and knowledge to a range of approaches in the field of mathematics and the ability to review, make adjustments and supervise related practices and processes concerning fields of specialization.	FYUP, research training, service learning.	Project presentations, project reports, research training reports.
PLO7 Numeracy Skills (NS)	Devise procedures on numerical and graphical information to make the right conclusions and decisions to manage and solve problems related to the field of mathematics.	Active learning projects.	Oral presentations, project reports and peer evaluation.
(b) Generic Skills			
PLO4 Interpersonal Skills (IPS)	Collaborate locally and globally with numerous people in diverse learning and working communities	Active learning, projects (Final year undergraduate project (FYUP),	Oral presentations, project reports, research training reports.

	as well as other organizations.	group/individual), research training.	
PLO5 Communication Skills (CS)	Deliver ideas to a variety of audiences in both written or oral formats, using relevant and diverse modes of expression, effectively, correctly, and coherently in the required context.	Active learning, projects (FYUP, group/individual), research training.	Written assignments, oral presentations, project reports, learning portfolio.
PLO6 Digital Skills (DS)	Use a wide variety of digital information, media, and technology to complete related tasks.	Active learning, projects (FYUP, group/individual), professional development courses, research training.	Written assignments, oral presentations, project reports and learning portfolio.
PLO8 Leadership, Autonomy and Responsibility (LAR)	Present leadership, autonomy, and expertise in coordinating and decision-making roles across large operational boundaries.	Active learning, group projects, service learning and research training.	Oral presentations, project reports, service learning and research training reports.
PLO9 Personal Skills (PRS)	Effectively involved in self-directed lifelong learning and career paths.	FYUP, co-curricular activities, group work, research training.	FYUP reports, learning portfolio and research training report.
PLO10 Entrepreneurial Skills (ENT)	Demonstrate an understanding of the entrepreneurship skill of chosen venture(s).	Lectures, assignments, case studies, seminar, workshop, co-curricular activities, group work.	Written assignments, oral presentations and group reports.
PLO11 Ethics and Professionalism Skills (ETS)	Demonstrate compliance and competency in identifying ethical problems, making ethical choices and conduct professionally on science, technology, and environmental concerns.	FYUP, research training, lectures, immersive experiential learning.	Research proposal, FYUP reports and research training report.

15. Classification of Courses

No.	Classification	Credit Hours	Percentage (%)
i.	Faculty Core	24	18.6
ii.	Programme Core	53	41.1
iii.	Programme Electives	33	25.6
iv.	University General Courses		
	a) General Courses Cluster	8	
	b) Languages	6	14.7
	c) Entrepreneurship	2	
	d) Free Elective	3	
	Total	129	100
No	Classification	Credit Hours	Percentage (%)
A	Mathematics Courses		73.6
	a) Lectures	95	9.3
	b) Research Training	12	4.7

	c) Final Year Undergraduate projects	6	
	Total credit hours for Part A	113	87.6
B	University General Courses		
	a) General Courses Cluster	12	9.3
	b) Languages	2	1.55
	c) Entrepreneurship	2	1.55
	Total credit hours for Part B	16	12.4
Total credit hours for Part A and B		129	100
16. Total Credit Hours to Graduate		129 credit hours	

17. Programme Structures and Features, Curriculum and Award Requirements

The course is offered on full-time mode and is based on two semester academic sessions with several courses being delivered and assessed in each semester. Assessment is based on final examination and coursework conducted throughout the semester.

Award requirements:

To graduate, students should:

- Attain a total of not less than 129 credit hours with minimum CPA of 2.0.
- Pass research training.
- Complete and pass the final year undergraduate project.

YEAR 1

SEMESTER 1			SEMESTER 2		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
SSCM 1023	Mathematical Methods I	3	SSCM 1033	Mathematical Methods II	3
SSCP 1143 / SSCC 1003	Mechanics / Principles of Chemistry	3	SSCM 1313	Computer Programming	3
SSCM 1103	Statistics	3	SSCM 1703	Differential Equations I	3
SSCM 1303	Computer Literacy	3	SSCM 1533	Logic and Set Theory	3
SSCM 1523	Linear Algebra	3	ULRS1 012	Value and Identity	2
UHMS 1182	Appreciation of Ethics and Civilization *	2	SXXX ***3	Free Elective	3
UHLM 1012	Malay Language for Communication 2 * (International Students) * International students choose one	2			
Total credit hours		17	Total credit hours		17

* International students choose ONE only (ULRS 1182 or UHIS 1022)

** Only for students with MUET below band 4 (Pre-requisite for UHLB 1122)

YEAR TWO

SEMESTER 3		
Course code	Course name	Credit hours
SSCM 2423	Numerical Methods I	3
SSCM 2773	Differential Equations II	3
SSCM 2793	Vector Calculus	3
SSCM 2833	Linear Programming (WBL)	3
UHS 1022	Philosophy and Current Issues*	2
UHLB 2122	Professional Communication Skills 1	2
Total credit hours		16

SEMESTER 4		
Course code	Course name	Credit hours
SSCM 2103	Mathematical Statistics	3
SSCM 2613	Advanced Calculus	3
SSCM 2863	Mathematical Modelling (WBL)	3
SSCM 2713	Partial Differential Equations	3
SSCM 2523	Modern Algebra	3
UKQF 2XX2	Service Learning & Community Engagement Courses	2
Total credit hours		17

YEAR THREE

SEMESTER 5		
Course code	Course name	Credit hours
SSCM 3503	Complex Variables	3
	Research Methodology and Information Retrieval (HW)	2
ULRS 3032	Entrepreneurship & Innovation	2
Electives (Choose 9 Credits)		
SSCM 3653	Discrete Mathematics	3
SSCM 3563	Rings and Fields Theory	3
SSCM 3153	Inferential Statistics	3
SSCM 3733	Dynamical Systems	3
SSCM 3843	Optimization Methods	3
Total credit hours		16

SEMESTER 6		
Course code	Course name	Credit hours
SSCU 3902	Undergraduate Project I	2
UHLB 3132	Professional Communication Skills 2	2
UHLX 1XX2	Foreign Language for Communication	2
Electives (Choose 12 Credits)		
SSCM 3793	Calculus of Variations	3
SSCM 3543	Number Theory	3
SSCM 3673	Functional Analysis	3
SSCM 3753	Fluid Mechanics	3
SSCM 3423	Numerical Methods II	3
SSCM 3363	Scientific Computing using Structured Programming	3
Total credit hours		18

YEAR FOUR

SEMESTER 7		
Course code	Course name	Credit hours
SSCU 4904	Undergraduate Project II	4

SEMESTER 8		
Course code	Course name	Credit hours
SSCU 4924	Research Training Report	4

			SSCU4 928	Research Training (HW)	8
			Total credit hours		12
Elective (Choose 12 credits)					
SSCM 4623	Introduction to Stochastic Models	3			
SSCM 4633	Fuzzy Set Theory	3			
SSCM 4653	Applied Abstract Algebra	3			
SSCM 4683	Topology	3			
SSCM 4623	Non-Euclidean Geometry	3			
SSCM 4813	Optimal Control	3			
SSCM 4763	Computational Fluid Dynamics	3			
SSCM 5053	Advanced Mathematical Method I	3			
SSCM 5373	Computational Mathematics	3			
SSCM 5693	Mathematical Analysis	3			
SSCM 5713	Methods of Engineering Mathematics	3			
SSCM 5423	Numerical Methods in Engineering	3			
SSCM 5703	Advanced Partial Differential Equation	3			
Total credit hours		16			

18. Mapping of Programme Learning Outcomes to Courses

COURSES OFFERED		LEARNING OUTCOMES									
		Knowledge and Understanding	Cognitive Skills	Practical Skills	Interpersonal Skill	Communication Skills	Digital Skills	Numeracy Skills	Leadership, Autonomy and Responsibility	Personal Skills	Entrepreneurial Skills
Code	Course Name	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
Core Courses											
SSCM 1023	Mathematical Methods I	/	/								
SSCP 1103	Mechanics	/	/								
SSCC 1003	Principles of Chemistry	/	/						/		
SSCM 1103	Statistics	/					/				
SSCM 1303	Computer Literacy	/	/			/					
SSCM 1033	Mathematical Methods II	/		/							
SSCM 1313	Computer Programming	/	/	/		/					
SSCM 1523	Linear Algebra										
SSCM 1703	Differential Equations I	/	/				/				
SSCM 2103	Mathematical Statistics	/					/				
SSCM 2423	Numerical Methods I	/	/			/					
SSCM 2773	Differential Equations II	/	/								
SSCM 2793	Vector Calculus	/	/								
SSCM 1533	Logic and Set Theory	/	/		/						

SSCM 2613	Advanced Calculus	/									
SSCM 2863	Mathematical Modelling	/	/		/						
SSCM 2523	Modern Algebra	/	/		/						
SSCM 3503	Complex Variables	/	/			/					
SSCM 2833	Linear Programming	/	/	/							
SSCM 2713	Partial Differential Equations	/	/			/					
SSCU 3622	Research Methodology & Information Retrieval (HW)	/	/			/	/				
SSCU 3902	Undergraduate Project I	/	/			/				/	
SSCU 4904	Undergraduate Project II	/	/	/		/	/	/		/	
SSCU 4924	Research Training Report	/	/			/		/			
SSCU 4928	Research Training (HW)			/	/	/	/			/	
TOTAL		23	19	5	3	8	6	5	0	4	0
Electives Courses											
SSCM 3653	Discrete Mathematics	/	/			/					
SSCM 3563	Rings and Fields Theory	/	/			/					
SSCM 3153	Inferential Statistics	/	/			/					
SSCM 4733	Dynamical Systems	/	/			/					
SSCM 3843	Optimization Methods	/	/			/					
SSCM 3363	Scientific Computing using Structured Programming	/	/		/						
SSCM 3793	Calculus of Variations	/	/		/						
SSCM 3543	Number Theory	/	/		/						
SSCM 3673	Functional Analysis	/	/		/						
SSCM 3753	Fluid Mechanics	/	/		/						
SSCM 3423	Numerical Methods II	/	/		/						
SSCM 4263	Introduction to Stochastic Models	/	/						/	/	
SSCM 4633	Fuzzy Set Theory	/	/						/	/	
SSCM 4653	Applied Abstract Algebra	/	/						/	/	

SSCM 4683	Topology	/	/						/	/	
SSCM 4813	Optimal Control	/	/						/	/	
SSCM 4623	Non-Euclidean Geometry	/	/						/	/	
SSCM 4763	Computational Fluid Dynamics	/	/						/	/	
SSCM 5053	Advanced Mathematical Methods I	/	/			/					
SSCM 5373	Computational Mathematics	/	/				/		/		
SSCM 5693	Mathematical Analysis	/	/			/					
SSCM 5713	Methods of Engineering Mathematics	/	/			/					
SSCM 5423	Numerical Methods in Engineering	/	/		/		/		/		
SSCM 5703	Advanced Partial Differential Equation	/	/			/					
XXXX ***3	Free Elective										
TOTAL		24	24	0	7	9	2	0	9	7	0
Core University Courses											
UHLM 1012	Malay Language for Communication 2 (International Students)					/					
UHMS 1182	Appreciation of Ethics and Civilisations	/					/				/
ULRS 1032	Entrepreneurship & Innovation										
ULRS 1012	Value and Identity										
UHS 1022	Philosophy and Current Issues										
UHLB 2122	Professional Communication Skills I					/					
UHLX 1112	Communication in Foreign Language Elective					/					
UKQF 2XX2	Service Learning & Community Engagement Courses						/		/	/	/
TOTAL		1	0	0	0	3	2	1	1	1	2

19. Programme Uniqueness

- This special programme is designed to produce excellent young and talented mathematicians researchers.
- Established links with international centres for mathematics for possible overseas research training.
- The only B.Sc in Mathematics with Honours programme in the country, which offers research training either locally or overseas.
- This programme allows the transfer of credits of equivalent courses offered by participating local or overseas institutions.

- Prepares students to be able to apply their mathematical knowledge and skills in the planning, decision-making, analysis and supervision of work related to public or private sectors.

20. Career Prospects and Career Path

Graduates of this programme can work as

- Academicians and researchers in academic and research institutions.
- Data analytic executive, data scientist, programmer.
- Quality assurance manager, production control engineer, meteorologist and planning officer in industries such as manufacturing, telecommunications and oil & gas.
- Statisticians, operations research analysts, sales and marketing executives in service industries.
- Economist, Financial executives in financial institutions.
- Administrative and Executive officers in public and private sectors.

21. Cross Campus Program

Students are given the opportunity to enrol certain courses at participating universities either locally or abroad. The grades and credits of up to 1/3 of the total credits of the curriculum are transferable.

22. UTM Professional Skills Certificate

UTM has designed its own UTM Professional Skills Certificate programme to enhance the knowledge and skills of its students. It provides students with value-added courses so that they will have a competitive-edge when they enter the employment market. Students are given the opportunity to enrol in this programme offered by UTM SPACE, UTMXCITE, UTM Career Centre, Akademi Bahasa, UTM iLeaGue dan UTMCAEL. (More information can be obtained from <https://ileague.utm.my/utm-professional-skills-certificate-utm-psc/>)

23. Facilities Available

List of rooms with IT facilities

1. Computer Laboratories
2. Smart Classrooms
3. Resource Centre
4. Lecture Halls

24. Support for Students and Their Learning

- One week induction programme for orientation and introductory study skills.
- Student Handbook (online).
- Extensive library and other learning resources and facilities.
- Online resources: e-learning, UTMACAD, e-portfolio.
- Students are assigned to academic advisors to assist them in education planning.

25. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning Mechanisms for Review and Evaluation of Teaching, Learning, Assessment, the Curriculum and Outcome Standards

a) Students performance in terms of:

- Kedudukan Bersyarat (KS)/ Kedudukan Baik (KB)
- Cumulative Grade Point Average (CGPA)
- Grade Point Average (GPA)
- Graduate on time (GOT)
- Completion rate

b) Employability

- Alumni survey
 - Market survey
- c) Lecturer's performance
- Teaching evaluation by students (e-PPP)
 - Annual staff appraisal (e-LPPT)
- d) Curriculum review
- Faculty academic committee
 - Research training survey
 - Continuous Quality Improvement (CQI) report
 - External examiner reports
 - Survey of Course Outcome (SCO) by students
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 - Exit Survey
- e) Delivery system
- Academic Quality Assurance Committee
 - i. Audit report
 - ii. MQA standard

26. Regulation of Assessment

- a) Summary of marks, grades and their evaluation points

Marks	Grade	Evaluation Point
90-100	A+	4.00
80-89	A	4.00
75-79	A-	3.67
70-74	B+	3.33
65-69	B	3.00
60-64	B-	2.67
55-59	C+	2.33
50-54	C	2.00
45-49	C-	1.67
40-44	D+	1.33
35-39	D	1.00
30-34	D-	0.67
00-29	E	0.00

- b) Role of Board of Study (BOS) which the members consist of the External Examiners, Industrial Advisory Panels and Alumni. They are appointed by the Faculty Academic Committee to
- review and evaluate program curriculum,
 - review and evaluate assessment procedure and methods,
 - make necessary recommendations to the Academic Committee.

27. Assessment Tools

Measurement Tools	Learning Outcomes											Duration	Action by
	P	P	P	P	P	P	P	P	P	P	P		
	L	L	L	L	L	L	L	L	L	L	L		
	O	O	O	O	O	O	O	O	O	O	O		
	1	2	3	4	5	6	7	8	9	10	11		
Course Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer

Course Assessment Report (CAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Annual Programme Assessment Report (APAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Faculty
Entry Survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	First semester first year	Faculty
Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of final semester	Faculty
Research Training Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	End of training	Faculty
Alumni Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty

BACHELOR OF SCIENCE (INDUSTRIAL MATHEMATICS) WITH HONOURS (SSCMH)

1. Awarding Institution		Universiti Teknologi Malaysia		
2. Teaching Institution		Universiti Teknologi Malaysia		
3. Programme Name		Bachelor of Science (Industrial Mathematics) with Honours		
4. Final Award		Bachelor of Science (Industrial Mathematics) with Honours		
5. Programme Code		UT6440002 (SSCMH)		
6. Professional or Statutory Body of Accreditation		Ministry of Higher Education		
7. Language(s) of Instruction		Bahasa Malaysia and English		
8. Mode of Study (Conventional, Distance Learning, etc)		Conventional		
9. Mode of Operation (Franchise, Self-governing, etc)		Self-governing		
10. Study Scheme (Full Time/Part Time)		Full Time		
11. Study Duration		Minimum: 4 years Maximum: 6 years		
Type of Semester	No. of Semesters		No. of Weeks per Semester	
	Full Time	Part Time	Full Time	Part Time
Long	8	10	18	20
Short	4	5	8	10
12. Entry Requirement	<p>Fulfil all university requirements and the following program requirements:</p> <p>STPM/Matriculation/Foundation Holders:</p> <ul style="list-style-type: none"> • Obtained at least CGPA 2.80 at STPM, Matriculation or Foundation level; and • Obtained at least Grade B (CGPA 3.00) in Pure Mathematics at the STPM, Matriculation or Foundation level; and • Obtained at least Grade B- (CGPA 2.67) in any ONE (1) of the following subjects: Physics, Chemistry and Biology; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level or equivalent; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET) <p>Diploma Holders:</p> <ul style="list-style-type: none"> • Obtained a Diploma from UTM or any other institutions approved by the Government of Malaysia and related to the applied course with CGPA of at least 3.00; or • Other equivalent holders approved by the Government of Malaysia and the University Senate and related to the applied course with a CGPA of less than at least 3.00; or • Candidates who obtained a CGPA less than 3.00 but have at least TWO (2) years working experience in related field are eligible to apply; and • Passes with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level; or • Obtained at least Grade C in any of Mathematics subjects at Diploma level; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET) 			

The detailed entry requirements can be obtained from the UTM Prospectus or website (<http://admission.utm.my>).

13. Programme Educational Objectives (PEO)

The objectives of the BSc (Industrial Mathematics) with Honours program are to provide the knowledge, skills and attributes that should be achieved by the graduates for a successful career. It is therefore anticipated that, graduates of the program will become

1. Knowledgeable and competent in managing industrial problems related to the field of mathematics.
2. Innovative with distinctive leadership qualities and comply to industrial standards of ethical conduct.
3. Contribute professionally towards a sustainable and well-being community.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
PEO1	✓	✓	✓				✓				
PEO2					✓	✓		✓	✓	✓	
PEO3				✓							✓

14. Programme Learning Outcomes (PLO)

Code	Intended Learning Outcomes	Learning and Teaching Methods	Assessment
(a) Technical Knowledge and Competencies			
PLO1 Knowledge and Understanding (KW)	Integrate theoretical and technical knowledge in industrial and applied mathematics.	Lectures, tutorials, directed reading, active learning	Examinations, quizzes, tests, assignments.
PLO2 Cognitive Skills (CG)	Construct solutions to issues in industrial problems using mathematical and statistical knowledge.	Lectures, tutorials, projects (group/individual), directed reading, computer-based exercises, active learning	Examinations, quizzes, tests, computing output, presentations, and reports.
PLO3 Practical Skills (PS)	Apply mathematical and statistical approaches to developed industrial processes.	FYUP, industrial training, service learning	Project presentations, project reports, industrial training reports.
PLO7 Numeracy Skills (NS)	Develop numerical and graphical procedures in mathematics and statistics to make the right decisions in managing industrial problems.	Active learning, projects	Oral presentations, project reports and peer evaluation.
(b) Generic Skills			
PLO4 Interpersonal Skills (IPS)	Work effectively with a wide variety of people during the process of problem solving.	Active learning, projects (Final year undergraduate project (FYUP), group/individual), industrial training	Oral presentations, project reports, industrial training reports.
PLO5 Communication Skills	Present ideas professionally in an	Active learning, projects (FYUP,	Written assignments, oral presentations,

(CS)	appropriate context to a diversity of audiences.	group/individual), industrial training	project reports, learning portfolio.
PLO6 Digital Skills (DS)	Use a wide range of information, media, and technology applications to support the learning process.	Active learning, projects (FYUP, group/individual), professional development courses, industrial training	Written assignments, oral presentations, project reports and learning portfolio.
PLO8 Leadership, Autonomy and Responsibility (LAR)	Show leadership, autonomy, and responsibility by undertaking significant levels of work in learning communities.	Active learning, group projects, service learning and industrial training	Oral presentations, project reports, service learning and industrial training reports.
PLO9 Personal Skills (PRS)	Engage effectively in developing your own skills for career pathways.	FYUP, co-curricular activities, group work, industrial training	FYUP reports, learning portfolio and industrial training report.
PLO10 Entrepreneurial Skills (ENT)	Display entrepreneurial skills in appropriate project(s).	Lectures, assignments, case studies, seminar, workshop, co-curricular activities, group work	Written assignments, oral presentations and group reports.
PLO11 Ethics and Professionalism Skills (ETS)	Make decisions ethically and professionally in a varied work and social environment.	FYUP, industrial training, lectures, immersive experiential learning	Research proposal, FYUP reports and industrial training report.

15. Classification of Courses

No.	Classification	Credit Hours	Percentage (%)
i.	Faculty Core	24	18.6
ii.	Programme Core	53	41.1
iii.	Programme Electives	33	25.6
iv.	University General Courses		
	a) General Courses Cluster	8	
	b) Languages	6	
	c) Entrepreneurship	2	
	d) Free Elective	3	
	Total	129	100

No	Classification	Credit Hours	Percentage (%)
A	Mathematics Courses		
	a) Lectures	95	73.6
	b) Industrial Training	12	9.3
	c) Final Year Undergraduate Projects	6	4.7
	Total credit hours for Part A	113	87.6
B	University General Courses		
	a) General Courses Cluster	12	9.3
	b) Languages	2	1.55
	c) Entrepreneurship	2	1.55
	Total credit hours for Part B	16	12.4
	Total credit hours for Part A and B	129	100

16. Total Credit Hours to Graduate

129 credit hours

17. Programme Structures and Features, Curriculum and Award Requirements

The course is offered on full-time mode and is based on a two semester academic session with several courses being delivered and assessed in each semester. Assessment is based on final examination and coursework conducted throughout the semester.

Award requirements:

To graduate, students should:

- Attain a total of not less than 132 credit hours with minimum CPA of 2.0.
- Pass industrial training.
- Complete and pass the final year undergraduate project.

YEAR 1

SEMESTER 1			SEMESTER 2		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
SSCM 1523	Linear Algebra	3	SSCM 1033	Mathematical Methods II	3
SSCM 1023	Mathematical Methods I	3	SSCM 1313	Computer Programming	3
SSCM 1103	Statistics	3	SSCM 1533	Logic and Set Theory	3
SSCM 1303	Computer Literacy	3	SSCM 1703	Differential Equations I	3
SSCP 1143 / SSCC 1003	Mechanics / Principles of Chemistry	3	ULRS 1012	Value and Identity	2
UHMS 1182	Appreciation of Ethics and Civilization*	2	XXXX ***3	Free Elective	3
UHLM 1012	Malay Language for Communication 2 (International Students)				
Total credit hours		17	Total credit hours		17

* International students choose ONE only (ULRS 1182 or UHIS 1022)

** Only for students with MUET below band 4 (Pre-requisite for UHLB 2122)

YEAR TWO

SEMESTER 3			SEMESTER 4		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
SSCM 2833	Linear Programming (WBL)	3	SSCM 2713	Partial Differential Equations	3
SSCM 2423	Numerical Methods I	3	SSCM 2613	Advanced Calculus	3
SSCM 2773	Differential Equations II	3	SSCM 2863	Mathematical Modelling (WBL)	3
SSCM 2793	Vector Calculus	3	SSCM 2853	Inventory Control and Queuing Theory (WBL)	3
UHIS 1022	Philosophy and Current Issues*	2	SSCM 2103	Mathematical Statistics	3
UHLB 2122	Professional Communication Skills 1	2	UKQF 2XX2	Service Learning & Community Engagement Courses	2

Total credit hours	16	Total credit hours	17
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YEAR THREE

SEMESTER 5			SEMESTER 6		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
SSCM 3123	Multivariate Analysis (WBL)	3	SSCU 3902	Undergraduate Project I	2
SSCU 3622	Research Methodology and Information Retrieval	2	UHLB 3132	Professional Communication Skills 2	2
ULRS 3032	Entrepreneurship & Innovation	2	UHLX 1XX2	Foreign Language for Communication	2
Electives (Choose 9 Credits)			Electives (Choose 12 Credits)		
SSCM 3503	Complex Variables	3	SSCM 3363	Scientific Computing using Structured Programming	3
SSCM 3883	Multi-Objective Decision Making	3	SSCM 3753	Fluid Mechanics	3
SSCM 3133	Statistical Quality Control	3	SSCM 3423	Numerical Methods II	3
SSCM 3153	Inferential Statistics	3	SSCM 3103	Design of Experiments	3
SSCM 3843	Optimization Methods	3	SSCM 3823	Scheduling	3
SBSD 1043	Organizational Behavior	3	SSCM 3113	Time Series	3
			SBSF 1013	Principles of Marketing	3
Total credit hours		16	Total credit hours		18

YEAR FOUR

SEMESTER 7			SEMESTER 8		
Course code	Course name	Credit hours	Course code	Course name	Credit hours
SSCU 4904	Undergraduate Project II	4	SSCU 4914	Industrial Training Report	4
			SSCU 4918	Industrial Training (HW)	8
Elective (Choose 12 credits)					
SSCM 4763	Computational Fluid Dynamics	3			
SSCM 4263	Introduction to Stochastic Models	3			
SSCM 4863	Financial Mathematics	3			
SSCM 4243	Sampling Techniques	3			
SSCM 4253	Introduction to Regression Modelling	3			
SBSD 1033	Principles of Management	3			

SSCM 5053	Advanced Mathematical Method I	3			
SSCM 5373	Computational Mathematics	3			
SSCM 5693	Mathematical Analysis	3			
SSCM 5713	Methods of Engineering Mathematics	3			
SSCM 5423	Numerical Methods in Engineering	3			
SSCM 5703	Advanced Partial Differential Equation	3			
Total credit hours		16	Total credit hours		12

18. Mapping of Programme Learning Outcomes to Courses

COURSES OFFERED		LEARNING OUTCOMES										
		Knowledge and Understanding	Cognitive Skills	Practical Skills	Interpersonal Skill	Communication Skills	Digital Skills	Numeracy Skills	Leadership, Autonomy and Responsibility	Personal Skills	Entrepreneurial Skills	Ethics and Professionalism Skills
Code	Course Name	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
Core Courses												
SSCM 1023	Mathematical Methods I	✓	✓									
SSCP 1103	Mechanics	✓	✓									
SSCC 1003	Principles of Chemistry	✓	✓							✓		
SSCM 1103	Statistics	✓						✓				
SSCM 1303	Computer Literacy	✓	✓				✓					
SSCM 1523	Linear Algebra	✓	✓									

SSCM 1033	Mathematical Methods II	✓		✓								
SSCM 1313	Computer Programming	✓	✓	✓			✓					
SSCM 1703	Differential Equations I	✓	✓					✓				
SSCM 1533	Logic and Set Theory	✓	✓			✓						
SSCM 2103	Mathematical Statistics	✓						✓				
SSCM 2423	Numerical Methods I	✓	✓				✓					
SSCM 2793	Vector Calculus	✓	✓									
SSCM 2773	Differential Equations II	✓	✓									
SSCM 2833	Linear Programming	✓	✓	✓								
SSCM 2713	Partial Differential Equations	✓	✓			✓						
SSCM 2613	Advanced Calculus	✓										
SSCM 2863	Mathematical Modelling	✓	✓		✓							
SSCM 2853	Inventory Control and Queuing Theory	✓	✓								✓	
SSCM 3123	Multivariate Analysis	✓	✓			✓						
SSCU 3622	Research Methodology and Information Retrieval (HW)	✓	✓			✓	✓					✓
SSCU 3902	Undergraduate Project I	✓	✓			✓				✓		✓
SSCU 4904	Undergraduate Project II	✓	✓	✓		✓	✓	✓		✓		✓
SSCU 4914	Industrial Training Report	✓	✓			✓		✓				
SSCU 4918	Industrial Training (HW)			✓	✓	✓	✓			✓		✓
TOTAL		24	20	5	2	8	6	5	0	4	1	4
Electives Courses												
SSCM 3503	Complex Variables	✓	✓			✓						
SSCM 3883	Multi-Objective Decision Making	✓	✓			✓		✓				
SSCM 3133	Statistical Quality Control	✓	✓			✓						
SSCM 3153	Inferential Statistics	✓	✓			✓						
SSCM 3843	Optimization Methods	✓	✓			✓						

SSCM 3363	Scientific Computing using Structured Programming	✓	✓		✓							
SSCM 3753	Fluid Mechanics	✓	✓		✓							
SSCM 3423	Numerical Methods II	✓	✓		✓							
SSCM 3103	Design of Experiments	✓	✓		✓							
SSCM 3823	Scheduling	✓	✓		✓							
SSCM 3113	Time Series	✓	✓		✓							
SSCM 4763	Computational Fluid Dynamics	✓	✓						✓	✓		
SSCM 4263	Introduction to Stochastic Models	✓	✓						✓	✓		
SSCM 4863	Financial Mathematics	✓	✓						✓	✓		
SSCM 4813	Optimal Control	✓	✓						✓	✓		
SSCM 4243	Sampling Techniques	✓	✓						✓	✓		
SSCM 4253	Introduction to Regression Modelling	✓	✓						✓	✓		
SSCM 5053	Advanced Mathematical Methods I	✓	✓			✓						
SSCM 5373	Computational Mathematics	✓	✓				✓		✓			
SSCM 5693	Mathematical Analysis	✓	✓			✓						
SSCM 5713	Methods of Engineering Mathematics	✓	✓			✓						
SSCM 5423	Numerical Methods in Engineering	✓	✓		✓		✓		✓			
SSCM 5703	Advanced Partial Differential Equation	✓	✓			✓						
TOTAL		23	23	0	7	9	2	1	8	6	0	0
Core University Courses												
ULRS 1022	Philosophy and Current Issues	✓								✓		✓
ULRS 1012	Value and Identity									✓		✓
UHLM 1012	Malay Language for Communication 2 (International Students)					✓						
ULRS 1182	Appreciation of Ethics and Civilizations	✓								✓		✓
ULRS 1032	Entrepreneurship and Innovation										✓	
UHLB 2122	Professional Communication Skills 1					✓						

UHLB 3132	Professional Communication Skills 2					✓						
UHLX 1XX2	Foreign Language for Communication					✓						
ULRF 2XX2	Service Learning & Community Engagement Courses				✓					✓		✓
XXXX XXX3	Free Elective											
TOTAL		2	0	0	1	4	0	0	0	4	1	4

19. Programme Uniqueness

- This special program is designed to produce excellent young and talented industrial mathematicians.
- Established links with the international centre for industrial mathematics for possible overseas industrial training.
- The only Bachelor Science in Industrial Mathematics program in the country which offers a six-month industrial training either locally or overseas.
- This program allows the transfer of credits of equivalent courses offered by participating local or overseas institutions.
- Prepares students to be able to apply their mathematical knowledge and skills in the planning, decision-making, analysis and supervision of work related to industries and public or private sectors.

20. Career Prospects and Career Path

Graduates of this programme can work as

- Data analyst, data scientist, programmer
- Quality assurance manager, production control engineer and planning officer in industries such as manufacturing, telecommunications and oil & gas.
- Statisticians, operations research analysts, sales and marketing executives in service industries.
- Financial executives in financial institutions.
- Administrative officers in public and private sectors.
- Academicians and researchers in academic and research institutions.

21. Cross Campus Program

Students are given the opportunity to enrol certain courses at participating institutions either locally or abroad. The grades and credits of up to 1/3 of the total credits of the curriculum are transferable.

22. UTM Professional Skills Certificate

UTM has designed its own UTM Professional Skills Certificate programme to enhance the knowledge and skills of its students. It provides students with value-added courses so that they will have a competitive-edge when they enter the employment market. Students are given the opportunity to enrol in this programme offered by UTMSPACE, UTMXCITE, UTM Career Centre, Akademi Bahasa, UTM iLeaGue dan UTMCAEL. (More information can be obtained from <https://ileague.utm.my/utm-professional-skills-certificate-utm-psc/>)

23. Facilities Available

List of rooms with IT facilities

1. Computer Laboratories
2. Smart Classrooms
3. Resource Centre
4. Lecture Halls

24. Support for Students and Their Learning

- One week induction programme for orientation and introductory study skills
- Student Handbook (online)
- Extensive library and other learning resources and facilities.
- Online resources: e-learning, UTMACAD, e-portfolio
- Students are assigned to academic advisors to assist them in education planning.

25. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning Mechanisms for Review and Evaluation of Teaching, Learning, Assessment, the Curriculum and Outcome Standards

- a) Students performance in terms of:
- Kedudukan Bersyarat (KS)/ Kedudukan Baik (KB)
 - Cumulative Grade Point Average (CGPA)
 - Grade Point Average (GPA)
 - Graduate on time (GOT)
 - Completion rate
- b) Employability
- Alumni survey
 - Market survey
- c) Lecturer's performance
- Teaching evaluation by students (e-PPP)
 - Annual staff appraisal (e-LPPT)
- d) Curriculum review
- Faculty academic committee
 - Industrial training survey
 - Continuous Quality Improvement (CQI) report
 - External examiner reports
 - Survey of Course Outcome (SCO) by students
 - Graduate employability report
 - Exit Survey
- e) Delivery system
- Academic Quality Assurance Committee
 - i. Audit report
 - ii. MQA standard

26. Regulation of Assessment

- a) Summary of marks, grades and their evaluation points

Marks	Grade	Evaluation Point
90-100	A+	4.00
80-89	A	4.00
75-79	A-	3.67
70-74	B+	3.33
65-69	B	3.00
60-64	B-	2.67
55-59	C+	2.33
50-54	C	2.00
45-49	C-	1.67
40-44	D+	1.33
35-39	D	1.00
30-34	D-	0.67

- b) Role of Board of Study (BOS) which the members consist of the External Examiners, Industrial Advisory Panels and Alumni. They are appointed by the Faculty Academic Committee to
- review and evaluate program curriculum,
 - review and evaluate assessment procedure and methods,
 - make necessary recommendations to the Academic Committee.

27. Assessment Tools

Measurement Tools	Learning Outcomes											Duration	Action by
	P	P	P	P	P	P	P	P	P	P	P		
	L	L	L	L	L	L	L	L	L	L	L		
	○	○	○	○	○	○	○	○	○	○	○		
	1	2	3	4	5	6	7	8	9	10	11		
Course Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Course assessment report (CAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Annual Program Assessment Report (APAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Faculty
Entry Survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	First semester first year	Faculty
Exit Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of final semester	Faculty
Industrial Training Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	End of training	Faculty
Alumni Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once a year	Faculty

BACHELOR OF SCIENCE BIOLOGY WITH HONOURS (SSCYH)

1. Awarding Institution		Universiti Teknologi Malaysia		
2. Teaching Institution		Universiti Teknologi Malaysia		
3. Programme Name		Bachelor of Science Biology with Honours		
4. Final Award		Bachelor of Science Biology with Honours		
5. Programme Code		UT642001 (SSCYH)		
6. Professional or Statutory Body of Accreditation		Kementerian Pengajian Tinggi		
7. Language(s) of Instruction		Bahasa Malaysia and English		
8. Mode of Study (Conventional, Distance Learning, etc)		Conventional		
9. Mode of Operation (Franchise, Self-governing, etc)		Self-governing		
10. Study Scheme (Full Time/Part Time)		Full Time		
11. Study Duration		Minimum: 4 years Maximum: 6 years		
Type of Semester	No. of Semesters		No. of Weeks per Semester	
	Full Time	Part Time	Full Time	Part Time
Normal	8	10	8	20
Short	4	5	8	10
12. Entry Requirement	<p>Fulfil all university requirements and the following program requirements:</p> <ol style="list-style-type: none"> 1. Pass Matriculation/STPM with a minimum CPA of 2.80, B in Mathematics and B- in ONE (1) science course. or 2. Diploma with minimum CPA of 3.00 and at least a credit in Mathematics at SPM level. <p>Programme Entry Requirements: STPM/ Matriculation/ Foundation Holders</p> <ul style="list-style-type: none"> • Obtained a CGPA of at least 2.80 at STPM/Matriculation/Foundation level; and • Obtained at least Grade B (CGPA 3.00) in Biology at STPM/Matriculation/Foundation level; and • Obtained at least Grade C+ (CGPA 2.33) in any TWO (2) of the following subjects: Chemistry, Physics and Additional Mathematics or Mathematics; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level or equivalent; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET); and • Candidates have no physical disabilities (e.g: blind/paralyzed).. <p>Diploma Holders</p> <ul style="list-style-type: none"> • Obtained a Diploma from UTM or any other institutions approved by the Government of Malaysia and related to the applied course with a CGPA of at least 3.00; or • Other equivalent qualifications approved by the Government of Malaysia and the University Senate and related to the applied course with CGPA of at least 3.00; or • Candidates who obtained a CGPA of less than 3.00 but have at least TWO (2) years working experience in related field are eligible to apply; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level; or • Obtained at least Grade C in any Mathematics subjects at Diploma level. 			

	<ul style="list-style-type: none"> Candidates have no physical disabilities (e.g: blind/paralyzed). <p>International Students Please check the entry requirements through the following website: https://admission.utm.my/undergraduate-international/ The detailed entry requirements can be obtained from the UTM Prospectus or website (http://admission.utm.my).</p>
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13. Programme Educational Objectives (PEO)

The objectives of the BSc Biology with Honours program is to produce graduates who are:

1. Knowledgeable and competent in solving biological problems and other related fields.
2. Innovative and resourceful in contributing new ideas for sustainable development and social well-being.
3. Practice quality professional skills with adherence to ethical principles.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
PEO1	✓	✓	✓				✓				
PEO2					✓	✓				✓	
PEO3				✓				✓	✓		✓

14. Programme Learning Outcomes (PLO)

Code	Intended Learning Outcomes	Learning and Teaching Methods	Assessment
(a) Technical Knowledge and Competencies			
PLO1 Knowledge and Understanding (KW)	Integrate comprehensive knowledge, concepts and theories related to biology and other disciplines.	Lectures, tutorials, directed reading, seminars, laboratory works, directed reading, and independent research, active learning	Examinations, quizzes, tests, written assignments, and oral presentations.
PLO2 Cognitive Skills (CG)	Construct solutions to complex problems in the field of biology and other disciplines	Lectures, tutorials, projects group/individual), directed reading, computer-based exercises, supervised projects, active learning	Examinations, quizzes, tests, laboratory reports, quizzes, written assignments, oral presentations, final year project reports, and industrial training reports.
PLO3 Practical Skills (PS)	Apply biological theories and techniques in conducting experiments to generate data for scientific reports.	Lab practical Exam lab, FYUP, industrial training	Examinations, laboratory reports, written and oral presentations, final year project reports and industrial training reports.
PLO7 Numeracy Skills (NS)	Integrate numerical and graphic concepts for data evaluation relevant to biology field	Active learning, projects, PBL, Case studies	Examinations, quizzes, tests, oral presentations, project reports and peer evaluation.
b) Generic Skills			
PLO4 Interpersonal Skills (IPS)	Interact professionally with different audiences for effective	Active learning, projects (Final year undergraduate project (FYUP),	Rubrics for written assignments, laboratory reports, oral presentations, final year

	collaboration and networking.	group/individual), industrial training	project report, final year project log book, poster presentations, industrial training reports, and industrial training log book.
PLO5 Communication Skills (CS)	Communicate scientific ideas effectively with relevant stakeholders through various media	Active learning, projects (FYUP, group/individual), industrial training	Tutorial, PBL, case study, oral presentations, assignments.
PLO6 Digital Skills (DS)	Combine various electronic media to search, evaluate and process information for data presentation and management.	Active learning, projects (FYUP, group/individual), professional development courses, industrial training	Written assignments, oral presentations, project reports, learning portfolio.
PLO8 Leadership, Autonomy and Responsibility (LAR)	Lead and act professionally in managing responsibilities and making decisions.	Active learning, group projects, service learning and industrial training	Oral presentations, assignments, peer assessment, project report, service learning and industrial training reports.
PLO9 Personal Skills (PRS)	Engage in continuous learning to broaden knowledge through searching and managing relevant information from different sources.	FYUP, assignments, co-curricular activities, group work, industrial training	Written assignments, peer assessment, presentation, laboratory report, industrial training logbook, industrial training report and FYUP reports
PLO10 Entrepreneurial Skills (ENT)	Demonstrate entrepreneurial competency based on selected projects.	Lectures, assignments, case studies, seminar, workshop, group work	Oral presentations, written assignments, entrepreneur activities, business plan and case study.
PLO11 Ethics and Professionalism Skills (ETS)	Practice adherence to legal, ethical and biosafety professional codes of practice.	Lectures, assignments, laboratory works, final year projects, industrial training.	Written assignments, final year project reports, industrial training reports, industrial training logbook.

15. Classification of Courses			
No.	Classification	Credit Hours	Percentage (%)
i.	Faculty Core	7	5.5
ii.	Programme Core	72	56.3
iii.	Programme Electives	30	23.4
iv.	Compulsory University Courses		
	a. Humanities	6	
	b. Languages	6	
	c. Co-curriculum	2	
	d. Entrepreneurship	2	
	e. Free Elective	3	
	Total	128	100

No	Classification	Credit Hours	Percentage (%)
A	Biology Courses		
	a. Lectures	70	54.7
	b. Laboratory	18	14
	c. Industrial Training	5	3.9
	d. Final Year Project	6	4.7
	Total credit hours for Part A	99	77.3
B	Related Courses		
	a. Chemistry	4	3.1
	b. Mathematics	3	4.7
	c. Humanities	6	4.7
	d. Languages	6	4.7
	e. Co-curriculum	2	1.6
	f. Entrepreneurship	2	1.6
	g. Free Elective	3	2.3
	Total credit hours for Part B	29	22.7
Total credit hours for Part A and B		128	100
16. Total Credit Hours to Graduate		128 credit hours	

17. Programme Structures and Features, Curriculum and Award Requirements

The course is offered on full-time mode and is based on two semester academic sessions with several courses being delivered and assessed in each semester. Assessment is based on final examination and coursework conducted throughout the semester. Two modules are offered; Environmental Science & Cell and Molecular Biology. The programme implements Research Infused Experiential Learning (REAL), under the MOHE's Experiential Learning and Competency-based education landscape (EXCEL) framework. To ensure the Programme sustainability, elements of SDG and 4IR are embedded in selected courses.

Award requirements:

To graduate, students should:

- Attain a total of not less than 128 credit hours with minimum CGPA of 2.0.
- Pass industrial training (equivalent to 12 credit hours).
- Complete and pass the final year undergraduate project.
- Complete the Professional Skills Certificate courses.

YEAR 1

SEMESTER 1				SEMESTER 2			
Course code	Course name	Credit hours	Pre-req	Course code	Course name	Credit hours	Pre-req
SSCT 1613	Microbiology (+Lab)	3		SSCY 1103	Cellular Biochemistry and Metabolism	3	SS
SSCT 1611	Microbiology Lab	1		SSCY 1101	Cellular Biochemistry and Metabolism Lab	3	
SSCY 1713	Cellular and Molecular Biology	3		SSCY 1403	Biostatistic	2	
SSCY 1432	Introduction to Bioscience	2		SSCY 1103	Bioorganic Chemistry	3	
SSCM 1023	Mathematical Methods 1	3		SSCK 1203	Analytical Chemistry for Engineering	3	

ULRS 1182	Appreciation of Ethics and Civilisation (Local/International)	2		SCK 1891	Analytical Chemistry Practical	1	
UHLM 1012	Malay Language for Communication 2 * (International Students)			ULRS 1012	Value and Identity	2	
Total credit hours			14/16*	Total credit hours			17

* International students choose ONE only (ULRS 1182 or ULRS 1022)

** UHLB 1112 English Communication Skills (Sem 1) only for students with MUET band 3.5 and below (Pre-requisite for UHLB 2122)

YEAR TWO

SEMESTER 3				SEMESTER 4				
Course code	Course name	Credit hours	Pre-req	Course code	Course name	Credit hours	Pre-req	
SSCY 2713	Genetic Engineering	3	SSCY 1713	SSCY 2903	Plant Physiology	3		
SSCY 2711	Genetic Engineering Lab	1	SSCY 1713	SSCY 2901	Plant Physiology Lab	1		
SSCY 2613	Mycology	3	SSCT 1613	SSCY 2803	Enzymology	3	SSCY 1103	
SSCY 2733	Genetics	3		SSCY 2801	Enzymology Lab	1	SSCY 1011	
SSCY 2633	Virology	3	SSCT 1613	SSCY 2303	Animal Physiology	3		
UHLB 2122	Professional Communication Skills 1	2		ULRF 2XX2	Service Learning and Community Engagement	2		
ULRS 1022	Philosophy and Current Issue *(Local/International)	2		**** ***3	Free Elective	3		
Total credit hours			7/15*	Total credit hours			16	11

* International students choose ONE only (ULRS 1182 or ULRS 1022)

YEAR THREE

SEMESTER 5				SEMESTER 6			
Course code	Course name	Credit hours	Pre-req	Course code	Course name	Credit hours	Pre-req
SSCY 3313	Immunology	3		SSCU 3902	Undergraduate Project I	2	
SSCY 3413	Research Methodology in Bioscience	3		SSCY 3803	Bioinformatics	3	
ULRS 3032	Entrepreneurship and Innovation	2		UHLB 3132	Professional Communication Skills 2	2	UHLB 2122

				UHL* 1112	Communication in Foreign		
Module 1 Cell and Molecular Biology (Choose 9 Credits)				Module 1 Cell and Molecular Biology (Choose 9 Credits)			
SSCY 3113	Bioenergetics	3	SSCY 1103	SSCY 3343	Cancer Cell Signaling	3	
SSCY 3733	Gene Therapy	3		SSCT 3323	Stem Cells in Tissue Engineering	3	
SSCY 3813	Protein Separation Techniques in Biotechnology	3	SSCY 2803	SSCY 3763	Gene Expression Technology	3	
SSCY 3833	Structural Biology	3		SSCY 3103	Nutritional Biochemistry	3	
Module 2: Environmental Science (Choose 9 Credits)				Module 2: Environmental Science (Choose 9 Credits)			
SSCT 3673	Bioprospecting of Industrial Microorganism	3	SSCT 1613	SSCT 3243	Biosensor Technology	3	
SCT 3213	Green Technology for Sustainable Environment	3		SSCY 3643	Biofilm and Microbial Community	3	
SSCY 3633	Extremophiles	3		SSCY 3603	Phycology	3	
SSCY 3253	Bioremediation and Biodegradation	3		SSCY 3263	Biological Control and Bioconservation	3	
Total credit hours		17		Total credit hours		18	1

YEAR FOUR

SEMESTER 7				SEMESTER 8			
Course code	Course name	Credit hours	Pre-req	Course code	Course name	Credit hours	Pre-req
SSCU 4904	Undergraduate Project II	3	SSCU 3902	SSCU 4914	Industrial Training (Report)	4	
SSCY 4452	Bioethics in Research and Development in Bioscience	2		SSCU 4918	Industrial Training (Practical-HW)	8	

Module 1 Cell and Molecular Biology (Choose 9 Credits)					
SSCY 4773	Metabologenomic	3			
SSCT 4333	Nanobiotechnology	3			
SSCY 4713	Genomics and proteomics	3	SSCY 2803		
SSCY 4313	Toxicology	3			
SSCY 4733	Synthetic Biology	3	SSCY 2713		
Module 2: Environmental Science (Choose 9 Credits)					
SSCY 4293	Environmental Quality Management	3			
SSCY 4753	DNA Barcoding	3			
SSCY 4473	Ecology	3			
SSCT 4233	Solid Waste Management	3			
SSCY 4493	Environmental Toxicology	3			
Total credit hours		18		Total credit hours	12

18. Mapping of Programme Learning Outcomes to Courses

COURSES OFFERED			PROGRAM LEARNING OUTCOMES										
			Knowledge & Understanding	Cognitive Skills	Practical Skills	Interpersonal Skills	Communication Skills	Digital Skills	Numeracy Skills	Leadership, Autonomy & Responsibility	Personal Skills	Entrepreneurial Skills	Ethics & Professionalism Skills
No.	Code	Course Name	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
			KW	CG	PS	IPS	CS	DS	NS	LAR	PRS	ENT	ETS
UNIVERSITY GENERAL COURSES													
1.	UHMS 1182	Appreciation of Ethics and Civilisations - International students	/								/		/
2.	UHLM 1012	Malay Language Communication 2 - International students					/						
3.	ULRS 1012	Value and Identity									/		/
4.	UHS 1022	Philosophy and Current Issues – Local/ International students	/								/		/
5.	UHLB 2122	Professional Communication Skills 1					/						
6.	ULRF 2**2	Service Learning and Community Engagement				/					/		
7.	**** ***3	Free Elective											
8.	UBSS 1032	Entrepreneurship and Innovation										/	
9.	UHLB 3132	Professional Communication Skills 2					/						
10.	UHL* 1**2	Communication in Foreign Language					/						

CORE COURSES												
1.	SSCT 1613	Microbiology	/				/		/			
2.	SSCT 1611	Microbiology Lab	/		/							/
3.	SSCM 1023	Mathematical Method I	/	/								
4.	SSCG 1713	Cellular and Molecular Biology	/				/			/		
5.	SSCG 1402	Introduction to Bioscience	/			/	/					/
6.	SSCG 1123	Biorganic Chemistry	/					/				
7.	SSCG 1103	Cellular Biochemistry and Metabolism	/				/					
8.	SSCG 1101	Cellular Biochemistry and Metabolism Lab	/		/							
9.	SSCC 1203	Analytical Chemistry	/	/					/			
10.	SSCC 1861	Analytical Chemistry Practical	/	/	/				/			
11.	SSCG 1403	Biostatistics	/				/	/	/			
12.	SSCG 2613	Mycology	/	/	/			/				/
13.	SSCG 2733	Genetics	/	/		/				/		
14.	SSCG 2633	Virology	/				/	/				
15.	SSCG 2713	Genetic Engineering	/				/			/		/
16.	SSCG 2711	Genetic Engineering Lab	/		/		/			/		
17.	SSCG 2803	Enzymology	/			/	/					
18.	SSCG 2801	Enzymology Lab	/		/		/					
19.	SSCG 2903	Plant Physiology	/				/		/	/		
20.	SSCG 2901	Plant Physiology Lab	/		/							
21.	SSCG 2303	Animal Physiology	/			/						/
22.	SSCG 3313	Immunology	/	/				/		/		
23.	SSCG 3413	Research Methodology in Biosciences	/					/				/
24.	SSCG 3803	Bioinformatics	/					/				

25.	SSCU 3902	Undergraduate project 1	/	/			/			/		/
26.	SSCU 4904	Undergraduate Project II		/	/		/	/	/		/	/
27.	SSCG 4452	Bioethics in Research and Development in Bioscience	/				/					/
27.	SSCU 4914	Industrial Training (Report)	/	/			/		/			
	SSCU 4918	Industrial Training (Practical HW)			/	/	/	/			/	/
ELECTIVE COURSES												
Semester 5 Modul Cell and Molecular Biology (Choose 9 credit)												
1.	SSCG 3113	Bioenergetics	/				/					
2.	SSCG 3733	Gene Therapy	/	/			/			/		/
3.	SSCG 3813	Protein Separation Techniques	/				/					
4.	SSCG 3833	Structural Biology	/				/					
Semester 5 Modul Environmental Sciences (Choose 9 credit)												
5.	SSCT 3673	Bioprospecting of Industrial Microorganism	/	/			/			/		
6.	SSCT 3213	Green Technology for Sustainable Environment	/	/			/			/		
7.	SSCG 3633	Extremophiles	/				/					
8.	SSCG 3253	Bioremediation and Biodegradation	/				/			/		
Semester 6 Modul Cell and Molecular Biology (Choose 12 credit)												
9.	SSCG 3343	Cancer cell Signaling	/				/			/		
10.	SSCT 3323	Stem cells and Tissue Engineering	/	/			/					/
11.	SSCG 3763	Gene Expression Technology	/	/			/			/		
12.	SSCG 3103	Nutritional Biochemistry	/			/	/					/
Semester 6 Modul Environmental Sciences (Choose 12 credit)												
13.	SSCT 3243	Biosensor Technology	/				/	/				
14.	SSCG 3643	Biofilm and Microbial Community	/	/			/		/			
15.	SSCG 3603	Phycology	/				/					/
16.	SSCG 3263	Biological Control and Bioconservation	/			/	/					
Semester 7 Modul Cell and Molecular Biology (Choose 12 credit)												

17.	SSCT 4333	Nanobiotechnology	/																	/
18.	SSCG 4713	Genomics and Proteomics	/					/					/							/
19.	SSCG 4313	Toxicology	/					/												/
20.	SSCG 4733	Synthetic Biology	/	/																/
21.	SSCG 4773	Metabologenomics	/	/			/													/
Semester 7 Modul Environmental Sciences (Choose 12 credit)																				
22.	SSCT 4233	Solid Waste Management	/	/			/													/
23.	SSCG 4753	DNA Barcoding	/					/												/
24.	SSCG 4473	Ecology	/																	/
25.	SSCG 4293	Environmental Quality Management	/	/				/												/
26.	SSCG 4493	Environmental Toxicology	/					/												/

19. Programme Uniqueness

- The Bachelor of Science (Biology) is a highly structured programme designed to cover both traditional and modern Biology which emphasizes coursework and training in many aspects of molecular biology, genetics, plant and animal physiology, phycology, mycology, ecology, enzymology, immunology, virology, cell signalling, proteomics and genomics, DNA analysis techniques, protein isolation techniques, and recombinant DNA techniques.
- The programme is designed not only to train students in the necessary technical skills but also to provide them with the theoretical basis for continued study.
- Graduates are prepared to pursue further graduate study in bioscience, molecular biology, biochemistry, and other related areas or to obtain employment in academic, industrial, or government research laboratories.

20. Career Prospects and Career Path

Graduates of this programme can work as

- Academicians
- Microbiologist
- Research Officers/ Research Scientist/Science Officer
- Clinical Coordinator
- Project Manager
- Environmental officer
- Postdoctoral position
- Corporate Learning Advisor
- Biotechnology Engineer
- Professional Editor
- Bio-entrepreneurs
- Enforcement Officer
- Lab Analyst & Executive
- Underwriting Associate
- Equipment/Chemical Specialist
- Biomanufacturing Associate
- Product Specialist

- Consultant
- Regulatory Affairs Specialist

Most of our graduates have opted to pursue their MSc or PhD degrees locally or abroad in more advanced fields of biosciences such as cell signalling, cancer and stem cell research, protein chemistry, and structural biology.

21. Mobility Program/ Student Exchange Program (Locally/Abroad)

Students are given the opportunity to enrol certain courses at participating institutions either locally or abroad. The grades and credits of up to 1/3 of the total credits of the curriculum are transferable.

22. UTM Professional Skills Certificate

UTM has designed its own UTM Professional Skills Certificate programme to enhance the knowledge and skills of its students. It provides students with value-added courses so that they will have a competitive edge when they enter the employment market. Students are given the opportunity to enrol in this programme offered by Students are given the opportunity to enrol in this programme offered by UTMSPACE, UTMXCITE, UTM Career Centre, Akademi Bahasa, UTM iLeaGue dan UTMCAEL. (More information can be obtained from <https://ileague.utm.my/utm-professional-skills-certificate-utm-psc/>)

23. Facilities Available

List of Laboratories:

1. Biosensors and Biomolecular Technology Laboratory
2. Bioinformatics Teaching Laboratory 1 and 2
3. Chemistry Teaching Laboratory 1 and 2
4. Fermentation / Enzyme Teaching Laboratory 1 and 2
5. Genetic Engineering Teaching Laboratory 1 and 2
6. Microbiology Teaching Laboratory 1 and 2
7. Central Analytical Laboratory
8. Analytical Service Laboratory
9. Animal Tissue Culture Laboratory
10. Biofilm Research Laboratory
11. Bioinformatics Research Laboratory
12. Bio-nanotechnology Laboratory
13. Bio-refinery Technology Research Laboratory
14. Cancer Research Laboratory
15. Environmental Bioengineering Laboratory
16. Enzyme Research Laboratory
17. Extremophiles Laboratory
18. Genomics Laboratory
19. Microbiology Research Laboratory
20. Nanomaterial Laboratory
21. Nutritional Biochemistry Laboratory
22. Plant Biotechnology Laboratory
23. Proteomics Laboratory
24. Structural Biology Laboratory
25. Tissue Engineering Laboratory
26. Virology Research Laboratory
27. Water & Wastewater Research Laboratory

List of special facilities/equipment

1. High Performance Liquid Chromatography
2. High Performance Liquid Chromatography
3. Luminomete

4. Top range UV-visible Spectrophotometer
5. Gas Chromatography
6. Total Organic Carbon Analyzer
7. Gradient and Real Time PCR machines
8. ACTA prime system for protein purification and others.

24. Support for Students and Their Learning

- a. Support Personnel
 - Alumni
- b. Infrastructure support
 - Internet Access
 - Online resources
 - Extensive
 - Counselling
 - Health Centre
- c. Financial Support
 - One week induction programme for orientation and introductory study skills
 - Student Handbook (online)
 - Extensive library and other learning resources and facilities.
 - Online resources: e-learning, UTMACAD, e-portfolio
 - Students are assigned to academic advisors to assist them in education planning.

25. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning Mechanisms for Review and Evaluation of Teaching, Learning, Assessment, the Curriculum and Outcome Standards

- a. Students' performance in terms of:
 - Kedudukan Bersyarat (KS)/ Kedudukan Baik (KB)
 - Cumulative Grade Point Average (CGPA)
 - Grade Point Average (GPA)
 - Graduate on time (GOT)
 - Completion rate
- b. Employability
 - Alumni survey
 - Market survey
- c. Lecturer's performance
 - Teaching evaluation by students (e-PPPk)
 - Annual staff appraisal (e-LPPT)
- d. Curriculum review
 - Faculty academic committee
 - Industrial training survey
 - Continuous Quality Improvement (CQI) report
 - External examiner reports
 - Survey of Course Outcome (SCO) by students
 - Graduate employability report
 - Exit Survey
 - Board of Study
- e) Role of External Examiners (Visiting Examiners) Visiting Examiners are appointed by the Faculty Academic Committee to
 - review and evaluate program curriculum,
 - review and evaluate assessment procedure and methods,
 - make necessary recommendations to the Academic Committee.

- e. Delivery system
- o Academic Quality Assurance Committee
 1. Audit report
 2. MQA standard

26. Regulation of Assessment

- a. Summary of marks, grades and their evaluation points

Marks	Grade	Evaluation Point
90-100	A+	4.00
80-89	A	4.00
75-79	A-	3.67
70-74	B+	3.33
65-69	B	3.00
60-64	B-	2.67
55-59	C+	2.33
50-54	C	2.00
45-49	C-	1.67
40-44	D+	1.33
35-39	D	1.00
30-34	D-	0.67
00-29	E	0.00

- b) Role of External Examiners (Visiting Examiners)

Visiting Examiners are appointed by the Faculty Academic Committee to

- review and evaluate program curriculum,
- review and evaluate assessment procedure and methods,
- make necessary recommendations to the Academic Committee.

27. Assessment Tools

Measurement Tools	Learning Outcomes											Duration	Action by
	P L O 1	P L O 2	P L O 3	P L O 4	P L O 5	P L O 6	P L O 7	P L O 8	P L O 9	P L O 10	P L O 11		
ePPPk	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Student/ Lecturer
Course assessment report (CAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Exit survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of final semester	Faculty
Industrial training survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	End of training	Faculty
Alumni Survey	✓	✓			✓		✓					Once a year	Department
Employer Survey		✓			✓	✓	✓	✓				Once a year	Faculty
Examination	✓	✓	✓									Continuous	Department
Assignment		✓	✓	✓					✓	✓		Per Semester	Department

Practical competency exam		✓	✓						✓			Per Semester	Department
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BACHELOR OF SCIENCE BIOTECHNOLOGY WITH HONOURS (SSCTH)

1. Awarding Institution		Universiti Teknologi Malaysia		
2. Teaching Institution		Universiti Teknologi Malaysia		
3. Programme Name		Bachelor of Science in Biotechnology with Honours		
4. Final Award		Bachelor of Science in Biotechnology with Honours		
5. Programme Code		UT6421003 (SSCTH)		
6. Professional or Statutory Body of Accreditation		Ministry of Higher Education Malaysia		
7. Language(s) of Instruction		Bahasa Malaysia and English		
8. Mode of Study (Conventional, Distance Learning, etc)		Conventional		
9. Mode of Operation (Franchise, Self-governing, etc)		Self-governing		
10. Study Scheme (Full Time/Part Time)		Full Time		
11. Study Duration		Minimum: 4 years Maximum: 6 years		
Type of Semester	No. of Semesters		No. of Weeks per Semester	
	Full Time	Part Time	Full Time	Part Time
Normal	8	10	18	20
Short	4	5	8	10
12. Entry Requirement	<p>Fulfil all university requirements and the following program requirements.</p> <p>Programme Entry Requirements:</p> <p>STPM/ Matriculation/ Foundation Holders</p> <ul style="list-style-type: none"> • Obtained a CGPA of at least 2.80 at STPM/Matriculation/Foundation level; and • Obtained at least Grade B (CGPA 3.00) in Biology at STPM/Matriculation/Foundation level; and • Obtained at least Grade C+ (CGPA 2.33) in any TWO (2) of the following subjects: Chemistry, Physics or Mathematics; and • Passed with a credit in Mathematics at the Malaysian Certificate of Examination (SPM) level or equivalent; and • Obtained at least a Band 2 in the Malaysian University English Test (MUET); and • Candidates do not have visual impairments or colour blindness, and physical disabilities that impede practical work. <p>Diploma Holders</p> <ul style="list-style-type: none"> • Obtained a Diploma from UTM or any other institutions approved by the Government of Malaysia and related to the applied course with a CGPA of at least 3.00; or • Candidates who obtained a CGPA of less than 3.00 but have at least TWO (2) years working experience in the related field are eligible to apply; and • Passed with a credit in Mathematics (Grade C) at the Malaysian Certificate of Examination (SPM) level; or • Obtained at least Grade C in any Mathematics subjects at Diploma level. <p>International Candidates:</p> <p>Please check the entry requirements through the following website https://admission.utm.my/entry-requirements-ug-international/</p> <p>The detailed entry requirements can be obtained from the UTM Prospectus or website (http://admission.utm.my).</p>			

13. Programme Educational Objectives (PEO)

The Programme Educational Objectives (PEO) of this program is designed to produce graduate who are:

1. Knowledgeable and competent in solving Biotechnology problems and other related fields.
2. Innovative and resourceful in product creation to support community towards sustainable development.
3. Practice quality professional skills with adherence to ethical principles.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
PEO1	✓	✓	✓				✓				
PEO2					✓	✓				✓	
PEO3				✓				✓	✓		✓

14. Programme Learning Outcomes (PLO)

Code	Intended Learning Outcomes	Learning and Teaching Methods	Assessment
(a) Technical Knowledge and Competencies			
PLO1 Knowledge and Understanding (KW)	Integrate comprehensive fundamental knowledge, concept and theories related to biotechnology.	Lecture, tutorial, seminar, directed reading, independent study, dissecting journal, computational hands-on, workshop, case study	Quiz, test, final examination, written assignment, oral presentation, lab report
PLO2 Cognitive Skills (CG)	Construct solutions to complex problems in the field of biotechnology related industry.	Lecture, tutorial, computer-based exercises, problem-based learning, project-based learning, lab work, supervised projects, industrial training.	Quiz, test, final examination, lab report, written assignment, oral presentation, final year project report, industrial training report
PLO3 Practical Skills (PS)	Apply biotechnology tools and techniques in conducting experiments to generate data for scientific report.	Lab practical, psychomotor skills assessment, group discussion	Practical examination, psychomotor skill assessment, final year project, industrial training
PLO7 Numeracy Skills (NS)	Integrate numerical and graphic concepts for data evaluation relevant to biotechnology field.	Tutorial, lab report, mini project, assignment, problem-based learning, cooperative learning, industrial training, final year undergraduate project	Final examination, lab report, industrial training and final year project report, mini project
b) Generic Skills			
PLO4 Interpersonal Skills (IPS)	Interact professionally with different audience and work collaboratively as part of a team.	Industrial Training, global outreach, programme, academic service learning, FYUP	Industrial training, service learning, FYUP

PLO5 Communication Skills (CS)	Communicate effectively with peers and relevant stakeholders using various media.	Group assignment, tutorial, lab work, industrial visit, case study, presentation, problem-based learning, self-based learning, industrial training, final year undergraduate project.	Written assignment, lab report, oral presentation, final year undergraduate report and logbook, industrial training report and logbook
PLO6 Digital Skills (DS)	Combine a broad range of digital media and technology for analysis, data interpretation and presentation.	Service learning, mini project, assignment, problem-based learning, capstones, industrial training, final year undergraduate project	Assignment, lab report, mini project, industrial training, and final year undergraduate project report
PLO8 Leadership, Autonomy and Responsibility (LAR)	Lead and act professionally in managing responsibilities and making decisions.	Tutorial, lab work, Information survey, group discussion, case study, scenario-based learning, industrial visit	Oral presentation, group assignment, lab report, Peer assessment
PLO9 Personal Skills (PRS)	Engage in continuous learning to broaden knowledge through searching and managing relevant information from different sources.	Group assignment, group discussion, laboratory works, cornerstone	Oral presentation, lab report, peer assessment, mini project
PLO10 Entrepreneurial Skills (ENT)	Demonstrate entrepreneurial competency based on selected projects.	Lecture, project-based learning	Oral presentation, written assignment
PLO11 Ethics and Professionalism Skills (ETS)	Demonstrate adherence to legal, ethical, and biosafety professional codes of practice.	Lectures, Problem based learning, Group discussion, Tutorial, Capstones, Flipped classroom	Group project, presentation, assignment, lab report

15. Classification of Courses

No.	Classification	Credit Hours	Percentage (%)
i.	University <ul style="list-style-type: none"> ● Malaysia Core Value ● Value & Identity ● Global Citizen ● Communication Skill ● Enterprising Skills ● Free Electives 	4 2 2 6 2 3	3.3 1.6 1.6 4.9 1.6 2.5
ii.	Faculty Core	7	5.7
iii.	Programme Core	75	61.5
iv.	Programme Electives	18	14.4
v.	Programme Free Elective	3	2.5
	Total	122	100

No	Classification	Credit Hours	Percentage (%)
A	Biology Courses		
	(a) Lectures	68	55.8
	(b) Laboratory	7	5.7
	(c) Industrial Training	12	9.8
	(d) Final Year Project	6	4.9
	Total credit hours for Part A	93	76.2
B	Related Courses		
	a) Chemistry	4	3.3
	b) Mathematics	3	2.5
	c) General (Humanities/ Entrepreneurship / Management)	14	11.5
	d) Co-curriculum	2	1.6
	e) Languages	6	4.9
	Total credit hours for Part B	29	23.8
	Total credit hours for Part A and B	122	100
16. Total Credit Hours to Graduate		122 credit hours	

17. Programme Structures and Features, Curriculum and Award Requirements

The programme is offered in full-time mode and follows a two-semester academic session. Each semester consists of multiple courses, which are delivered and assessed. Assessment is based on both a final examination and coursework completed throughout the semester. Students have the option to choose from four modules: Environmental, Agricultural, Industrial, and Medical. Additionally, students are required to undertake a final year project and participate in a 6-month Industrial Training during their last semester.

Award requirements:

To graduate, students should:

- Attain a total of not less than 122 credit hours with minimum CGPA of 2.0.
- Pass industrial training.
- Complete and pass the final year undergraduate project.
- Complete the Professional Skills Certificate courses.

YEAR 1

SEMESTER 1			
Course code	Course name	Credit hours	Pre-req
SSCT 1613	Microbiology	3	
SSCT 1611	Microbiology Lab	1	
SSCY 1713	Cellular and Molecular Biology	3	
SSCT 1412	Introduction to Biotechnology	2	
SSCM 1023	Mathematical Methods 1	3	
ULRS 1182	Appreciation of Ethics and Civilisations	2	

SEMESTER 2			
Course code	Course name	Credit hours	Pre-req
SSCY 1103	Cellular Biochemistry and Metabolism	3	
SSCY 1101	Cellular Biochemistry and Metabolism Lab	1	
SSCY 1123	Bioorganic Chemistry	3	
SSCY 1403	Biostatistics	3	
SSCK 1203	Analytical Chemistry for Engineering	3	
SSCK 1891	Analytical Chemistry Practical	1	

	(Local/ International*)		
UHLM 1012	Malay Language Communication (International)	2	
Total credit hours		14/16	

ULRS 1012	Value and Identity	2	
Total credit hours		16	

*International students may choose either UHMS 1182 Appreciations of Ethics and Civilizations (Sem 2/Year 1) or UHIS 1022 Philosophy and Current Issues (Sem 1/Year 2).

#UHLB 1122 English Communication Skills is compulsory (Mandatory Attendance - HW) for students with MUET Band 3.5 and below.

YEAR TWO

SEMESTER 1			
Course code	Course name	Credit hours	Pre-req
SSCT 2513	Fermentation Technology	3	SSCT 1613 SSC Y 1103
SSCT 2511	Fermentation Technology Lab	1	SSCT 1613 SSC Y 1103
SSCY 2713	Genetic Engineering	3	SSC Y 1713
SSCY 2711	Genetic Engineering Lab	1	SSC Y 1713
ULRS 1022	Philosophy and Current Issues (Local/ International*)	2	
UHLB 2122	Professional Communication Skills 1	2	
XXXX XXX3	Free Elective	3	
Total credit hours		15/13	

SEMESTER 2			
Course code	Course name	Credit hours	Pre-req
SSCT 2543	Product Recovery in Biotechnology	3	SSC T 251 3
SSCT 2541	Product Recovery in Biotechnology Lab	1	SSC T 251 1
SSCT 2823	Enzyme Technology and Biocatalysis	3	SSC Y 110 3
SSCT 2821	Enzyme Technology and Biocatalysis Lab	1	SSC Y 110 1
SSCT 2703	Gene Expression and Regulation	3	
SSCT 2423	Research Methodology in Biosciences	3	
ULRF 2XX2	Service Learning and Community Engagement	2	
Total credit hours		16	

*International students may choose either UHMS 1182 Appreciations of Ethics and Civilizations (Sem 2/Year 1) or UHIS 1022 Philosophy and Current Issues (Sem 1/Year 2).

YEAR THREE

SEMESTER 1			
Course code	Course name	Credit hours	Pre-req

SEMESTER 2			
Course code	Course name	Credit hours	Pre-req

SSCT 3353	Animal Tissue Culture Technology	3	
SSCT 3913	Plant Tissue Culture Technology	3	
SSCT 3411	Tissue Culture Technology Lab	1	
ULRS 1032	Entrepreneurship and Innovation	2	
XXXX XXX3	Free Elective	3	
Environmental Biotechnology Module (Choose 6 credits)			
SSCT 3213	Green Technology for Sustainable Environment	3	
SSCT 3513	Microbial Biotechnology	3	
SSCT 3233	Biocatalysis and Biotransformation in Environmental Biotechnology	3	SSCY 1103
Medical Biotechnology Module (Choose 6 credits)			
SSCY 3313	Immunology	3	
SSCT 3653	Medical Microbiology	3	SSCT 1613
SSCY 3733	Gene Therapy	3	
Agricultural Biotechnology Module (Choose 6 credits)			
SSCT 3973	Application of Plant Tissue Culture	3	
SSCT 3933	Plant Biochemistry	3	

SSCY 3803	Bioinformatics	3	
SSCT 3403	Trends in Biotechnology	3	
SSCU 3902	Undergraduate Project I	2	
UHLB 3132	Professional Communication Skills 2	2	
UHLX 1XX2	Communication in Foreign Language Elective	2	
Environmental Biotechnology Module (Choose 6 credits)			
SSCT 3223	Environmental Biotechnology	3	
SSCT 3203	Industrial Waste Management	3	
SSCT 3243	Biosensor Technology	3	SSCT 2823
Medical Biotechnology Module (Choose 6 credits)			
SSCT 3523	Drug Design and Discovery	3	
SSCT 3323	Stem Cells and Tissue Engineering	3	
SSCT 3623	Medical Virology	3	
Agricultural Biotechnology Module (Choose 6 credits)			
SSCT 3703	Plant Molecular Biology	3	
SSCT 3723	Molecular Techniques for Food Quality Control	3	

SSCT 3953	MicroRNA in Plant Biology System	3	
Industrial Biotechnology Module (Choose 6 credits)			
SSCT 3613	Industrial Microbiology	3	SSCT 1613
SSCT 3673	Bioprospecting of Industrial Microorganism	3	SSCT 1613
SSCT 3533	Natural Product	3	
Total credit hours		18	

SSCT 3823	Plant Proteomics and Bioinformatics	3	
Industrial Biotechnology Module (Choose 6 credits)			
SSCT 3503	Biorefinery Technology	3	
SSCT 3523	Drug Design and Discovery	3	
SSCT 3543	Halal Industry Regulation, Management and Practices	3	
Total credit hours		18	

YEAR FOUR

SEMESTER 1			
Course code	Course name	Credit hours	Pre-req
SSCU 4904	Undergraduate Project II	4	SSCU 3902
SSCT 4413	Bioethics in Research and Development	3	
Module Environmental Biotechnology (Choose 6 credits)			
SSCT 4213	Metal Bioremediation	3	
SSCT 4813	Multi-omics for Environmental Application	3	
SSCT 4273	Environmental Bioengineering	3	
SSCT 4233	Solid Waste Management	3	
Module Medical Biotechnology (Choose 6 credits)			
SSCT 4333	Nanobiotechnology	3	

SEMESTER 2			
Course code	Course name	Credit hours	Pre-req
SSCU 4914	Industrial Training (Report)	4	
SSCU 4918	Industrial Training (Practical - HW)	8	

SSCT 4353	Application of Biotechnology in Cancer	3					
SSCT 4393	Enzymes in Medicine	3	SSCT 2823				
Module Agricultural Biotechnology (Choose 6 credits)							
SSCT 4913	Biofertilizer	3					
SSCT 4253	Phytoremediatio n	3					
SSCT 4433	Agribusiness and Entrepreneurship	3					
SSCT 4933	Plant GMO/GMP, Biosafety and Bioethics	3					
Module Industrial Biotechnology (Choose 6 credits)							
SSCT 4513	Bioreactor Design	3					
SSCT 4533	Biopharmaceuti cal Technology	3					
SSCT 4553	Fungal Biotechnology	3	SSCT 1613				
Total credit hours		13			Total credit hours	12	

18. Mapping of Programme Learning Outcomes to Courses

		LEARNING OUTCOMES										
		Knowledge and understanding	Cognitive Skills	Practical Skills	Interpersonal Skill	Communication Skills	Digital Skills	Numeracy Skills	Leadership, Autonomy and Responsibility	Personal Skills	Entrepreneurial Skills	Ethics and Professionalism Skills
Code	Course Name	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
General Courses												
ULRS 1182	Appreciation of Ethics and Civilizations	✓								✓		✓
UHLM 1012	Malay Language for Communication 2 (International student)					✓						
ULRS 1012	Value and Identity									✓		✓
ULRS 1022	Philosophy and Current Issues	✓								✓		✓
UHLB 2122	Professional Communication Skills 1					✓						
ULRF 2XX2	Service Learning and Community Engagement				✓					✓		✓
ULRS 1032	Entrepreneurship and Innovation										✓	
UHLB 3132	Professional Communication Skills					✓	✓					
UHLX 1XX2	Communication in Foreign Language Elective	✓				✓						
XXXX XXX3	Free Electives											
Faculty Core Courses												
SSCM 1023	Mathematical Methods I	✓	✓									
SSCK 1203	Analytical Chemistry for Engineering	✓	✓					✓				

SSCK 1861	Analytical Chemistry Practical I	✓	✓	✓				✓				
Programme Core Courses												
SSCT 1613	Microbiology	✓				✓		✓				
SSCT 1611	Microbiology Lab	✓		✓								✓
SSCY 1713	Cellular and Molecular Biology	✓				✓			✓			
SSCT 1412	Introduction to Biotechnology	✓										✓
SSCY 1113	Bioorganic Chemistry	✓					✓					
SSCY 1103	Cellular Biochemistry and Metabolism	✓				✓						
SSCY 1101	Cellular Biochemistry and Metabolism Lab	✓		✓								
SSCY 1403	Biostatistics	✓				✓	✓	✓				
SSCT 2543	Product Recovery in Biotechnology	✓								✓		
SSCT 2541	Product Recovery in Biotechnology	✓		✓								✓
SSCY 2713	Genetic Engineering	✓				✓			✓			✓
SSCY 2711	Genetic Engineering Lab	✓		✓		✓			✓			
SSCT 2513	Fermentation Technology	✓	✓					✓	✓			
SSCT 2511	Fermentation Technology Lab	✓	✓	✓				✓	✓			
SSCT 2823	Enzyme Technology and Biocatalysis	✓	✓			✓						
SSCT 2821	Enzyme Technology and Biocatalysis Lab	✓		✓					✓			
SSCT 2703	Gene Expression and Regulation	✓					✓			✓		
SSCT 2423	Research Methodology in Biosciences	✓					✓					✓
SSCT 3353	Animal Tissue Culture Technology	✓	✓									✓
SSCT 3913	Plant Tissue Culture Technology	✓	✓									✓
SSCT 3411	Tissue Culture Technology Lab	✓		✓					✓			
SSCY 3803	Bioinformatics	✓					✓					
SSCT 3403	Trends in Biotechnology	✓	✓									✓
SSCU 3902	Undergraduate Project I	✓	✓			✓				✓		✓

SSCU 4904	Undergraduate Project II		✓	✓		✓	✓	✓		✓		✓
SSCT 4413	Bioethics in Research and Development	✓					✓					✓
SSCU 4914	Industrial Training (Report)	✓	✓			✓		✓				
SSCU 4918	Industrial Training (Practical)			✓	✓	✓	✓			✓		✓
Electives Courses												
Environmental Biotechnology Module												
SSCT 3213	Green Technology for Sustainable Environment	✓	✓			✓			✓			
SSCT 3513	Microbial Biotechnology	✓	✓						✓			✓
SSCT 3233	Biocatalysis and Biotransformation in Environmental Biotechnology	✓							✓			
SSCT 3223	Environmental Biotechnology	✓					✓		✓			
SSCT 3203	Industrial Waste Management	✓	✓		✓		✓					
SSCT 3243	Biosensor Technology	✓				✓	✓					
SSCT 4213	Heavy Metals Bioremediation	✓	✓			✓						✓
SSCT 4813	Multi-omics for Environmental Application	✓					✓					✓
SSCT 4273	Environmental Bioengineering	✓	✓		✓							✓
SSCT 4233	Solid Waste Management	✓	✓			✓						✓
Medical Biotechnology Module												
SSCY 3313	Immunology	✓	✓				✓		✓			
SSCT 3653	Medical Microbiology	✓	✓						✓			
SSCY 3733	Gene Therapy	✓	✓			✓			✓			✓
SSCT 3523	Drug Design and Discovery	✓			✓		✓					
SSCT 3323	Stem Cells and Tissue Engineering	✓	✓				✓					
SSCT 3623	Medical Virology	✓				✓	✓					
SSCT 4333	Nanobiotechnology	✓										✓
SSCT 4353	Application of Biotechnology in Cancer	✓								✓		✓

SSCT 4393	Enzymes in Medicine	✓	✓						✓			✓
Agricultural Biotechnology Module												
SSCT 3973	Application of Plant Tissue Culture	✓				✓			✓			
SSCT 3933	Plant Biochemistry	✓							✓			
SSCT 3953	microRNA in Plant Biology System	✓	✓				✓		✓			
SSCT 3703	Plant Molecular Biology	✓					✓					
SSCT 3723	Molecular Techniques for Food Quality	✓	✓		✓		✓					
SSCT 3823	Plant Proteomics	✓					✓					
SSCT 4913	Biofertilizer	✓	✓								✓	✓
SSCT 4253	Phytoremediation	✓					✓					✓
SSCT 4333	Agribusiness and Entrepreneurship	✓									✓	✓
SSCT 4933	Plant GMO/GMP Biosafety and Bioethics	✓										✓
Industrial Biotechnology Module												
SSCT 3613	Industrial Microbiology	✓	✓						✓			
SSCT 3673	Bioprospecting of Industrial Microorganism	✓	✓			✓			✓			
SSCT 3533	Natural Product	✓							✓			
SSCT 3503	Biorefinery Technology	✓	✓				✓					✓
SSCT 3543	Halal Industry regulation, Management and Practices	✓	✓				✓				✓	
SSCT 4513	Bioreactor Design	✓						✓				✓
SSCT 4533	Biopharmaceutical Technology	✓	✓									✓
SSCT 4553	Fungal Biotechnology	✓	✓		✓							✓

19. Programme Uniqueness

This programme focuses on providing a strong academic foundation in using living organisms in innovative ways, and how they can be applied in biotechnology, such as industrial, agricultural, environmental, and medical fields. The curriculum offers diverse knowledge and technical skills in a wide range of biotechnology concepts to accomplish the needs of biotechnological based industries and also research institute. Moreover, the program emphasizes Industry Driven Experiential Learning (IDEAL), which is a part of the MOHE's Experiential learning and Competency-based education landscape (EXCEL) framework. Selected courses in the program address relevant SDG and 4IR elements that pertain to the current biotechnology scenario.

20. Career Prospects and Career Path

Graduates of the program can work as

- Research Scientist/Science Officer/Assistant Science Officer
- Academician (Lecturer/teacher)
- Biotechnologist/Biotechnology Engineer
- Quality Control Officer/Quality Control Engineer
- Product Specialist/ Sales Executive for Biotechnology Product
- Microbiologist
- Clinical Coordinator
- Environmental Safety Officer
- Laboratory Manager
- Entrepreneur

21. Cross Campus Program – Mobility Program/Student Exchange Program (Locally/Abroad)

Students are given the opportunity to enrol certain courses at participating institutions either locally or abroad. The grades and credits of up to 1/3 of the total credits of the curriculum are transferable.

22. UTM Professional Skills Certificate

UTM has designed its own UTM Professional Skills Certificate programme to enhance the knowledge and skills of its students. It provides students with value-added courses so that they will have a competitive edge when they enter the employment market. Students are given the opportunity to enrol in this programme offered by UTM SPACE, UTMXCITE, UTM Career Centre, Akademi Bahasa, UTM iLeaGue and UTMCAEL.

More information can be obtained from <https://ileague.utm.my/utm-professional-skills-certificate-utm-psc/>

23. Facilities Available

List of Laboratories :

1. Biosensors and Biomolecular Technology Laboratory
2. Bioinformatics Teaching Laboratory 1 and 2
3. Chemistry Teaching Laboratory 1 and 2
4. Fermentation / Enzyme Teaching Laboratory 1 and 2
5. Genetic Engineering Teaching Laboratory 1 and 2
6. Microbiology Teaching Laboratory 1 and 2
7. Central Analytical Laboratory
8. Analytical Service Laboratory
9. Animal Tissue Culture Laboratory
10. Biofilm Research Laboratory
11. Bioinformatics Research Laboratory
12. Bio-nanotechnology Laboratory
13. Bio-refinery Technology Research Laboratory
14. Cancer Research Laboratory
15. Environmental Bioengineering Laboratory
16. Enzyme Research Laboratory
17. Extremophiles Laboratory
18. Genomics Laboratory
19. Microbiology Research Laboratory
20. Nanomaterial Laboratory
21. Nutritional Biochemistry Laboratory
22. Plant Biotechnology Laboratory
23. Proteomics Laboratory
24. Structural Biology Laboratory
25. Tissue Engineering Laboratory

26. Water & Wastewater Research Laboratory

List of special facilities/equipment

1. High Performance Liquid Chromatography (HPLC)
2. Luminometer
3. Top range UV-visible Spectrophotometer
4. Gas Chromatography (GC)
5. Total Organic Carbon Analyzer
6. Gradient and Real Time PCR machines
7. AKTA prime system for protein purification and others.
8. Gel documentation system
9. Biolistic
10. Nanodrop
11. Upright Fluorescent Microscope
12. Benchtop Scanning Electron Microscope

24. Support for Students and Their Learning

- a) Support Personnel
 - Academic Advisor
 - Counsellor
 - Student Association (PESAT)
 - Symbiosis
 - Alumni Association (Biosas)
- b) Infrastructure support
 - Internet access (Wireless)
 - Online resources: e-learning, UTMACAD, e-portfolio
 - Extensive library and other learning resources and facilities.
 - UTM Health Centre
 - UTM Counselling Centre
 - Sports and recreational areas
- c) Financial support
 - Perbadanan Tabung Pendidikan Tinggi Negara (PTPTN)
 - MARA
 - JPA and others.

25. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning Mechanisms for Review and Evaluation of Teaching, Learning, Assessment, the Curriculum and Outcome Standards

- a) Students' performance in terms of:
 - Kedudukan Bersyarat (KS) / Kedudukan Baik (KB)
 - Cumulative Grade Point Average (CGPA)
 - Grade Point Average (GPA)
 - Graduate on Time (GOT)
 - Completion rate
- b) Employability
 - Alumni Survey
 - Market Survey
 - Program Exit Survey
- c) Lecturer's performance
 - Teaching evaluation by students (e-PPPk)
 - Annual staff appraisal (e-LPPT)
- d) Curriculum review
 - Faculty academic committee

- Board of Studies (BOS)
- Industrial training survey
- Continuous Quality Improvement (CQI) report
- External examiner reports
- Survey of Course Outcome (SCO) by students
- Graduate employability report
- Exit Survey

e) Role of External Examiners (Visiting Examiners)

Visiting Examiners are appointed by the Faculty Academic Committee to:

- review and evaluate program curriculum,
- review and evaluate assessment procedure and methods,
- make necessary recommendations to the Academic Committee.

f) Delivery system

- Academic Quality Assurance Committee
 - i. Audit report
 - ii. MQA standard

26. Regulation of Assessment

- a) The performance of a student in a course is represented by the grade obtained. The relationship between the marks, grades, and grade points is listed below:

Marks	Grade	Grade Points
90-100	A+	4.00
80-89	A	4.00
75-79	A-	3.67
70-74	B+	3.33
65-69	B	3.00
60-64	B-	2.67
55-59	C+	2.33
50-54	C	2.00
45-49	C-	1.67
40-44	D+	1.33
35-39	D	1.00
30-34	D-	0.67
00-29	E	0.00

- b) Role of Board of Study (BOS) which the members consist of the External Examiners, Industrial Advisory Panels and Alumni. They are appointed by the Faculty Academic Committee to:

- review and evaluate program curriculum,
- review and evaluate assessment procedure and methods,
- make necessary recommendations to the Academic Committee.

27. Assessment Tools

Measurement Tools	Learning Outcomes											Duration	Action by
	P	P	P	P	P	P	P	P	P	P	P		
	L	L	L	L	L	L	L	L	L	L	L		
	○	○	○	○	○	○	○	○	○	○	○		
	1	2	3	4	5	6	7	8	9	1	1		
									0	1	1		

ePPPk	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Students / Lecturers
Course assessment report (CAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Lecturer
Programme assessment report (PAR)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of semester	Department
Exit survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of final semester	Faculty
Industrial training survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	End of training	Faculty
Employer Survey	✓	✓	✓	✓	✓	✓	✓		✓		✓	Once a year	Faculty
Examination	✓	✓					✓					End of semester	Student/ Lecturer
Practical exam competency			✓									Continuous/End of semester	Student/ Lecturer
Assignment	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	Continuous	Student/ Lecturer

SYNOPSIS OF PHYSICS COURSES

Compulsory Courses

SSCM1023 – Mathematical Methods I

The course revises and extends Matriculation and STPM topics such as differentiation and integration and includes topics such as complex numbers and differential equations, which may be new to many students. Topics covered include parametric equations, functions, polar coordinates, vectors, and complex numbers. Students will learn how to define functions, and plot the graphs, using the Cartesian as well as polar coordinates; solve problems involving complex numbers and vectors. Additional topics include limits and continuity, differentiation techniques and its applications, integration techniques including improper integrals. Upon completion, the students would have acquired some quite powerful tools of analysis. This is also an introductory course on differential equations. Topic includes first order ordinary differential equations (ODEs). Students will learn how to classify and solve first order ODEs.

SSCM1033 – Mathematical Methods II

This course continues and extends the techniques introduced in Mathematical Methods I, with further differential equations and calculus of multivariable functions. Topics include linear second order ODEs with constant coefficients, functions of several variables, partial differentiation and multiple integrations. Students will learn how to classify and solve second order linear ODEs with constant coefficients using the method of undetermined coefficients and variation of parameters. They will also learn to determine the domain and range, techniques of graph sketching, and limit & continuity, find (partial) derivatives and evaluate (double and triple) integrals, pertaining to a function of two and three variables. The use of cylindrical and spherical coordinates is also highlighted. Applications include finding the volume, mass, centre of gravity, and moment of inertia of a solid.

SSCP1102 — Introduction to Physics Program

Physics is one of the most fundamental scientific disciplines with the main goal of understanding how the universe behaves. It covers a wide range of phenomena from the smallest sub-atomic particles to the largest galaxies, it is the scientific study of matter and energy and how they interact with each other. Physicist is a scientist who studies or practices physics. Examples of careers in physics are scientists and researchers in various fields of science and technology. The philosophy of physics is essentially a part of the philosophy of science.

SSCP1143 – Mechanics

This course mainly discusses motion of a body or a system. Beginning with the basic and derived physical quantities and vector as mathematical tool, various types of motion such as linear, free-fall, projectile, circular, rotational and simple harmonic motions are described. Other topics such as equilibrium, elasticity, gravitation and fluids mechanics illustrate the application of a body in motion under the influence of a force.

SSCP1153 – Electricity and Magnetism

The course examines the force of electromagnetism, which encompasses both electricity and magnetism. It includes the exploration of some electromagnetic phenomena. It begins by examining the nature of electric charge and then a discussion of interaction of electric charges at rest. It then study about charges in motion particularly electric circuit. It continues into the study of magnetic interaction how moving charges and currents responds to magnetic field. The principle of electromagnetic induction and how resistors, inductors and capacitors behave in ac circuits is discussed. The understanding the electrical energy-conversion devices such as motors, generators and transformers are also discussed. Finally the study of the four fundamental equations that completely described both electricity and magnetism.

SSCP1163 – Sound, Wave and Optics

The course starts with introduction to the concept of sound, how it is produced, its characteristics, intensity and quality as well as the interference of sound which will be applied to modern sound devices. Finally, emphasize on optics on its dual properties. These will be inseminated in the phenomenon of interference and diffraction of light and its modern-day applications. In general, the course provides the basic concepts of sound and optics.

SSCP1223 – Modern Physics

The course begins with a brief discussion on the nature of science in the quest of better understandings of the natural phenomena, highlighting the dilemmas and failures of classical physics in the face of some landmark experiments and discoveries, which gave the impetus to new ideas and paradigm shift into the modern physics. Finally, formalities of quantum mechanics is introduced by discussing the 1-D time independent Schrodinger equation (TISE), applied to an idealised infinite square potential well.

SSCM1523 – Linear Algebra

The course begins with the study of matrices and determinant. Starting with simple matrix operations, elementary row operation and inverses, and determinant of matrices. Solve the linear system using matrix inverse, Cramer's rule, Gauss and Gauss—Jordan elimination method. Next, the focus is on the vector spaces, subspace, linear independence, spanning sets, bases, coordinate vector and change of basis, orthogonal bases, and the Gram-Schmidt process. There follows a discussion of linear transformation and matrices, as well as the kernel and range. Finally, find the eigenvalues and eigenvectors and use them in diagonalization problem.

SSCM1703 – Differential Equations

An introductory first course in differential equations. Topics include first order ordinary differential equations (ODEs), linear second order ODEs with constant coefficients, the Laplace transform and its inverse, Fourier series, and elementary partial differential equations (PDEs). Students will learn how to classify and solve first order ODEs, solve second order linear ODEs with constant coefficients using the method of undetermined coefficients and variation of parameters, use the technique of Laplace transforms to solve ODEs with specified initial or boundary conditions, and use the technique of separation of variables to solve initial-

boundary value problems involving heat and wave equations and boundary value problems involving Laplace equation.

SSCP1811 – Practical Physics I

Students perform experiments related to mechanics, electricity and magnetism and wave optics. These experiments are performed in pairs. At the end of the experiments, students submit technical reports which describe the experiment, the analysis and the findings. Upon completion, students should have the ability to handle the instrumentations and relate the experiments to the theories learned in Mechanics and Electricity and Magnetism, perform experimental analysis and write technical reports.

SSCP1821 – Practical Physics II

Students perform experiments related to thermodynamics, optics, modern physics and electronics. These experiments are performed in pairs. At the end of each experiment the student submit a technical report which describes the experiment, the analysis and the findings. Upon completion, the students should have the ability to handle the instrumentations and relate the experiments to the theories learned in Sound, Wave and Optics and Modern Physics, perform experimental analysis on the laboratory works and write technical reports.

SSCP2113 – Thermodynamics

The course starts with discussions on basic concepts of thermodynamics, thermodynamic properties of materials and thermodynamic processes. Energy transfer and energy analysis of systems and processes using the first and second laws of thermodynamics will be covered. The principles of gas power and refrigeration cycles are also briefly highlighted. In general, the course provides on the basic concepts of thermodynamics and its applications in conservation and utilisation of energy.

SSCP2213 – Nuclear Physics

The course introduces major concepts and theories of nuclear physics. The course begins with understanding the basic knowledge of the constituents of nucleus and the properties of nuclear forces. Radiation sources and the types of ionizing radiations are introduced. Nuclear decay process and the properties of ionizing radiations will be discussed. The interactions of nuclear radiations with matter and mechanism of nuclear reaction are covered. Basic concepts on radioactivity including radioactive decay law, radioactive decay series and radioactive equilibria are covered. Some nuclear models such as liquid drop model, shell model and optical model of the nucleus will be introduced at the end of the course.

SSCP2313 – Basic Electronics

The course starts with introduction to electronic components, circuit building and basic measurement of signal. Various circuit theory analysis such as superposition principle, mesh current analysis, Thevenin and Norton theorem are taught. DC and AC circuit analysis and the use of semiconductor devices such as diodes and transistors are discussed. Simple transistor amplifier are analysed using r-parameter model. JFET principle and bias circuit are also covered. The course provides good balance between theoretical and practical works on electronic circuits and its everyday applications.

SSCP2333 – Computer Programming

This course begins with a comprehensive introduction to computer, role of computer in physics, and operating system. Computer programming involving choices of computer languages and programming concept is also discussed. In the laboratory, the student experience working with a Linux desktop, client-server working environment, and all the necessary tools for terminal-server programming works. Throughout the course students are guided to build computer programs from simple to complex, all about solving various physics problem, based on the Java programming language. Students are exposed to methods for writing command-line based programs and tools utilising widgets for building application with graphical user interface.

SSCP2413 – Solid State Physics

Introduces basic concepts in solid state physics, with emphasis on crystal structures. The roles of phonons and electrons in a solid are discussed, using various models. Upon completion, students should be able to explain basic concepts used in solid state physics and techniques used in determining crystal structures. Students should also be able to discuss thermal properties of solids and the behaviour of electrons in solids, using various models.

SSCP2613 – Mathematical Physics

The main aim of the course is to integrate physics and mathematics and to provide students with mathematical techniques for solving problems in physics. The course content consists of vector analysis, vector calculus, complex variable, matrices, ordinary and partial differential equations and Fourier series.

SSCP2821 – Practical Physics IV

Students perform experiments related to materials science, advanced electronics, lasers, optics and nuclear physics. These experiments will be conducted in groups of two or three students. At the end of each experiment the group prepares a technical report which contains the experimental procedure, detailed data analysis, discussion on the findings, and the conclusions. Upon completion, the student should have the ability to relate the experiments to the physical principles learned in relevant courses in materials science, advanced electronics, lasers, optics and nuclear physics, perform experimental analysis on the laboratory works and write technical reports.

SSCP3113 – Electromagnetism

The course introduces the vector and calculus approach in understanding various laws and principles of electromagnetism and time independent Maxwell's equations. The course describes the time varying electromagnetic fields and its physical principles in various applications.

SSCP3123 – Classical Mechanics

The course starts with brief discussion on Lagrangian and Hamiltonian dynamics. Euler and Lagrange equations, Hamiltonian principle, Euler theorem and kinetic energy, space time homogeneity, isotropy of specific velocity and momentum space, canonical equation, cyclic coordinates are discussed. Central field motion, orbit in a central field, planetary motion, Kepler's law, motion in an inverse square field, Rutherford scattering are highlighted. Dynamics of rigid body, kinetic energy, inertia tensor, angular momentum, base axis for inertia are studied.

Oscillation, one dimensional motion, simple harmonic motion in one and two dimensions, damped and forced oscillations, electric circuit oscillation, coupled oscillation, two coupled oscillators and weak coupled oscillation are also discussed. The course ends with discussion on orthogonality of eigenvector, normal coordinate and molecular vibration.

SSCP3133 – Thermal and Statistical Physics

The course introduces the concepts of statistical mechanics and quantum statistics. The partition function, properties of large numbers of particles, the Fermi Dirac, Bose-Einstein and Maxwell-Boltzmann distribution laws are discussed. Upon completion, the student will have the ability to solve problems, relating to the properties of large numbers of particles and explain the connection between entropy and the number of accessible quantum states. The students should also be able to relate between the free energy and the partition function and be able to calculate the properties of thermodynamic systems.

SSCP3323 – Advanced Electronics

The course begins with the hybrid h and ϕ small signal models for transistor. The small signal amplifiers and power amplifiers are analysed. The operational amplifier and its applications such as summing, differential amplifier, differentiator or integrator, and active filter are discussed. Sensors and amplification of signals are introduced. Basic concepts and principles of digital circuits, number codes and number system, Boolean algebra, logic gates, Karnaugh maps, IC specification and interfacing, encoding and decoding, flip-flops, counters, shift registers and digital arithmetic circuits are also discussed. Analog to digital and digital to analog conversion are covered. The course will be conducted by lectures and hands-on to provide students with basic concepts and practical experience in advanced analog and digital electronics.

SSCP3343 – Instrumentation and Data Acquisition

The course consists of two parts. The first part begins with a review of basic elements in measurement systems, sensing element, signal conditioning, signal processing and signal presentation. The classification of instruments, errors in measurement, static and dynamic characteristics of instrument and calibration are introduced. The measurements of physical quantities which include displacement, velocity and acceleration for translational and rotational motion, force and torque, low, medium and high pressure, temperature, flow, level, humidity and electrical quantities are discussed. For the second part, basic concepts and techniques for interfacing a microcontroller to external devices for data collection and process control and developing the related software required are discussed. Transferring and converting analogue variables into the digital form needed for processing are covered. The course provides the general concepts of measurement technique and system technology. 104

SSCP3433 – Quality Control

The course starts with a brief discussion on the general concept and definition, the importance, as well as the costs of quality in managing a business organization. Topics that are focused include the quality management principles, total quality management and ISO 9001 quality management requirements in manufacturing and servicing industries. The statistical techniques in quality control such as the process modelling, the acceptance sampling and the statistical process control

(SPC) are discussed. Common SPC tools for troubleshooting and monitoring a process including the process capability analysis are emphasized. Basic concepts and definition of reliability is also highlighted. The course provides the general concepts of quality, quality management systems and the applications of various techniques in statistical quality control (SQC) both in production and service industries.

SSCM3503 – Complex Variables

This course introduces calculus of functions of a single complex variable. Topics covered include the algebra and geometry of complex numbers, complex differentiation, complex integration, complex series including Taylor and Laurent series, the theory of residues with applications to the evaluation of complex and real integrals, and conformal mapping with applications in solving boundary value problems of science and engineering.

SSCP3523 – Modern Optics

The course introduces the fundamentals of modern optics. Elementary optics, ray optics, optical instruments, source and detector, interference and diffraction, image processing, laser, polarization and electromagnetic effects, fibre optics and integrated optics are discussed. Upon completion, students should be able to apply the concepts to solve problems related to optical phenomena. Students should have the ability to apply and use standard optical components including laser and fibre optics. Students should be able to explain the functions of various components in optical systems for various applications.

SSCP3613 – Quantum Mechanics I

This course introduces phenomena that lead to the development of quantum mechanics. Black body radiation, photoelectric effect, particle-wave duality, wave packets, Schrödinger equations, observable expectation values, quantum operator and postulates of quantum mechanics are discussed. One dimensional time independent Schrödinger equations for infinite and finite square potential well, potential barrier, harmonic oscillator, hydrogen atom are discussed. Basic concepts in quantum mechanics are described and the application of quantum mechanical approach in solving contemporary quantum mechanical problems are explained. The differences of quantum mechanics and classical mechanics are emphasized.

SSCP3811 – Practical Physics V

Students taking Practical Physics V will conduct two mini projects. They work in pairs, perform open-ended experiments and produce formal technical report of their work. The students will be supervised on one-to-one basis and are expected to develop ability to work independently. At the end of semester the student will present a short seminar which describes the project, its analysis and findings.

SSCP3821 – Practical Physics VI

Students taking Practical Physics VI will conduct two mini projects on physics based ICT. The students are required to develop ICT projects to solve problems related to physics. The students will be supervised by a supervisor, but they are encouraged to work independently. At the end of semester the student will present a short seminar which describes the project, its analysis and findings.

SSCU3905 / SSCU3915 – Industrial Training / Research Training

Industrial training or research training is viewed as an important training to expose students to real work life situation and to equip them with the necessary skills so that they would be job ready upon graduation. The students undertake a 12-week training at an organization or industry. During this training, the students will apply the knowledge learned in the university and boost their skills needed by a profession. The students will involve in hands-on use of instruments or quality control or statistical analysis and optimization techniques and other relevant skills. At the end of the training, the students should acquire basic skills in a professional manner and the experience gained during the training should enrich their generic skills.

SSCU4902 – Undergraduate Project I

A student is required to plan a project (research) under a supervisor in an agreeable field of physics and document the findings. Students will learn to gather information of the related topic through literature survey/review activities, construct research methodology, anticipate the expected results (if no data were obtained), and write conclusion and references. Finally, students are required to submit a research proposal comprising of the title, introduction, literature survey/review, research methodology, expected results and discussion, Gantt chart and references.

SSCU4904 – Undergraduate Project II

A student is required to execute a project (research) under a supervisor in an agreeable field of physics and document the findings. Students will learn to gather information of the related topic through literature survey/review activities, construct research methodology, perform the related experiments, collect the data, discuss the results, and make conclusions. Finally, it is compulsory for the students to submit a thesis, proceeding and present their work in an undergraduate symposium.

Elective Courses

SSCP3143 – Relativity

The course presents main concepts of general relativity theory. The emphasis is on the physical understanding of the theory and the mathematical development is kept simple. The principle of equivalence, energy momentum stress tensor, Einstein field equation and Schwarzschild solutions are discussed. Tests of general relativity are described. Black holes and gravitational collapse are explained. The course ends with description of gravitational waves and their detection.

SSCP3153 – Elementary Particle

This course is designed to expose student to understand the most fundamental components of nature using the quark model. Some topics of interest would be the structure, definition, flavor and the combination of quarks to form other particles. Classifications of particles and their interactions into a number of easily identifiable categories, and a number of empirical rules will also be studied. Interactions between particles will be dealt with in terms of the four types of forces and the exchange of particles between them. The conservation theory of various interactions in terms of lepton number, parity, charge conjugate and time reversal are covered. At the end of the course, the students are expected to understand

the unification theory of forces which incorporate the mechanics of the strong, weak and electromagnetic interactions into a single theory.

SSCP3163 – Energy and Environmental Physics

The course starts with a brief introduction on the processes and issues in environmental physics which include the global warming. The main topics are the physics of the built environment, energy for living, environmental health, revealing the planet, the biosphere, the global climate and climate change. The alternative sources of energy such as nuclear, wind and water are included. This course provides essential physics principles that govern environmental issues and the contribution to the interdisciplinary field of environmental science.

SSCP3333 – Computational Physics

This course begins with a comparative discussion about analytical and numerical methods of studying physical phenomena. The design of program codes and equivalent pseudo codes are discussed. Numerical methods for investigation of elementary mechanics problems such as projectile, oscillatory, planetary motions, and the chaos of non-linear pendulum are introduced. Calculation of potential surface, electric and magnetic fields, and visualization of the respective calculated data are also covered. Wave phenomena are investigated numerically. Methods for investigation of random system and Monte Carlo simulation are also studied. The course ends with an introduction to molecular dynamic simulation method and how to animate visualization of simulated system.

SSCP4013 – Data Processing

This course introduces the ways of expressing data from experiment and how to analyze and draw meaningful conclusions. Emphasis is on the usage of open source software packages. Measurement uncertainty, accuracy, precision, systematic and random errors, sources of errors, standard deviation and level of confidence, error propagation, and rejection of measurement using Chauvenet's criterion are discussed. Binomial, Gaussian, Lorentzian, and Poisson distributions are described. Student will be introduced to linear and non linear curve fitting techniques which include linear regression, multiple regressions, peak resolution and fitting, correlation coefficient and Chi-squared measure of fitting quality. Various methods of data visualisation will be highlighted. These include 2D plot, surface plot, vector plot, and plot animation. Student will learn to do drawing of scientific diagram, digital image manipulation, import and export of image files. Scientific data analysis software packages that are used include Gnuplot, Octave, Scilab, and Maxima.

SSCP4123 – Non Destructive Testing and Evaluation

The course introduces major non-destructive testing (NDT) methods such as penetrant testing, magnetic particle testing, industrial radiography and Eddy current testing. Discussion of their physical principles and the techniques used follows. Specific application techniques based on the methods are discussed in detail, focussing on parameters affecting the outcome of each NDT method. The applications of eddy current techniques in material inspection such as thin plates and tubes are described. In radiography, the parameters affecting the exposure and the radiograph quality are discussed. The codes and standards and their application to specific NDT methods are described. Acceptance criteria

applicable to specific requirements are also discussed. Safety aspects in NDT which include radiation and work safety are emphasized.

SSCP4133 – Industrial Electronics

The subject of industrial electronics is introduced. Discrete control, input and output devices, solid state devices in industrial electronics are described. Operational amplifiers and linear ICs. SCRs, triacs and other thyristors are discussed. Discrete automation sensors and devices, analog process control devices and sensors are highlighted. Other topics covered are safety, DC motors and control circuits, AC motors and variable speed drives, special purpose motor and control devices programmable logic controllers embedded microcontrollers, open and closed loop process control. The course provides the basic knowledge of electronic devices, motors and machines related to industrial applications and the working principle of common instruments in industrial applications.

SSCP4143 – Electronic Circuit Simulation

This course introduces students to the principle and the various techniques in electronic circuit simulation such as DC, AC, transients, and worst-case scenario analysis. The circuit simulation utilizes SPICE and QUCs circuit simulator packages. Noise and performance analysis, harmonic distortion and sensitivity analysis are also discussed. The course focuses on discrete passive and active electronic components. The course provides alternative way to experience circuit building and analysis without having to build real circuit.

SSCP4163 – Astrophysics

Students will be introduced to the concepts and methods of astronomy and astrophysics. Topics covered by the course include astronomical objects and their classification, measurements and units, astrophysical nature of radiation, orbital dynamics, stellar structure, and many body dynamics.

SSCP4173 – Quantum Mechanics II

The courses starts with discussion on quantum phenomena such as black body radiations, photoelectric effects, particle-wave duality and wave packets. Schrödinger equations, observable expectation values, quantum operator and postulates of quantum mechanics are discussed. One dimensional time independent Schrödinger equations for infinite and finite square potential well, potential barrier are examined and solved. Harmonic oscillator and hydrogen atom are described using operators. The students are expected to understand spin and Zeeman effect, perturbation theory and Stark effect. At the end of the course, the student should be able to solve some quantum mechanical problems. The students should also be able to work in a team and adhere to professional ethics.

SSCP4203 – Medical Radiation Protection

This course will give an overview on the various techniques and radiation doses involved in diagnostic radiology, radiotherapy and nuclear medicine. The current trends in use of diagnostic radiology, radiotherapy and nuclear medicine are surveyed. The relevant laws, regulations and procedures that need to be observed and be implemented for radiological protection in medical practice will be elaborated. At the end of the course, students should have an overall grasp on the operation of the medical radiological protection.

SSCP4213 – Advanced Nuclear Physics

This is a continuation of the introductory Nuclear Physics course. Some topics are repetition of the introductory course but would be dealt in more detail. The course begins with the discussion of the nuclear properties, followed by the quantum mechanics theory applied specifically to the different potential wells of the nucleus. Different aspects of nuclear forces are dealt with great length. The classical shell models of the nucleus are discussed in detail together with some other realistic nuclear models. The alpha emission, beta decay and gamma radiation will also be dealt. In addition the types of nuclear reactions, types and processes are included. The course ends with the introduction of nuclear energy production and nuclear astrophysics.

SSCP4223 – Radiation Detection

The important detection techniques of ionizing radiations are introduced. The discussion begins with introducing the principles of radiation detection related to radiation units, radiation sources and radiation interactions. Nuclear radiation detector parameters such as detector model, detector efficiency, energy resolution, counting curve and counting statistics are discussed. The principles of operation and basic characteristics of various detection systems are outlined. Various nuclear detectors such as gas filled detector, scintillation detector and semiconductor detector are described. The course also emphasizes on the principle and operation of thermal and fast neutron detector. The principle of radiation dosimetry such as thermoluminescent dosimetry, chemical dosimetry, film dosimetry and calorimeter are also discussed at the end of the course.

SSCP4233 – Radiation Protection

The course is designed to ground students in the principles of radiation protection, that is, on justification, optimization and dose limits. It emphasizes on the theories, the techniques and the procedures for external dose control that is the use of distance, shielding and time. Internal dose control, including introduction to the physics of aerosol, use of unsealed sources, primary and secondary containments, radioactive laboratories and leak tests are discussed. The course also discusses organization and radiation protection programmes, emergency procedures, monitoring, radiological protection in radiation devices, transport regulations and radioactive waste management. Upon completion, students should have an overall grasp of the radiation protection principles and practice and most importantly the safety culture required.

SSCP4243 – Applied Radiation Physics

This course is a follow-up of Nuclear Physics and is designed to expose student to different types of radiation that exist in nature and environment, in particular the nuclear based radiation. Primary and secondary, directly and indirectly ionizing radiation are differentiated. Interactions of alphas, betas, photons and neutrons with matter are detailed. Radiation effects on materials are discussed. Applications of radiation in radio tracing, gauging, dating, and industrial imaging are studied. Accelerator as sources of radiation and their usefulness is also covered. Upon completion student are expected to have good grounding in applied radiation physics and ability to explain and discuss the application of radiations in various fields.

SSCP4253 – Medical Physics

This course introduces medical physics to physics majors as an elective in their program. Three main areas of medical physics namely medical imaging, nuclear medicine and radiotherapy are surveyed. The emphasis is in the physics that govern the field. At the end of the course students are expected to have an idea of the subject matter, its usefulness and applications in modern medicine.

SSCP4263 – Occupational Health and Safety

This course is designed in such a way that the student understands the issues of health that are prevailed among workers. The concept of the relationship between work and health will be discussed in detail. Some of the relevant topics covered during the course will be the subject of toxicology, thermal stress and mental health. Students are required to know about the principles of epidemiology, ergonomics and health services related to work. This course prepares student to understand the management of occupational health through health education, health promotion program, management of risks as well as from the legislative point of views such as the safety and health act.

SSCP4273 – Nuclear Energy

The course starts with brief discussion on neutron physics related to production, absorption and scattering of neutron, neutron cross sections and nuclear fission. The principle of neutron moderation and neutron multiplication leading to steady state fission reactor core design based on diffusion theory are outlined. The principle of fusion reaction and energy production from controlled thermonuclear fusion is also briefly highlighted. The course provides general concepts of neutron physics and its application in nuclear reactor for energy generation.

SSCP4283 – Environmental Radiation Protection

This course introduces students to the theoretical basis of environmental radiological protection and the basic principles and procedures of radiological protection in medical practice. Sources of environmental radiation and its dosage implications will be elaborated. Environmental models for radionuclide dispersal will be introduced. Handling of TENORM will be discussed. At the end of the course, students should have an overall grasp on the operation of the environmental radiological protection. Transport regulation and radioactive waste management.

SSCP4293 – Radiation Dosimetry

This course introduces radiation dosimetry as an area of radiation physics. Principle of dosimetry, radiation dose, radiation units, fluence, kerma and absorbed dose will be discussed. Dosimetry techniques and measurements, Bragg-Gray cavity theory and stopping power are discussed. The working principles of standard air chamber, thimble chamber and its calibration for dose measurement are discussed. High energy photon and electron dosimetry are briefly outlined. Internal dosimetry of beta and gamma, and external neutron dosimetry are also studied. At the end of the course students are expected to have a working knowledge of radiation dosimetry.

SSCP4303 – Process Control

This course begins with discussion of process control of a system related to a production process, the criterion of control system for performance evaluation,

the piping and instrumentation drawing (P&ID) to process control system, the process control system responses, sensor time response – first order and second order response and the various aspects of digital control system. The process control characteristics and some aspects of digital process control are discussed. The course will be conducted by lectures and simple simulated hands-on to provide students with practical experience in process control.

SSCP4323 – Electronics and Instrumentations

The course begins with discussion of operational amplifier and its applications such as summing and differential amplifier, differentiator or integrator, and active filters. Basic elements in measurement systems, sensing element, signal amplification, signal conditioning, signal processing and signal presentation are introduced. Basic concepts and principles of digital circuits, number codes and number system, Boolean algebra, logic gates, Karnaugh maps, IC specification and interfacing are discussed. Finally analog to digital and digital to analogue conversion are covered. In general, the course will be conducted by lectures and hands-on to provide students with basic concepts and practical experience in advanced analog and digital electronics.

SSCP4333 – Digital Signal Processing

The course starts with the discussion on the breadth and depth of digital signal processing. Then students will learn about the mathematics essential to signal processing such as statistics, probability, complex number, matrices and polynomial. Analog to digital converter and digital to analog converter.

SSCP4353 – Ultrasonic Techniques

The course describes the physical principles of ultrasonic waves and its interactions with media leading to the application in defect detections of engineering components and systems. The discussion will highlight the transduction mechanisms, ultrasonic systems, and various ultrasonic application techniques ranging from low to high intensity applications.

SSCP4363 – Electronic Testing and Maintenance

The course provides the basic knowledge of how to test suspected electronic components and how to properly maintain and handle them during usage. The course starts with hazard and safety procedure in dealing with electricity. Basic electronic testing instruments such as digital multi meter, oscilloscope, and spectrum analyser are described. Common electronic problems such as short and open circuit, loading effect, ground loop, electrostatic discharge, electromagnetic interference, impedance mismatch are discussed. Testing basic discrete electronic components such as resistors, capacitors, inductors, diodes, transistors are covered. Common sensors such as thermocouple, Hall effect sensors, accelerometer and piezoelectric crystal are discussed. Upon completion, students will have basic skill to procure cost effective testing instruments, to use the equipments, to identify common electronic problems and to perform basic troubleshooting on basic components. The focus on safety will enable students to avoid electrical hazard.

SSCP4373 – Electronic Communications

This course introduces several process controls in industries. The process control characteristics and some aspects of digital process control are discussed. After

completing this course, the student are expected to be able to describe the various industrial process controls. The student must also be able to explain the techniques in digital process control.

SSCP4383 – Signal Processing

The course covers the continuous (analog) and discrete (digital) signal processing. Students are introduced to continuous and discrete systems. The focus will be on linear time invariant system. Laplace and Z transforms are discussed, followed by Fourier and discrete Fourier transforms. Finally students are taught to design the analogue and digital filters. Upon completion, students will have adequate background to explore the world of signal processing.

SSCP4393 – Computer Interfacing

This course introduces basic concepts and techniques for interfacing a microcontroller to external devices for data collection and process control and developing the related software required. This includes transferring and converting analog variables into the digital form needed for processing. It is aimed at students interested in data acquisition and real-time control systems.

SSCP4403 – Microscopy and Material Analysis

This is an introductory course on microscopic techniques that deals with the basic working principles and construction of various microscopes, namely, light microscope, electron microscope, x-ray microscope, acoustic microscope, field ion microscope, and scanning probe microscope. For each type of microscope, particular reference is given to the resolving power, sample preparation, and analysis of the micrograph. In general, this course provides the students with necessary knowledge on the choice of microscope for the study of materials.

SSCP4413 – Semiconductor Physics

The aim of this course is to provide basic knowledge and theory of semiconductor physics and introduction to semiconductor devices. It will start with the growth and doping of semi conducting materials. The energy band and carrier concentration in thermal equilibrium and carrier transport phenomena in semiconductor are studied. Discussion on the p-n junction and some selected diodes are made toward the end of the course.

SSCP4423 – Condensed Matter Physics

The course starts with the discussion on single electron model and Schrodinger equation, followed by the theory of a nearly free and tightly bound electron. The electron-electron interaction and the band structure are discussed. The dynamic theory of the electron transport is studied in detail. The knowledge is important for example in industry that deals with low temperature physics.

SSCP4433 – Magnetism

The course describes the fundamentals of magnetism, its discovery and its impact on civilisation and technology. The phenomenological and theoretical approach will be employed, beginning with a brief review on elementary magnetostatics and origins of magnetism, magnetic dipole, its response to an applied magnetic field and various interactions giving rise to different types of magnetic ordering in solids. It covers material's classifications: Diamagnetism, para-, ferro-, antiferro- and

ferrimagnetism, as well as relevant rules, laws, theoretical approaches: Hund's Rule, Curie's and Curie-Wiess law, Langavín and Stoner theories. Crystalline–electric field effects are treated at a level that is sufficient to provide the basic knowledge in understanding the properties of materials. Other topics include the techniques for magnetic field generation and measurements, magnetic materials and their various applications, such as in electrical and media devices. In general, the students should be able to understand phenomenon related to magnetism, distinguish between the class of magnetic materials and types of magnetism, their wide applications and technological advancements, and be able to perform basic calculations.

SSCP4443 – Magnetic Materials

The course covers fundamentals of magnetism, basic theories and applications of magnetic materials. It begins with a brief review on elementary magnetostatics and origins of magnetism. The basic theories describing ferro-, ferri-, para-, dia- and antiferromagnets will be outlined briefly. Properties such as anisotropy and magneto-optical effect are discussed in order to understand their applications. Finally, the students will be introduced to some novel magnetic phenomena and exotic magnetic materials with some modern device applications. The students will also undertake a written assignment to cover other related topics, such as in the field of space science, medicine, biology and agriculture.

SSCP4453 – Low Temperature Physics and Superconductivity

This course introduces basic knowledge of low temperature physics and many important properties of materials at low temperature regimes. Important aspects of the cryogenic world – the cryogens and cryophysics are introduced. Liquid helium and its important properties which are important in the cryophysics will be discussed in detail, followed by the techniques and methods of achieving low temperatures and measurement at low temperatures. Low temperature phenomena such as superconductivity and related theory are discussed. Basic properties of superconductivity will be discussed. Theories of superconductivity such as Gorter and Casimir theory, London theory, Ginzburg-Landau theory and BCS theory are introduced. The course ends with the discussion on high temperature superconductors.

SSCP4463 – Corrosion Science

This is an introductory course on corrosion science with emphasis on the electrochemistry and kinetics of corrosion. The areas covered are measurements and testing of corrosion, standard practices in corrosion prevention and inhibition, choices of materials and their environments, atmospheric corrosion, and metals oxidation. This course will provide students with general knowledge on corrosion mechanism and methods and ways of combating corrosion.

SSCP4473 – Spectroscopy and Material Analysis

The course starts with a basic concept of spectroscopy followed by the properties of electromagnetic waves. The interaction of electromagnetic radiation with matter is discussed. Basic instrumentation that is used in the spectroscopy is described. The spectrum and its intensity are discussed. Molecular vibration, microwave spectroscopy, infrared spectroscopy, Raman spectroscopy, NMR spectroscopy are highlighted. The course provides some knowledge on the

spectroscopy techniques for material analysis that are used mainly in material related industry.

SSCP4483 – Semiconductor Devices

This course is designed to focus on the semiconductor devices and material requirement for devising particular devices. It started with discussion on the growth, doping process, contact materials and properties of semiconductor. The study and discussion on the p-n junction and Schottky contact/diode will be a main objective of the subject. The basic principle, operation and material requirement of devices and introduction to micro and nano-materials and electronics will be given toward the end of the lectures.

SSCP4493 – Metallurgy

Solidification and crystallization, phase equilibrium diagrams, composition determination, steel hardening process, heat treatment of steel, welding process and types of welding, defects in welding, casting process and types of casting, forging process and defects in forging, types of oxidation formation, corrosion, corrosion protection, metallography testing, mechanical testing

SSCP4513 – Laser Physics

This course relates the principle of laser generation and its fundamental characteristics. It starts by discussing the rejuvenation of optics due to the invention of laser. This is followed by introducing the nature of light interaction with atom, Einstein relation, absorption and gain coefficient, laser mode, and laser beam modulation. Last but not least the laser light properties are highlighted and comparison is made with respect to conventional light.

SSCP4523 – Laser Technology

This course introduces the laser source and its application in industry. It covers basic laser, light interaction with atom, laser structure and generation, laser type. The laser sources have been applied in many areas including in industry and holography. In engineering the laser is used for material processing. Holography is used for quality control. Laser is used to drive fusion interaction. In military the lasers are used as a guidance and weapon.

SSCP4533 – Fibre Optic Technology

The course introduces the historical development and the importance of fibre optics in different applications. The parameters involved in the usage of optical fibres and the components of a fibre optic system will be described. Techniques of preparing an optical fibre will be discussed, including instruments used for preparation and measurement. The application of fiber optics in communication and sensing will be described and discussed. Upon completion, the students are expected to be able to describe the structure, material content and various characteristics of an optical fibre. The student should also be able to analyze the functional role of the various components of an optical fibre system for use in communication and sensing, and be able to describe the preparation and measurement techniques required.

SSCP4543 – Optoelectronics

This course is designed to expose the students to the present trends in optoelectronics and will be introduced to the basic concepts and working

principles in optoelectronic components and devices. The fundamental and functional of components in optoelectronic system are discussed, including the analysis of parameters essential in the design and applications of optoelectronic system. Students are expected to have the ability to explain the main concepts of optoelectronics as it emerges in wide range of physics especially light and optics. Students are expected to comprehend the working of various optoelectronic concept, components and devices, describe and discuss the functions of the components and analyze the parameters involved in the design and application of optoelectronic system.

SSCP4553 – Applied Optics

This course introduces the variety of applications related to optics. Optical design techniques, photometry, radiometry, application of laser optics, fibre optics components and optical systems are described and discussed. Upon completion, students should have the ability to make simple optical design using standard optical components including laser and fibre optics components. The students should also be able to explain the functions of various components in optical systems in various applications.

SSCP4563 – Photonics

The course introduces the various fields of study in photonics such as fourier optics, crystal optics, integrated optics, nanophotonics and biophotonics. The principles and parameters involved in the various fields of study will be described. The applications that have emerged from these studies such as in communication, sensing and imaging will be described and discussed. Upon completion, the student must have the ability to describe the models used in the various fields of study in photonics. The student should also be able to analyze the functional role of the various components and devices in different photonic systems, such as their roles in communication, sensing and imaging systems.

SSCP4573 – Laser In Medicine

This course introduces laser devices applied in medicine. It covers laser biophysics, nonlinear effect and photodisruption, mechanism of damage induced by Nd:YAG laser, laser tissue interactions, laser in eye surgery, laser in dentistry, laser acupuncture, low level laser therapy, digital holography. Lasers have been utilized in wide area of medical field.

SSCP4583 – Photometry

The course introduces basic concepts in photometry and various the photometric parameters involved. Photometric measurement procedures and instrumentation will be described. Fundamentals of colorimetry will also be discussed, including the CIE system used. Upon completion, the students are expected to be able to describe the various photometric parameters, measurement procedures and instrumentation related to photometry and colorimetry. The student should also be able to use photometry parameters in analyzing simple optical systems.

SSCP4593 – Solid State Laser Engineering

This course describes the design and construction of solid state laser. This includes the design of optical resonator, which cover the transverse modes, longitudinal mode, intensity and frequency control, hardware design, unstable resonator and wavelength selection. To pump the laser, various pump sources are discussed. The

pump radiation transfer methods are also described. To stabilize the laser, the effect of thermo-optic is considered. Finally the laser beam is modulated by Q-switch and mode locked.

SSCP4603 – Vacuum and Thin Film Technology

Conductance and throughput. Vacuum gauges and pumps. Nucleation, physical vapour deposition, chemical vapour deposition, characterization measurements, properties – structural, optical, electrical and magnetic, novel properties – quantum effect, giant magnetoresistance, thin film solar cells, layered magnetic nanostructures - GMR sensors, single-electron devices.

SSCP4623 – Material Science

This course introduces basic and important properties of materials. This includes material structures and defects that determine the vital properties such as its mechanical, electrical or optical properties. Students are also taught the important parameters of materials characteristics and methods of testing these parameters. In general this course provides the relationship between the required properties and materials processing to suit certain product application

SSCP4633 – Ceramic and Amorphous Materials

The course starts with a brief introduction on the amorphous and ceramic materials, the formation theory and thermodynamic approach. Their preparation techniques will be given consequently. The microscopic and the macroscopic structure of amorphous and ceramic materials which include the bond and the imperfections are discussed. The physical, mechanical, optical and the electrical properties will be emphasized. The chemical durability of amorphous will be attentively highlighted. In general, the course provides some knowledge on the amorphous and ceramic materials and their characterization that are useful in the glass and ceramic industry.

SSCP4643 – Polymeric Materials

The course starts with basic concept of polymer and degree of polymerization. The classification of polymer will then followed. Preparation techniques and crosslinkages are studied. The crystallinity, amorphousity and the morphology of the polymer are highlighted. The mechanical, physical and thermal properties will also be presented. In general, the course provides some knowledge on the polymeric material and their characterization that are useful in polymer industry.

SSCP4713 – Introduction to Nonlinear Optics

This course describes the interaction of laser with nonlinear materials. It starts with interaction of photon and atom, followed by discussion of laser operation, laser oscillation, electro-optic, and introduction to non linear optic. The nonlinear process includes second harmonic generation, parametric and phase conjugation. Finally, the solitary wave in dispersive media for generating ultra-short pulse is discussed.

SSCP4913 – Radiobiology

This course introduces students to the theoretical basis and the model of the biological effects of radiation. Physical, chemical and cellular perspectives will be elaborated. It will examine the macroscopic effects of radiation, be it deterministic, somatic, stochastic or genetic. The course will also discuss the effects

of ingested radionuclide and the various models involved in it, radiation ecology and the effects of non-ionizing radiations. At the end of the course, students should be able to make informed judgments on the short and the long-term health physics and radiological protection implications of a radiation exposure.

SYNOPSIS OF CHEMISTRY COURSES

SSCC 1633 Organic Chemistry I

This course discusses the fundamental concepts in organic chemistry which includes structures and properties of organic molecules and the basic of organic chemical reactions. It will also emphasise on the three-dimensional structures and fundamental concepts of stereochemistry. Several functional groups will be discussed consists of aliphatic and aromatic hydrocarbons. For each functional group, students will be introduced to the structures and the nomenclature, physical properties, preparations, reaction, visual tests, relevant inter-conversion reactions and related reaction mechanism.

SSCC 1821 Organic Chemistry Practical I

This course comprises several laboratory experiments related to organic chemistry. The basic laboratory skills of recrystallization, extraction, separation, refluxing and distillation will also be emphasized. Upon completion, students should be able to perform experiment, to synthesise selected organic compounds, analyse the data obtained and produce scientific report.

SSCC 1713 Main Group Elements

This course introduces the basic concepts of inorganic chemistry, focusing largely on the structure, reactivity and periodicity of inorganic substances of the main group elements. The course also teaches the systematic survey of the descriptive inorganic chemistry of the main group elements, including industrial applications and practical uses of important classes of inorganic compounds.

SSCC 1851 Inorganic Chemistry Practical I

This course introduces the basic concepts and skills in inorganic chemistry practical. The experiments are focused on physicochemical properties of elements and compounds of Group IA, Group IIA, Aluminium, Nitrogen, Sulphur and Halogen. This course also exposes students to basic skill of handling chemicals and preparing solution.

SSCC 1313 Occupational Safety, Health and Environment

The emphasis of this subject is to inculcate awareness culture for an improved safety and health working attitudes on the students. The fundamental concept and theory related to laboratory organization and design, material, human, chemical managements, safe practices in laboratories, storage, inventory control and international standard for documentation will be introduced, discussed, with actual case scenarios. Students are expected to be able to construct, plan, defend, suggest, evaluate and criticise various angles of the subject and apply them in related cases or incidents. Understanding Factories and Machinery Act 1967 and Occupational Safety and Health Act 1994 is a must.

SSCC 1881 Basic Laboratory Skills

This course introduces basics laboratory skills required for undergraduate chemistry experiments. This course consists of three main components; proper handling of glassware and laboratory apparatus, preparation of stock, standard and buffer solutions, separation and purification of organic and inorganic compounds using thin-layer chromatography and crystallization methods.

SSCC 1203 Analytical Chemistry

This course discusses general analytical techniques, data analysis and classical analytical methods. The topics include introduction to chemical analysis, sampling, sample preparation, data analysis, quantitation and calibration methods, method validation, gravimetric analysis and volumetric analysis.

SSCC 1861 Analytical Chemistry Practical I

The course introduces students to Good Laboratory Practices in classical (wet chemistry) methods. Experiments include gravimetric and volumetric techniques. Part of the course consists of a mini project.

SSCC 1643 Organic Chemistry II

This course is a continuation of Organic Chemistry I (SSCC1633) which discusses other functional groups in organic compounds. These consists of alcohols, phenols, ethers, epoxides, aldehydes, ketones, carboxylic acids and amines. For each functional group, students will be introduced to the structures and the nomenclature, physical properties, preparations, reaction, visual tests, relevant inter-conversion reactions and related reaction mechanism. Infrared spectroscopy will also be included as a technique in characterizing the functional groups of organic compounds.

SSCC 1891 Organic Chemistry Practical II

This course introduces students to the techniques and knowledge required in the preparation of isomeric compounds, derivative of glucose, azo dyes and the isolation, purification and reaction of lipid. Students will be exposed to the infrared spectroscopic technique as a tool to determine the functional groups of the synthetic and isolated compounds.

SSCC 1323 Information Literacy

This course presents efficient internet search strategies, productivity and online chemistry resources, social media, in addition with relevant use of several spreadsheets and software packages for chemistry students. Topics discussed include online information resources, spreadsheet, data analysis, structure drawing, database searching for properties, spectral, crystallographic and safety information, chemistry software packages, computer security and ethics.

SSCM 1023 Mathematical Methods 1

The course revises and extends Matriculation and STPM topics such as differentiation and integration towards hyperbolic and trigonometric inverses. Applications in computing arc length and area of surfaces of revolution are also included. Other topics covered are improper integrals, parametric equations, polar coordinates, sequence, and series. This later topic serves as an introduction to three-dimensional calculus which students will learn in Mathematical Methods II. It is hoped that upon completion of the course, students should have acquired some firm basic tools to pursue further mathematics.

SSCC 2223 Spectrometric Methods of Analysis

This course introduces the principles, instrumentation and applications of spectroscopic methods used in analytical chemistry. Emphasis is on ultraviolet-visible spectroscopy, fluorescence spectroscopy, atomic absorption spectroscopy, atomic emission spectroscopy, inductively coupled plasma-atomic

emission spectroscopy and inductively coupled plasma-mass spectrometry. Sample preparation of organic and/or inorganic analytes is also discussed.

SSCC 2871 Analytical Chemistry Practical II

The subject introduces students to laboratory work related to instrumental methods of analysis. Experiments include techniques in ultraviolet-visible spectroscopy, atomic absorption spectroscopy, fluorescence spectroscopy and atomic flame emission photometry.

SSCC 2413 Chemical Thermodynamics

The course is an introduction to chemical thermodynamics, and provides an understanding of the basic principles, laws and theories of physical chemistry that are required for chemistry. You will use mathematical equations to describe physical phenomena and solve problems quantitatively. The course begins with a topic on Gases, which include the properties and equation of states of ideal and real gas, virial equation and principle of corresponding states. The next topic will emphasize on Chemical Thermodynamics: Basic concepts of thermodynamics – State functions, heat, enthalpy, internal energy, Gibbs free energy, Helmholtz free energy, heat capacity, First, Second and Third Laws of thermodynamics and Zeroth law of thermodynamics. Topics on Chemical Equilibria will focus on chemical potential and phase equilibria which include the phase rule and phase diagram of single component system. The final topic will cover Solutions: Compositions, partial molar quantities, ideal solutions, ideally dilute solutions and non-ideal solutions.

SSCC 2831 Physical Chemistry Practical I

This course is designed to increase and strengthen students' understanding on the concepts and principles in Chemical Thermodynamics through experiments conducted in the laboratory. The experiments selected for the course illustrate concepts explored in the Chemical Thermodynamics lecture, enable students to test the relation of theories with experiments, learn experimental methods used by physical chemist, develop laboratory skills and the ability to work independently, learn how to effectively present scientific results and appreciate the limitations inherent in both theoretical treatments and experimental measurements.

SSCC 2463 Quantum Chemistry

This course discusses the fundamental principles and techniques of quantum mechanics and the applications in describing atoms and molecules. This course introduces the need for quantum theory and key ideas in quantum mechanics. It continues with the examples of quantum systems such as a particle in a box, quantum harmonic oscillator, rigid rotors, and hydrogen-like atoms. Approximation techniques such as perturbation theory, variational method, Huckel theory, and valence bond and molecular orbital theories will also be discussed to describe properties of many-electron atoms and molecules.

SSCC 2653 Polymer Chemistry

This course is designed as an introduction to polymers chemistry for undergraduate students which covers the basic principles of polymer chemistry and the characterisation methods of polymers. Topics covered in this course include nomenclatures, polymer synthesis (chain-growth and step-growth polymerisations), polymerisation mechanisms and polymerisation kinetics related

to degree of polymerization and molecular weight control and molecular distributions. In term of physical aspect of polymers, this course deals with polymer morphology, polymer solubility, physical characterisation of polymers, and polymer rheology. A short special topic on current trendy polymeric materials and current issues is also discussed and presented as a presentation.

SSCC 2713 Coordination Chemistry

This course introduces the different types of ligands used in coordination chemistry and how their different modes of coordination lead to isomerism. The systematic way of naming metal complexes will be outlined. The different ideas on bonding in metal complexes will be discussed and this will help students to understand the advantages and limitations of each theory. The substitution mechanistic pathways of metal complexes and its kinetics and how this mechanism is determined experimentally are illustrated. The electronic spectra and colour properties of the metal complexes will be explained. Spectroscopic characterization techniques of coordination compounds are also covered.

SSCC 2851 Inorganic Chemistry Practical II

The emphasis of this course is to provide the students with an appreciation for the synthesis and characterizations of coordination compounds. It is also aimed to provide the students with a degree of competence in the laboratory skills required for accurate and precise chemical analysis. The experiments selected for this course include developing skills in the synthesis and isolation of coordination compounds or metal complexes with different kinds of ligands followed by characterization by conventional methods such as gravimetry, titrimetry and melting point, including characterization techniques used by coordination chemists such as UV-visible, NMR and FTIR spectroscopies. The principles of the spectroscopic methods are described and discussed with respect to their respective spectral outputs and interpretation obtained from the as-synthesized coordination compounds.

SSCC 2453 Chemical Kinetics and Electrochemistry

This course discusses the fundamental and application of chemical kinetics and electrochemistry. The chemical kinetics includes the rate and mechanism of reactions, order of reactions, rate laws and the comparison of theories with experiments for simple gas reactions, reactions in solution, complex reactions, homogeneous catalysis, chain reactions and rapid reactions. The electrochemistry includes the electrolyte conductivity, theory on conductivity, activity, transport numbers, electrochemical cells and electrode processes and kinetics. Students will show the ability to respect a diversity of team members and work well together when solving industrial problem related to electrochemistry.

SSCC 2841 Physical Chemistry Practical II

This course is designed to increase and strengthen students' understanding on the concepts and principles of Chemical Kinetics and Electrochemistry through experiments conducted in the laboratory. This course allows students: to illustrate concepts learned in the Chemical Kinetics and Electrochemistry lectures through experimental works; to relate the experiments with related theories; to develop and enhance experimental and laboratory skills; to work independently, and also to work in a team; and to learn and hence present scientific results effectively to

appreciate the limitation exist in both theoretical treatments and experimental measurements

SSCC 2213 Environmental Chemistry

This course introduces the students to the environmental consequences of human activities and methods of minimizing their impacts through understanding of processes and technology. Ecological concepts and ecosystem process. Water chemistry in natural water system; water pollution prevention and water quality requirement. Water treatment: Water sources and their quality. Conventional water treatment unit operations: Sedimentation, coagulation, flocculation, filtration, disinfection. Advanced water treatment processes. Waste water characteristic and treatment: Primary treatment and Secondary Treatment system. Sedimentation and sludge treatment.

SSCC 2233 Industrial Environmental Chemistry

This course introduces the students to the environmental consequences of human activities and methods of minimizing their impacts through understanding of processes and technology. Ecological concepts and ecosystem process. Water chemistry in natural water system; water pollution prevention and water quality requirement. Water treatment: Water sources and their quality. Conventional water treatment unit operations: Sedimentation, coagulation, flocculation, filtration, disinfection. Advanced water treatment processes. Waste water characteristic and treatment: Primary treatment and Secondary Treatment system. Sedimentation and sludge treatment. Air Pollution and the Atmosphere. Air Pollutants: Sources, Effect on human and the environment. Control of air pollution.

SSCC 2473 Molecular Spectroscopy

The emphasis of this course is to expose the students to the fundamental principles of molecular spectroscopy focusing on molecular energy levels and their interaction with electromagnetic radiation, spectral outputs and their interpretation in relation to molecular structure. The branches of spectroscopy covered include rotational spectroscopy, vibrational spectroscopy (IR and Raman), electronic spectroscopy (absorption and emission) and spin resonance spectroscopy (NMR and ESR). The general spectrometer components and the requirements for high resolution spectrum of FTIR and FT NMR will be discussed to represent the practical aspects of this subject.

SSCU 2622 (Equivalent to SSCU 3622) Research Methodology and Information Retrieval (HW)

This course teaches the students on principles of research methodology and information retrieval. Topics include research philosophy and objectives, literature study and review, choosing and defining research problems and design, preparing and writing research proposals, technical report writing (the elements of technical writing), types of technical report writing, dissertation writing, public speaking (preparation and presentation) and information retrieval (search strategies). Presentation of assignment is also an important component in this course.

SSCC 2663 Polymer Processing

This course is designed as an introduction to polymer chemistry for undergraduate students which covers the basic principles of polymer chemistry and the polymer processing methods. This course covers nomenclatures, reaction of monomers to form polymers by chain-growth and step-growth polymerisations, diene polymerisation and kinetics related to degree of polymerization and molecular weight control and molecular distributions. In addition, introduction to processing methods used to process polymeric components will be discussed. Discussion of the concepts and principles of basic thermoplastic processing methods with emphasis on their practical applications in industry. Topics covered will include polymer extrusion, casting, molding, thermoforming, spinning, calendaring, coating processes, materials selection, and manufacturing process selection. The course is concluded with the application and properties of polymer product which consists of industrial standards, failure and damage analysis of polymer.

SSCC 3243 Separation Methods

This course introduces the basic principles, instrumentation and focused on applications of separation methods commonly used in chemical analysis. A general overview and classifications of common separation methods is first given followed by their basic principles of separation. Major separation methods and their applications discussed include extraction, chromatography and electrophoresis. Industrial scale analytical separations will also be briefly introduced.

SSCC 3643 Application of Spectroscopy

This course discusses the theory and application of infrared (IR), nuclear magnetic resonance (NMR), ultraviolet (UV) spectroscopies and mass spectrometry (MS) for structural determination of organic compounds. In addition, elemental analysis for determination of molecular formula and index of hydrogen deficiency will be discussed.

SSCC 3443 Chemical Reactions Process

This course is designed to discuss the basic principles involved in chemical reactions processes. It involves dimensional analysis, material and energy balance, basic unit operations, basic separation processes and process control. Dimensional analysis stresses on the basic units, dimensions, conversions of units which usually applied in scientific and engineering calculations. Material and energy balance discuss the fundamental calculations in non-reactive and reactive systems as well as recycle, bypass and purge on chemical processes. Basic unit operations and separation processes include type of reactors, heat exchanger, distillation, absorption and filtration processes. Process control discusses the process flow, flow-diagram and automation in chemical industries.

SSCC 3373 Quality Management System

The emphasis of this subject is to inculcate and immerse fundamental concept and theory related to laboratory organization, management of resources, inventory control, budgeting, contracts, laboratory design, product specifications, material sourcing, vendors, and auditing. All management systems are based on local and global market needs based on selected major industries. Students are expected to be able to construct, plan, defend, suggest, evaluate and criticize various angles of the subject and apply them in related cases. Quality Laboratory

System, accreditation process and validation process will be highlighted. Common QMS systems such as ISO17025, ISO 9001, 9002, 45000, 22000, series, HACCP, SEDEX, RSPO, MESTI, subcontracting analysis processes such as HALAL, KOSHER analysis, and other related issues will be discussed. Lab Information Management System(LIMS) will also be introduced.

SSCC 3603 Medicinal Chemistry

This course discusses the general principles of medicinal chemistry with emphasis on the molecular interaction of drugs with biological systems. The functional groups commonly found in drugs are reviewed with respect to their nomenclature and chemical reactivity. The absorption and metabolism characteristics are then related to the physicochemical properties of these functional groups. The theories and principles of drug-receptor interactions and drug design are presented, as well as the general principals of drug metabolism. To illustrate current drug developments, this course will utilize examples from chemical biology, bioorganic chemistry and drug design.

SSCC 3673 Industrial Organic Chemistry

The course is intended to expose the students to organic chemicals in industries. The scope includes the organic chemicals used in foods, pharmaceuticals, cosmetics, agro-based industries, petroleum and polymers. The synthesis and analysis of some selected chemicals will be discussed. The course will involve industrial chemicals such as flavours and fragrances; vitamins; antioxidants; dyes and colouring materials; common drugs including antibiotics, anti-inflammatory, anticancer, antihypertensive and antidepressant; soaps and detergents; insecticides, fungicides and pesticides. Basic knowledge and uses of phytochemicals from herbs and spices will be introduced. In addition, general industrial chemicals for petroleum and polymers will be included. Students will be exposed to leadership, autonomy and responsibility attributes in group assignment related to industrial organic chemistry.

SSCC 3773 Inorganic and Organometallic Polymers

The course is intended to give an understanding of the basic principles of inorganic and organometallic polymers. It will emphasise on the physical properties, chemical synthesis, the characterisation and practical applications of the polymers. All the major inorganic and organometallic polymers such as polyphosphazenes, polysilanes, polysiloxanes, polyferrocenes and other polymers will be dealt with. Structural build-up of dendrimers and metal organic framework will also be discussed.

SSCU 3902 Undergraduate Project I

Students are required to execute a project (research) under an identified supervisor in an agreeable field of chemistry and document their findings. Students will learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate expected results, write current findings, and references. Finally, students are required to submit a research proposal and a draft project/research report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Expected Findings, Conclusion and References. This course will address Sustainability and Development Goals (SDGs) in particular SDG 4 that focus on obtaining a quality education is the foundation

to improving people's lives and sustainable development, SDG 5 that focus on Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world and SDG 10 that focus on reducing the inequalities, policies should be universal in principle, paying attention to the needs of disadvantaged and marginalized populations.

SSCC 3543 Modelling and Simulation

This course is an introduction to some of the techniques used in computational chemistry, and to illustrate how this technique can be used to study physical, chemical and biological phenomena in pharmaceutical. Molecular modellers use quantum mechanics, molecular mechanics, minimisation, simulations, conformational analysis and other computer-based method for understanding and predicting the behaviour of molecular systems. Emphasis is to train students to be able to study organic/inorganic chemistry related problems via computational tools. Wide variety of methods will be focused that can be used, either individually or in combination to select compounds with targeted properties that shall assist in chemistry application.

SSCC 3493 Surface and Colloid Chemistry

This course introduces the fundamentals and application of surface and colloid chemistry. The fundamental concept of different types of surfaces and interfaces are discussed to better understand surface phenomena including physical and chemisorption processes, classification of adsorption isotherm, capillary rise, wetting and spreading. For colloidal and emulsion systems, the course discusses the classification, mechanism of formation, stability and instability phenomena. Throughout this course, students will encourage to work together with their peer in order to understand and apply the knowledge in chemical industries and daily life.

SSCC 3653 Organic Synthesis

This course discusses the interconversion of various functional groups and the formation of C-C bonds; which represent two crucial areas in organic synthesis. Students will be introduced to the use of protecting groups and oxidation/reduction in the synthetic methodology. The retrosynthesis approach in organic synthesis will also be elaborated. Specific topic on carbonyl functionalities will be discussed which highlight the related condensation reactions. Further discussion on special topics consists of rearrangement, pericyclic, asymmetric synthesis and metal-catalysed reactions will be emphasized. Throughout the course, the usefulness of the synthetic methods will be related with their applications in various research and industry. Upon completion, the students should be able to plan synthetic strategy and pathway using both functional interconversion and C-C bond formation.

SSCC 3433 Solid State Chemistry

This course exposes students to solid state chemistry beginning with introduction to simple crystals structures, symmetry, lattices and units cells, crystalline solids, and lattice energy. Following this, the main topic discussed include X-ray Diffraction and its use in solving single crystal structures; various preparative methods in solid states; bonding in solids states and electronic properties and electronic conductivity in simple metals, semiconductors and doped semiconductors; defects and non-stoichiometry; ionic conductivity in solids, solid electrolytes; non-

stoichiometric compounds and electronic properties of non-stoichiometric oxides; application of physical techniques in characterization of inorganic solids; optical properties of solids; magnetic and dielectric properties of materials; phase diagram and its interpretation; relationship between structure, physicochemical and mechanical properties of materials including zeolites and related structures.

SSCC 3563 Instrumentation Competency

This course develops the student's competency in operating instrumentation that may enhance graduate employability. The instruments operated on are those that are commonly found in industries and research institutions. This course will review the fundamental theory and concepts of chemistry and the related instrumental techniques. The students would acquire the skills to operate the software, basic operation of running samples with the appropriate trouble shooting and maintenance. Standard methods for sampling, sample preparation and sample analysis that includes standard solution preparation and data evaluation will be introduced and applied to samples of various matrix. Students will work in small groups in undertaking projects that may relate to real industrial problems and activities.

SSCC 3363 Green Chemistry

This course introduces students to the principles and application of Green Chemistry which was developed based on historical cases and current research. Topics include the twelve principles of Green Chemistry, evaluation methods for environmental and human health impact, alternative reagents in designing safer reactions and chemicals, green chemical synthesis, green chemical products, and economic advantages to Green Chemistry. Real-world cases in green chemistry will be used to illustrate the goals of Green Chemistry.

SSCC 3003 Chemistry of Biomolecules

This course introduces the chemical structures, functions and importance of four main main biomolecules in nature, i.e carbohydrates, proteins, lipids and nucleic acid. The course include classifications, physical properties and reactions of the building units such as amino acids and monosaccharides and how they are connected to form the biomolecules. It also include discussions on applications of biomolecules in our life.

SSCC 3763 Nanochemistry

The objective of this course is to provide a broad foundation of understanding nanochemistry in the field of nanotechnology, so that students are prepared to continually learn about this emerging field. This course mainly focuses on the synthesis and fabrication of nanostructures and nanomaterials. Size effect on some special properties of nanomaterials will also be discussed. Different methods of synthesis, fabrication and characterization techniques will be highlighted. Examples of application of these materials in several fields will be deliberated. Based on this knowledge, students can have ideas about controlling physicochemical properties of nanomaterials to solve the specific issues that give significant impact to the society.

SSCC 3733 Nuclear Chemistry

This course discusses on the fundamentals of nuclear structure including the radioactivity and nuclear processes. Quantitative aspect of radioactivity such as

rates of nuclear decay, half-life, measurements and detection will be covered. Some aspects of nuclear reactor design, nuclear energy generation, nuclear fuel reprocessing and nuclear waste management and disposal will be highlighted.

SSCC 3203 Extraction and Chromatographic Techniques

This course is designed to discuss the basic principles involved in chemical reactions processes. It involves dimensional analysis, material and energy balance, basic unit operations, basic separation processes and process control. Dimensional analysis stresses on the basic units, dimensions, conversions of units which usually applied in scientific and engineering calculations. Material and energy balance discuss the fundamental calculations in non-reactive and reactive systems as well as recycle, bypass and purge on chemical processes. Basic unit operations and separation processes include type of reactors, heat exchanger, distillation, absorption and filtration processes. Process control discusses the process flow, flow-diagram and automation in chemical industries.

SSCC 3423 Industrial Chemical Process

This course is designed to discuss the basic principles involved in chemical industrial processes. This includes basic concepts and representation of chemical reactions. Thermodynamics and kinetics of chemical reactions. Yield, selectivity, and kinetics of complex reactions. Adsorption, desorption and kinetics of catalytic reactions. Diffusion and reaction of gas-solid catalytic reactions. Mass and energy balances of chemical reactor design.

SSCC 3293 Radioanalytical Chemistry

This course focuses on the principles of radioactivity and their applications in analytical chemistry including use of radiotracers in quantitative work. Error in techniques used will also be covered. Some of the analytical approaches discussed are isotope dilution analysis; radiometric titrations including selection of radiotracers. Some techniques of using radiotracers such as liquid scintillation techniques, its principles and applications will be discussed. Other related techniques include radioimmunoassay, neutron activation analysis, radiocarbon dating and geological chronology, radiochromatography and Mossbauer spectroscopy. Some industrial applications in industry will also be covered.

SSCC 3133 Liquid Crystals

This course focuses on the principles of radioactivity and their applications in analytical chemistry including use of radiotracers in quantitative work. Error in techniques used will also be covered. Some of the analytical approaches discussed are isotope dilution analysis; radiometric titrations including selection of radiotracers. Some techniques of using radiotracers such as liquid scintillation techniques, its principles and applications will be discussed. Other related techniques include radioimmunoassay, neutron activation analysis, radiocarbon dating and geological chronology, radiochromatography and Mossbauer spectroscopy. Some industrial applications in industry will also be covered.

SSCC 3553 Computer-Aided Chemistry

This course introduces the application of computer methods in chemistry. Topics discussed include regression analysis, multivariate calibration, pattern recognition, experimental design and optimisation, handling of chemical structures, chemical databases, molecular modelling, and artificial intelligence. Applications of these

methods in data analysis, structural searching, prediction of properties and drug design are discussed.

SSCC 3253 Food Analysis

This course is designed to provide students with an understanding of the principles and procedures for the analysis of chemical components of food. Introduction of food chemistry, food regulations, international standards and guidelines, sample handling and preparation of data collection, reporting and analysis of data are included. Sample local case will also be studied. Key analytical and separation techniques will also be discussed, including food microbiological testing, proximate analysis, rapid techniques, and relevant modern techniques. Students will also be exposed to industrial practices in handling food analysis, according to Food Act 1983, Food Analyst Act 2011 and Regulations, Codex Alimentarius, AOAC International, American Oil Chemists' Society (AOCS), American Association of Cereal Chemists, AACC, American Public Health Association (APHA), etc. At the end of the course, students are expected to fully understand and apply the knowledge in real scenario and its application in cottage industries, small and medium enterprises, as well as global players.

SSCC 3143 Interfacial Chemistry

This course introduces the fundamentals and application of surface and colloid chemistry. The fundamental concept of different types of surfaces and interfaces are discussed to better understand surface phenomena including physical and chemisorption processes, classification of adsorption isotherm, capillary rise, wetting and spreading. For colloidal and emulsion systems, the course discusses the classification, mechanism of formation, stability and instability phenomena. Throughout this course, students will encourage to work together with their peer in order to understand and apply the knowledge in chemical industries and daily life.

SSCC 3573 Industrial Instrumentation Competency

This course develops the student's competency in operating instrumentation that may enhance graduate employability. The instruments operated on are those that are commonly found in industries and research institutions. This course will review the fundamental theory and concepts of chemistry and the related instrumental techniques. The students would acquire the skills to operate the software, basic operation of running samples with the appropriate trouble shooting and maintenance. Standard methods for sampling, sample preparation and sample analysis that includes standard solution preparation and data evaluation will be introduced and applied to samples of various matrix. Students will work in small groups in undertaking projects that may relate to real industrial problems and activities.

SSCC 3273 Forensic Science

This course introduces forensic science and the legal aspects. The roles of forensic scientist as crime scene investigator to laboratory analyst and finally as an expert witness in court are highlighted. Forensic analyses of paints, glass, hairs & fibres, fire debris and explosives, question document, drugs of abuse, blood, semen and saliva are covered in this course.

SSCC 3663 Natural Product Chemistry

This course introduces the fundamental concepts of natural products chemistry. The biosynthetic pathway of the secondary metabolites such as terpenes, flavonoids and alkaloids will be discussed. Isolation, classification and structural identification of terpenes, flavonoids and alkaloids will be covered. Reaction and synthesis associated with these compounds will be further examined.

SSCC 3013 Organic Chemistry-Biomolecules

This course introduces the chemical structures, functions and importance of four main main biomolecules in nature, i.e carbohydrates, proteins, lipids and nucleic acid. The course includes classifications, physical properties and reactions of the building units such as amino acids and monosaccharides and how they are connected to form the biomolecules. It also includes discussions on applications of biomolecules in our life.

SSCC 3753 Catalytic Chemistry

This course introduces students to the role of catalysts in chemical processes. Kinetics and reaction mechanism of catalysed reactions and structural aspects of catalysts will be highlighted. Emphasis is on the factors that influences catalysts reactivity in both homogeneous and heterogeneous catalysis. Different methods of preparation and characterization of catalytic materials and the underlying principles with regard to industrial application of the catalyst will be discussed. Upon completion, students should be able to develop and apply knowledge in explaining the principles of catalysis in industrial processes, identify methods of preparing and characterizing catalysts such as supported metal catalysts, zeolites and metal oxides.

SSCC 3353 Consumer Chemistry

This course discusses on the fundamentals of nuclear structure including the radioactivity and nuclear processes. Quantitative aspect of radioactivity such as rates of nuclear decay, half-life, measurements and detection will be covered. Some aspects of nuclear reactor design, nuclear energy generation, nuclear fuel reprocessing and nuclear waste management and disposal will be highlighted.

SSCU 4904 Undergraduate Project II

Students are required to execute a project (research) under an identified supervisor in an agreeable field of chemistry and document their findings. Students will learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate results, analyze findings, draw conclusion, write references, and to suggest further research. Finally, students are required to submit a proceeding and a project or research report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Analysis of Findings, Conclusion, and References. This course will address Sustainability and Development Goals (SDGs) in particular SDG 4 that focus on obtaining a quality education is the foundation to improving people's lives and sustainable development, SDG 5 that focus on Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world and SDG 10 that focus on reducing the inequalities, policies should be universal in principle, paying attention to the needs of disadvantaged and marginalized populations.

SSCC 4713 Energy Materials

This course introduces how many active researches are directed towards materials used in conventional energy applications, as well as materials and material combinations for possible future energy systems. In both of these areas, control and fundamental understanding of the chemistry are of paramount importance for the design of new energy-related materials.

SSCC 4693 Metabolism of Biomolecules

This course discusses the metabolism of biomolecules such as carbohydrates, lipids and proteins. Discussion includes catabolism and anabolism for each biomolecule. Production of ATP from biomolecules based on Chemiosmotic theory will be discussed. Inborn errors of metabolism related to specific biomolecules will be highlighted.

SSCC 4633 Heterocyclic Chemistry

This course discusses the concept of heterocyclic and heteroaromatic compounds which include six membered heteroaromatic: pyridine and derivatives; Five membered heteroaromatic: pyrrole, furan and thiophene; Fused-ring heterocyclic: indole, quinoline and isoquinoline. In each topic, the students will be introduced to the structures, properties, reactivity, synthesis, and reactions of these heterocyclic compounds.

SSCC 4113 Thermal Chemistry

This subject is designed to provide students with an understanding of the principles and application of thermal analysis methods. Key thermal analysis methods such as Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) are discussed, including instrumental system, factors affecting measurements, and the effect of sample properties on thermograms. Other thermal analysis methods discussed include microthermal and thermomechanical methods. Discussions will also cover interpretation of thermograms and application of the various thermal analysis methods.

SSCC 4263 Electroanalytical Chemistry

This course is designed to provide students with an understanding of the principles of analytical electrochemistry. Fundamental aspects of electrode reactions and structure of the interfacial region and application of electrode reactions to electrochemical characterization are included. Electroanalytical techniques including polarography, cyclic voltammetry, pulse, differential pulse voltammetry and stripping analysis will be included. Principles of potentiometric measurements including chemical and biochemical sensors will also be discussed. Students will also carry out practical work using at least one instrument such as voltammetry techniques for metal ions study.

SSCC 4533 Applications of Computer in Chemistry

This course introduces the application of computer methods in chemistry. Topics discussed include regression analysis, multivariate calibration, pattern recognition, experimental design and optimisation, handling of chemical structures, chemical databases, molecular modelling, and artificial intelligence. Applications of these methods in data analysis, structural searching, prediction of properties and drug design are discussed.

SSCC 4723 Organometallic Chemistry

The course teaches the chemistry of Organometallic Compounds. It includes the definition and classification of the compounds, 18-electron rule and its limitations, types of bonding and methods of preparation followed by characterization of organometallic compounds. The discussion continues with the types of reactions and application of organometallic compounds as catalysts and others; metal-carbonyl complexes: synthesis, structure, reactions and applications; clusters compounds and their structure and isolobal relationship; the bioinorganic compound: coenzyme B12, and nitrogen fixation.

SSCC 4393 Special Topic in Chemistry

In this course, the concept and application of solid acids and bases, and their catalytic properties are introduced with emphasis on fundamental aspects and chemical principles. These include the surface properties (in particular, acidic and basic properties), the structures of the solids, determination of the acidic and basic properties of catalysts and catalyst supports in oxidation, reduction, hydrogenation, hydrocracking, etc. The effect of the preparation method and the pre-treatment condition of solid acids and bases on the acidic and basic properties, the nature of acidic and basic sites and the mechanism regarding the generation of acidity and basicity are introduced in this course. Ability to work autonomously, and show leadership and professionalism in managing responsibilities within team groups.

SSCC 4783 Bioinorganic Chemistry

This course discusses the bioinorganic chemistry concepts in the study of inorganic species especially metal ions in a biological system. The course will begin with the principles of coordination chemistry and a survey of biological molecules and ligands. Study on metalloproteins: metal storage and transport; dioxygen transport in mammals and lower organisms. Electron transfer in biology: iron cytochromes, and iron-sulfur clusters. Metalloenzymes: copper enzymes, zinc enzymes and hydrolytic enzymes Vitamin B12, nitrogenases and hydrogenases. This course will further discuss the use of metal complexes as therapeutic agents.

SSCC 4023 Spectroscopic Methods in Organic Chemistry

This course discusses the theory and application of infrared (IR), nuclear magnetic resonance (NMR), ultraviolet (UV) spectroscopies and mass spectrometry (MS) for structural determination of organic compounds. In addition, elemental analysis for determination of molecular formula and index of hydrogen deficiency will be discussed.

SSCC 4303 Oleochemistry

This course discusses the concept of heterocyclic and heteroaromatic compounds which include six membered heteroaromatic: pyridine and derivatives; Five membered heteroaromatic: pyrrole, furan and thiophene; Fused-ring heterocyclic: indole, quinoline and isoquinoline. In each topic, the students will be introduced to the structures, properties, reactivity, synthesis, and reactions of these heterocyclic compounds.

SSCC 4383 Special Topics in Industrial Chemistry

This lecture course is intended for chemistry students who have an interest in the industrial chemistry field. Lectures will briefly cover the early history and general

characteristics of the chemical industry. The chemistry behind everyday products produced from industrial chemicals will also be highlighted. Economic, social and environmental aspects of industrial chemical production will also be discussed. Green approaches to industrial chemistry will also be considered. Students will be expected to independently research some aspects of the chemical industry and present their findings.

SSCC 4483 Corrosion Chemistry

This course introduces the concept of corrosion, importance of corrosion, the driving force for corrosion reactions, thermodynamic and kinetics of corrosion. This will include characteristic forms of electrochemical corrosion, prevention and control of electrochemical corrosion and high temperature corrosion/oxidation. Pourbaix diagram is introduced to better understand concept of corrosion in various metals. Butler-Volmer equation and Tafel plot will be used to discuss the kinetics of corrosion process. The concept of cathodic inhibition, sacrificial anode, coating and design will be discussed.

SSCC 4683 Biotechnology

This course aims to give chemistry major students an understanding of the multidisciplinary nature of biotechnology. It includes understanding some of the basic principles of microbiology, biochemistry and engineering aspects of bioprocesses. The course mainly focuses on industrial and environmental aspects of Biotechnology where chemists can play an important role. Introduction to microbiology will be taught to familiarize students with the terms commonly used in Biotechnology. Topics include classification of microorganisms; prokaryotic and eukaryotic cells; biomolecules, DNA as genetic material, bacterial growth and metabolism, microbial culture systems in bioreactors: batch, fed batch and continuous systems, and cell immobilisation. Some insights into industrial biotechnology: production of antibiotics, amino acids; organic acids, solvents and enzymes. While environmental biotechnology touches on bioremediation, sewage system and wastewater treatment processes and metal recovery. Also a brief introduction on animal cloning and stem cells technology as a special interest topic.

SSCC 4743 Materials Chemistry

This course is intended to give an overall introduction to the importance of materials and how chemistry controls its properties. The types of materials involved include metals, semiconductors, superconductors, ceramics, glass, composites, polymers and nanomaterials. Different types of bonding that exist in materials and the general properties of materials will also be discussed. The relationship between the structures of materials with respect to their physicochemical properties will be examined. Apart from that, the synthesis, processing, fabrication and application of industrial materials will be highlighted. Various characterization techniques of solid materials shall be discussed.

SSCC 4343 Chemical Sensors

This course introduces various types of chemical and biochemical sensors and their applications in industrial processes, environmental and biomedical applications. This course will cover the basic principles for chemical sensors; sensing component systems (types of transducers and receptor parts); sensor

analytical performance; details on electrochemical sensors, optical sensors, mass and thermal sensors; and lastly discussion on applications of sensors.

SSCC 5713 Advanced Inorganic Chemistry

The course will cover the theoretical aspects of chemical bonding, molecular structure and symmetry. Emphasis is given on the chemistry of transition metals, including coordination and organometallic compounds. Primary reactions of organometallic compounds will be highlighted. Examples of important catalytic reactions involving organometallics as catalyst will be discussed. The students will be given a group assignment related to the topics discussed during lectures and an oral presentation will be executed.

SSCC 5413 Advanced Physical Chemistry

Advanced physical chemistry provides an insight into the fundamental and basic understanding of physicochemical characterizations of materials. This course gives students an advanced understanding of the properties and characteristics of solids from a fundamental level right through to methodology for materials preparation and characterization. It emphasises on the key preparation processes, which include sol gel process, coprecipitation method, thin film techniques and solid state process. The course features essential characterization tools including X-ray techniques, electron microscopy, photo electron spectroscopy and many more. Illustrations of the preparation and characterization techniques will be discussed in detail based on real researched materials through project works.

SSCC 5613 Advanced Organic Chemistry

This course discusses the advanced concepts of organic chemistry. These include stereochemistry analysis of enantiomers, diastereomers and meso compounds, followed by asymmetric synthesis. Conformations analysis of acyclic and cyclic compounds will be introduced. Types of organic reactions and mechanisms of reactions such as oxidation-reduction, substitution, elimination, condensation and rearrangements will also be included.

SSCC 5203 Advanced Analytical Chemistry

This course covers technical aspects and applications of analytical separation methods, spectroscopy and analytical electrochemistry for qualitative and quantitative analysis. The analytical separation methods include sample preparation in analytical chemistry, gas chromatography (GC), high performance liquid chromatography (HPLC), and capillary electrophoresis (CE). The spectroscopic methods include mass spectrometry, atomic absorption spectroscopy (AAS), atomic emission spectroscopy (AES), inductively-coupled plasma-atomic emission spectroscopy (ICP-AES), inductively-coupled plasma-mass spectrometry (ICP-MS). Analytical electrochemistry covers the development and applications of finite-current-controlled techniques including linear sweep and cyclic voltammetry, pulse and differential pulse voltammetry, stripping analysis and chemical sensors with emphasis on chemically modified electrodes.

SSCC 5813 Forensic Analytical Instrumentation

This course provides the basic principles and application of various instrumental methods for examination of physical evidence, including microscopy,

spectrophotometric and chromatographic techniques, electrophoresis, mass spectrometry as well as other forensically relevant instruments.

SSCC 5823 Forensic Chemistry

This course covers the principal areas of forensic chemistry, whereby physico-chemical properties of important evidences such as colorant, polymers and blood alcohol will be explored. Student will be introduced to qualitative and quantitative chemical analysis. This subject introduces to principles of forensic chemistry, basic analytical chemistry procedures, sampling, sample preparation, data analysis, immunoassay, analysis of color and colorants, analysis of polymers, analysis of blood alcohol concentration and statistical analysis. Case examples will also be presented and discussed.

SSCU 4928 Research Training (Practical)

Undergraduate students from the Faculty of Science are required to undertake a period of 6 months research training in their field of study. The research training will take place during semester 8 of the fourth academic year at appropriate industries, laboratories or research institutions. Students are expected to undertake research related activities during the research training period. The research training allows students to apply and further develop their knowledge and skills in the workplace. Students are expected to secure the internship placement themselves but under the supervision of the research training coordinators from each department. Successful completion of the research training is mandatory for graduation from any undergraduate degrees offered by the Faculty of Science UTM, complying with the MOHE and MQA regulations for undergraduate programmes in both public and private colleges and universities.

SSCU 4924 Research Training (Report)

This course is to be undertaken concurrently with SSCU 4928. Students will be graded according to their logbook and final report submitted at the end of the internship by both organization and faculty supervisors.

SSCU 4918 Industrial Training (Practical)

Undergraduate students from the Faculty of Science are required to undertake a period of 6 months industrial training in their field of study. The research training will take place during semester 8 of the fourth academic year at appropriate industries, laboratories or research institutions. Students are expected to undertake industries related activities during the industrial training period. The industrial training allows students to apply and further develop their knowledge and skills in the workplace. Students are expected to secure the internship placement themselves but under the supervision of the research training coordinators from each department. Successful completion of the research training is mandatory for graduation from any undergraduate degrees offered by the Faculty of Science UTM, complying with the MOHE and MQA regulations for undergraduate programmes in both public and private colleges and universities.

SSCU 4914 Industrial Training (Report)

This course is to be undertaken concurrently with SSCU 4918. Students will be graded according to their logbook and final report submitted at the end of the internship by both organization and faculty supervisors.

SYNOPSIS OF MATHEMATICS COURSES

SSCM 1023 Mathematical Methods I

The course revises and extends Matriculation and STPM topics such as differentiation and integration towards hyperbolic and trigonometric inverses. Applications in computing arc length and area of surfaces of revolution are also included. Other topics covered are improper integrals, parametric equations, polar coordinates, and multivariable functions. This later topic serves as an introduction to three-dimensional calculus which students will learn in Mathematical Methods II. The chapter will merely be devoted to sketching surfaces and finding limits of two variable functions. It is hoped that upon completion of the course, students should have acquired some firm basic tools to pursue further mathematics.

SSCM 1033 Mathematical Methods II

This course is a continuation of SSCM 1023. Four main topics are covered, namely sequences and series, partial derivatives and its applications, and multiple integrals. Students will learn how to recognize the appropriate test of convergence for sequence and series, find partial derivatives and evaluate double and triple integrals. The use of cylindrical and spherical coordinates is also highlighted. Applications include finding the area, volume, mass, centre of gravity and moments of inertia of a solid.

SSCP 1103 Mechanics

This course mainly discusses motion of a body or a system. Beginning with the basic and derived physical quantities and vector as mathematical tool, various types of motion such linear, free-fall, projectile, circular, rotational and simple harmonic motions are described. Other topics such as equilibrium, elasticity, gravitation and fluids mechanics illustrate the application of a body in motion under the influence of a force.

SSCC 1003 Principles of Chemistry

This course strengthens principles of chemistry knowledge before proceeding to more specialized and higher levels chemistry subjects. The first part of this course exposes students to fundamentals of atoms and molecules and concepts which are known to be the main sources of chemical processes. The formation of chemical bonding, structure of molecules and properties of compounds are discussed. The second part of this course concentrates on stoichiometry and the relation between reacted species in reactions. The last part of this course strengthen student in term of fundamental knowledge of organic chemistry and introduces students the ideas of green chemistry concept.

SSCM 1103 Statistics

The course is an introduction to statistics, reviewing some descriptive statistics which includes probability and random variables. Then, the topic of sampling distributions and inferential statistics which include estimation procedures and hypothesis testing is covered. The latter using the method of analysis of variance when more than two means are involved. Also, simple linear regression and contingency table are introduced. Students will be trained in the use of computer software such as Microsoft Excel and SPSS.

SSCM 1303 Computer Literacy

This course presents efficient internet search strategies and relevant use of several spreadsheets and software packages for prospective mathematics majors. These spreadsheets and software packages are introduced for analytical and computational purposes. Students will embark in an experiential assignment that involve the community by employing the materials learnt in the course.

SSCM 1313 Computer Programming

This course will provide the basic programming skill in Computer C++ Programming. Topics include flowcharts, algorithms, basic syntax in C++, procession of compiling, pre-processing components, operators, loops, branches, data/variable types, strings, arrays, functions, pointer and structure. Students will learn to write an efficient and maintainable program using Microsoft Visual C++ software. The lectures are supplemented with the non-trivial lab exercises.

SSCM 1523 Linear Algebra

The course begins with the study of matrices, starting with simple matrix operations, elementary row operations and inverses, and determinant of matrices. Solving linear systems using Inverses of matrices, Cramer's rule, Gauss and Gauss-Jordan elimination methods, are next in line. Next, the focus is on the vector spaces, subspaces, linear independence, spanning sets, bases, coordinate vector and change of basis, orthogonal bases, and the Gram-Schmidt process. A discussion of linear transformation and matrices, as well as the kernel and range are also studied. Finally, the discussion will be on eigenvalues and eigenvectors together with their usage in diagonalization problems.

SSCM 1533 Logic and Set Theory

This course introduces axiomatic set theory and elementary logic. Since set theory and logic form the foundation of mathematics and are greatly intertwined, informal approach to sets is first reviewed to gather vocabulary for a study of logic. The logic parts include propositional algebra and predicate calculus, arguments and methods of proof. Set theory includes the basic axioms and definitions. Basic laws are derived rigorously using methods of logic. Further topics for introducing modern advanced mathematics include properties of numbers, sets and relations, equivalence relations, functions and cardinality.

SSCM 1703 Differential Equations I

This is an introductory course on differential equations. It provides students with basic concepts and theories as well as analytical tools for solving ordinary differential equations (ODEs). Topics include first order ODEs, linear ODEs with constant coefficients, and Laplace transforms.

SSCM 2103 Mathematical Statistics

This course explores the concept and theory on mathematical statistics. Discussion will start with basic concepts and definition of set theory and probability, univariate and bivariate random variables, transformation of variables and their mathematical expectations. Also discussed are Chebyshev's Inequality, moment generating function for univariate and bivariate variables. The discussion will end with order statistics and limiting distribution.

SSCM 2423 Numerical Method I

This course discusses various numerical methods that can be used to solve problems involving non-linear equations, linear systems, interpolation and curve fitting, numerical differentiation and integration, eigenvalue problems, ordinary differential equations and partial differential equations.

SSCM 2523 Modern Algebra

The course begins with the study of groups, types of groups, isomorphism between groups, composition of groups to form a direct product, and types of subgroups including normal subgroups and factor groups. Next, all these topics are applied to a selected topic of Sylow Theorems and their applications.

SSCM 2613 Advanced Calculus

The course begins with the study of the real numbers, starting with field axiom, order axiom, mathematical induction and inequalities. The least upper bound axiom (completeness axiom), supremum and infimum, inequalities, are next in line together with the sequences of real numbers, namely the convergent sequence, limits of sequences, subsequences, Cauchy sequences and Cauchy criterion for convergence sequence of real numbers. Next, the topological properties involving countability, open sets, closed sets and accumulation points are verified. Finally, the validation of limits, continuity, differentiation and integration of functions is done. This includes the limits of functions, one-sided limits, continuous functions; properties of continuous functions, uniform continuity of functions, properties of derivative, Riemann integral and its properties, fundamental theorem of calculus.

SSCM 2713 Partial Differential Equation

Wave, heat and Laplace equations in one and two-dimensional spaces. Solution of equations in Cartesian, cylindrical and spherical coordinate systems using the method of separation of variables. Also, solution for selected non-homogeneous and non-homogenous boundary conditions wave and heat equations.

SSCM 2773 Differential Equations II

This course continues the Differential Equations I course, with the focus on second order ordinary differential equations with variable coefficients and systems of first order equations. Analytical solution methods, and qualitative approach to autonomous systems will be introduced. To further strengthen students' notions on mathematics, basic theory of linear systems and first order IVPs also are covered. Upon completion students should be able to demonstrate understanding of the theoretical concepts and select and use appropriate techniques for finding solutions to second order differential equations and systems of linear first order differential equations.

SSCM 2793 Vector Calculus

This course explores the calculus on vector valued functions. Discussions will start with basic concepts, definitions and theorems pertaining to position vectors and graphs, vector differentiation and integration, unit tangent, unit normal, and unit binormal vectors as foundation for further discussion. Also discussed are ideas of curvature, radius of curvature, torsion, Frenet-Serret formulas, del operator, gradient, divergence, curl, normal vector to the surface, directional derivative, rate of change. With the foundation in hand, the discussions proceed to line

integral in two and three dimensions and its applications on work. Green's Theorem is introduced as tool to facilitate efforts in solving problems related to potential functions and conservative force fields. The discussion will end with surface integral for scalar functions, surface area, surface integral for vector functions, Gauss's Theorem, and Stokes's Theorem.

SSCM 2853 Inventory and Queuing Theory

The course comprises of two main topics: inventory analysis and queueing systems. Inventory analysis covers development and analysis of deterministic models and probabilistic models. The concept of Material Requirements Planning (MRP) and Just in Time (JIT) is also introduced. Analysis of queueing systems covers various steady-state mathematical formulae and basic simulation. The models include machine repair model, queues in series, and queues with priorities. Industrial Revolution 4.0 (IR4.0) and 21st Century Learning will be implemented through the online learning tools and programming software.

SSCM 2833 Linear Programming

Introduces the basic methodology of Operational Research (OR). Mainly deals with Linear Programming (LP) and related topics such as duality, sensitivity analysis, Transportation Problem, and Integer Linear Programming. Besides manual calculations, students learn how to use computer packages to solve and analyse problems.

SSCM 2863 Mathematical Modelling

Introduces the basic principles of mathematical modelling. Emphasis is on some underlying general concepts related to mathematical modelling and differential equations. These include topics in first and second-order differential equations, mathematical models and numerical methods, systems of differential equations, nonlinear systems and phenomena, eigen-values and boundary value problems. Upon completion, students should exhibit the ability to analyze resulting models by making use of both classical and numerical mathematical techniques and the essential knowledge and basic skills of mathematical modelling in describing, comprehending and predicting the behavior of various physical, biological, mechanical processes and as well as other relevant dynamical systems.

SSCM 3103 Design of Experiments

The aim of this course is to develop skills and relevant theories to a range of traditional statistical techniques for designing and analysing scientific experiments. An extension to model multiple variables is also introduced. The focus is on understanding the underlying design and model to answer scientific research question by planning appropriate design, seeking scientific information by communicating with scientist, interpreting output, and presenting results. The statistical design covers Completely Randomised Design and Blocking, Factorial Design, Fractional Design and Multiple Linear Regression. Examples and assignments involve computing in R/Microsoft Excel or SPSS. The prerequisite for this course is SSCM 1103 and the software.

SSCM 3123 Multivariate Analysis

This is an introduction to the theoretical and practical statistical techniques for multivariate data analysis. We focus on selected traditional statistical techniques when several quantitative measurements are made on each individual/object in

one or more samples. The selected statistical techniques presented in this course are broadly categorized into five data analysis approaches: Comparison of Means, Dimension Reduction, Measures of Association and Predictive Analysis. The course covers relevant multivariate methods using R programming software.

SSCM 3133 Statistical Quality Control

This course uses the statistical concepts and techniques to improve the quality of the manufactured goods and services. An introduction to the philosophy and basic concepts of quality control will be study. The statistical quality control consists of statistical process control and acceptance sampling.

SSCM 3113 Time Series

The course is designed to provide students to learn time series modelling in theory and practice with emphasis on practical aspects of time series analysis. Methods are hierarchically introduced-starting with terminology and exploratory graphics, progressing to descriptive statistics, and ending with basic modelling procedures. The time series modelling will start with reviewing the fundamental concepts in regression, exponential smoothing and general class of Box Jenkins models.

SSCM 3153 Inferential Statistics

This course explores the concept and theory on inferential statistics. It is concerned with the frequentist approach to inference covering point and interval estimation of parameters and hypothesis testing. Properties of estimators such as unbiasedness and sufficiency applied to estimators of parameters of various distributions. The discussion will end with theory of statistical hypothesis testing.

SSCM 3363 Scientific Computing using Structured Programming

Python is an extremely usable, high-level open-source programming language that is quickly becoming a standard in scientific computing. The goal of this course is to provide students with the structured programming to solve and visualize a wide range of science and engineering problems. This course emphasis on three main parts. First, the elementary programming concepts which includes arithmetic expressions, for-loops, logical expressions, if statements, functions and classes, while the second part is the mathematical applications, which includes solving problems in differential equations, linear algebra, numerical and probability. The third part related to database and data science. Students are expected to be able to implement the knowledge and skills of scientific computing to solve a specific task given in the assignments and project. IR4.0 and 21st century learning will be implemented through the online learning tools and programming software. Element of experiential learning is embedded in this course where students will carry out mini scale project as service-learning activities that involves the community.

SSCM 3423 Numerical Methods II

This course explores and solves problem using numerical methods that involve systems of nonlinear equations and differential equation with initial and boundary value problems using finite difference method, shooting method, finite element method and cubic spline. IR4.0 and 21st century learning will be implemented through the online learning tools and programming software.

SSCM 3543 Number Theory

Number theory is one of the oldest branches of mathematics, and yet it is very much an alive subject, with discoveries made every day. This course is intended to focus on the topics that relate specifically to the natural numbers. The goal of this course is to develop the student's ability with abstract concepts. Familiar properties of the counting numbers are studied, relationships are discovered, and deductive reasoning is used to verify consistency of these relationships. In the process, students gain insight into the nature of mathematical reasoning, especially common techniques of proof.

SSCM 3503 Complex Variables

This course contains further topics on Complex Variables such as complex series including Taylor and Laurent series, the theory of residues with applications to the evaluation of complex and real integrals, and conformal mapping with applications in solving boundary value problems of science and engineering.

SSCM 3563 Rings and Fields Theory

The course begins with the study of the concepts of rings and fields. Next, the explanation is given to both the subject matter and the structure of proofs on ring, integral domain, homomorphism, quotient ring, fields, and field of quotients, vector space, extension field and algebraic extension.

SSCM 3653 Discrete Mathematics

The course begins with the study of sets, logic, proving techniques, relations, and functions. Explaining the properties and types of algebraic structures and graph theory is next in line. Next, the basic concepts of sets, relations, functions and graph theory are applied to Boolean algebra and logic networks, while the advanced concepts of functions and algebraic structures are applied to finite state machines and coding theory.

SSCU 3622 Research Methodology & Information Retrieval

This course teaches the students on principles of research methodology and information retrieval. Topics include research philosophy and objectives, literature study and review, choosing and defining research problems and design, preparing and writing research proposals, technical report writing (the elements of technical writing), types of technical report writing, dissertation writing, public speaking (preparation and presentation) and information retrieval (search strategies). Presentation of assignment is also an important component in this course.

SSCM 3673 Functional Analysis

This course begins with introducing the metric spaces which include open set, closed set, convergence, Cauchy sequences and completeness. These are followed by the normed spaces which cover vector space, normed space, Hilbert space, finite dimensional normed space and subspaces, compactness and finite dimension. Inner Product Spaces, Hilbert Space, Further properties of inner product spaces, Orthogonal complements and direct sums, Orthogonal sets and sequences. Linear operators, bounded and continuous linear operators, linear functionals, linear operators and functionals on finite dimensional spaces. The course ends with Banach Fixed Point Theorem which include contraction mapping and error bound in iterations. The course also emphasizes on the applications of

Banach Fixed Point Theorem to system of linear equations (Jacobi and Gauss-Seidel iterations), differential equations (Picard's existence and uniqueness theorem).

SSCM 3733 Dynamical Systems

This course introduces the concepts of discrete and continuous dynamical systems. For continuous autonomous dynamical systems students learn about fixed points, orbit and invariant sets, the stability of fixed points and bifurcation. In the discrete dynamical systems, they learn about orbits of one-dimensional maps, bifurcation, period doubling which can lead to chaos. Applications include population growth, and electrical engineering. Computer software will be used to simulate and study the dynamical systems.

SSCM 3753 Fluid Mechanics

This course explores thoroughly on the fundamental process of fluid flow. Discussions will start with an introduction of fluid properties and fluid kinematics including viscosity, velocity field, material derivative, streamlines and pathlines, stream function, stagnation points, vorticity and circulation. This course also discussed the fundamental physical principle of mass conservation as well as the use of stream function. This course next introduces the mathematical description of fluid flows through continuity equation and momentum equation for control volumes. With the fundamental concepts in hand, the so-called Euler's equation for inviscid flow and Navier-Stokes equation for viscous flow will be discussed followed by the analytical solution of some important flow problems including fluid flow between two parallel plates and flow in a pipe.

SSCM 3793 Calculus of Variations

This course discusses mainly the extremals of functionals. Beginning with a review of similar concepts in functions of many variables, the concepts of functional and variational problems are introduced. Topics include analytical methods of solution (extremals of functionals) and selected numerical methods. Upon completion, the students should be able to locate and identify extremizing functions as solutions to variational problems, based on the necessary and the sufficient conditions for an extremum, solve some basic applied problems, and know how to use the direct methods for finding the extremum.

SSCM 3843 Optimization Methods

This course is a course in optimization methods. The subject matter of the course is optimization algorithms meant for finding solutions of unconstrained and constrained optimization problems. The course will start with some preliminary results from multivariable calculus and discussions on a few basic algorithms for unconstrained and constrained problems. The course covers topics on unconstrained optimisation such as one-dimensional and n-dimensional search methods, interpolation method and gradient methods. The course also covers topics on constrained optimisation such as the Kuhn Tucker method, modified Hooke and Jeeves search method, complex method, penalty function methods. Students will be encouraged to use programming to solve problems. Upon completion, students should be at ease to use these methods for finding local solutions for the constrained and unconstrained optimization problems.

SSCM 3823 Scheduling

This course discusses various scheduling classes namely single machine, identical parallel processor, unrelated parallel processor, uniform parallel processor, flow shop, job shop scheduling. Various performance measures and suitable objective functions will be considered in obtaining a good schedule. Approaches for mathematical modelling and solving scheduling problems using heuristics of the mentioned scheduling classes will be discussed. Students will be encouraged to use C programming to write programs on the heuristics algorithms. Other than that, LINGO / CPLEX software can be used to solve mathematical programming model that have been developed for exact solution approach. Upon completion, students should be at ease to use all methods that have been discussed for finding feasible and exact solutions for task scheduling in single processor, parallel processors and shop scheduling problems.

SSCM 3883 Multi-Objectives Decision Making

This course is an introduction to the theory and methods behind optimization under competing objectives and criteria involving single and also multiple decision makers. In this course, several approaches for finding the solution to the multi criteria decision problems will be explored, as well as the concepts of Pareto optimality and trade-off curves to better understand the trade-offs between objectives that occur in multi-objective decision-making problems.

SSCM 4243 Sampling Techniques

This course introduces sampling methods used in sample surveys. The students are given a comprehensive account of sampling theory for use in sample surveys and include illustrations of how the theory is applied in practice. A prerequisite is familiarity with algebra, knowledge of probability for finite sample spaces and basic statistics. Topics include simple random sampling, sampling proportion and percentages, estimation of sample sizes, stratified random sampling, ratio estimators, systematic sampling, and cluster sampling.

SSCM 4253 Introduction to Regression Modelling

This course consists of two parts that is regression model consisting of simple and multiple linear regression, non-linear regression and the theory of generalized linear model (GLM). SPSS and R statistical package is used to apply generalized linear model to the above models.

SSCM 4263 Introduction to Stochastic Models

The aim of this course is to develop skills and relevant theories to a range of traditional techniques in understanding random phenomena. The focus is on understanding and describing stochastic models to make appropriate analysis and decision with modern flavour. The stochastic models considered might include Poisson Process, Markov Chain and Renewal Process. The application of stochastic process in decision and analysis cover population model and queueing system. Examples and assignments involve computing in R software. There is no prerequisite for this course. However, students should have working knowledge of probability, statistics, matrix algebra and R software.

SSCM 4633 Fuzzy Set Theory

The course starts with brief discussion on an overview of crisp sets. It then follows with basic definition and important terminologies, which include- cut, extension

principle, and operation on Fuzzy sets such as complement, union, intersection and difference. Cartesian product of two fuzzy sets is also discussed. Fuzzy Arithmetic on Fuzzy Numbers including operations on intervals are also thoroughly highlighted. Fuzzy relations, fuzzy graph, fuzzy function and fuzzy logics are also discussed. In general, the course provides on the general concepts of fuzzy sets and its operations. The emphasis is also given for its applications in Uncertainty Modelling.

SSCM 4653 Applied Abstract Algebra

Introduces some basic applications of abstract algebra. Topics include applications of modern algebra in symbolic computations, error correcting codes and computations in Galois fields. Computer packages such as Maple will be used.

SSCM 4683 Topology

This course is an introduction to the basic concepts of modern topology: metric spaces, topological spaces, connectedness, compactness, completeness, quotient spaces, manifolds, and classification of surfaces. While the course will emphasize the geometric aspects of topology, some applications to analysis will also be discussed. The material is very conceptual in nature; therefore, it is all about proving abstract theorems, applying those theorems to examples, and finding counter examples to false statements.

SSCM 4623 Non-Euclidean Geometry

This course is a survey of significant concepts in Euclidean and Non-Euclidean geometry with an emphasis on developmental history, the axiomatic approach, compass-and-straightedge constructions and documenting logical proof. A study of Euclid's Elements, his axioms of geometry and their consequences, along with basic theorems of Euclidean geometry and rigorous proofs for them are offered. Non-Euclidean geometry is then introduced as a response to the limitations of Euclidean geometry, with a focus on hyperbolic and elliptic geometries and their respective spatial models. The similarities and differences between Euclidean and non-Euclidean geometries, plus the notion of surface curvature, will be discussed.

SSCM 4763 Computational Fluid Dynamics

This is an introductory course on Computational Fluid Dynamics (CFD) where students are exposed to the techniques of obtaining the numerical solution to fluid flow problems using computer. Historical development, philosophy and the significance of CFD are discussed. The governing equations of fluid dynamics are derived from the fundamental physical principles. The derivation of finite difference approximations to derivatives is revised. Discretization is based on both explicit and implicit techniques. The application to classic fluid flow problems such as Couette flow and other unidirectional flows for viscous fluids, supersonic and subsonic flow for inviscid fluids will be discussed.

SSCM 4813 Optimal Control

This course introduces the optimal control theory. The discussion includes definitions and classification of system control types. Topics include necessary and sufficient conditions using calculus of variation. Upon completion, students should exhibit understanding of the basic concepts and principles of mathematical control systems. The students should also be able to determine systems

characteristics and solve basic optimal control problem. Students will be encouraged to use MATLAB for solving optimal control problems.

SSCM 4863 Financial Mathematics

The first part of the course begins with an introduction to basic financial mathematics covering the computation of simple interest and discount rates, deriving the compound interest, and applications of different rates of interest in determining the present and future values of different types of annuities for different time periods. The second part of the course relates to the subject of financial derivatives and its concepts. Two main option pricing models for pricing derivatives are examined specifically the Binomial option pricing model and the Black-Scholes option pricing model.

SSCU 3902 Undergraduate Project I

Students are required to execute a project (research) under an identified supervisor in an agreeable field of mathematics and document their findings. Students will learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate expected results, write current findings and references. Finally, students are required to submit a research proposal and a draft project/research report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Expected Findings, Conclusion and References.

SSCU 4904 Undergraduate Project II

Students are required to execute a project (research) under an identified supervisor in an agreeable field of mathematics and document their findings. Students will learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate results, analyze findings, draw conclusion, write references, and to suggest further research. Finally, students are required to submit a report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Analysis of Findings, Conclusion and References.

SSCU 4914 Industrial Training Report

This course is to be undertaken concurrently with SSCU 4918. Students will be graded according to their logbook and final report submitted at the end of the internship by both organization and faculty supervisors.

SSCU 4924 Research Training Report

This course is to be undertaken concurrently with SSCU 4928. Students will be graded according to their logbook and final report submitted at the end of the internship by both organization and faculty supervisors.

SSCU 4918 Industrial Training

Undergraduate students from the Faculty of Science are required to undertake a period of 6 months industrial training relevant to their fields of study. The industrial training will take place during semester 8 at appropriate industries, laboratories or research institutions. Students are expected to undertake non-research related activities during the internship training. The internship training allows students to

apply and further develop their knowledge and skills in the workplace. Students are expected to secure the internship placement themselves under the supervision of the industrial training coordinators. Successful completion of the industrial training is mandatory for graduation from any undergraduate degrees offered by the Faculty of Science UTM, in complying with the MOHE and MQA regulations for undergraduate programmes in both public and private colleges and universities.

SSCU 4928 Research Training

Undergraduate students from the Faculty of Science are required to undertake a period of 6 months research training in their field of study. The research training will take place during semester 8 of the fourth academic year at appropriate industries, laboratories or research institutions. Students are expected to undertake research related activities during the research training period. The research training allows students to apply and further develop their knowledge and skills in the workplace. Students are expected to secure the internship placement themselves but under the supervision of the research training coordinators. Successful completion of the research training is mandatory for graduation from any undergraduate degrees offered by the Faculty of Science UTM, complying with the MOHE and MQA regulations for undergraduate programmes in both public and private colleges and universities.

SSCM 5053 / MSCM 1023 Advanced Mathematical Method I

This subject provides selected advanced mathematical methods that can be used to construct solutions for differential equations of applied mathematics. The contents deal with the representation of solutions by hypergeometric series expansions, with the method of integral transforms, and with conformal mapping method. This course also integrates the use of standard mathematics software (e.g. Mathematica) to study special functions, integral transforms and conformal mapping.

SSCM 5373 / MSCM 1053 Computational Mathematics

This course provides the fundamentals of programming, program design, verification and visualization using C++ and MATLAB language. The goal is to provide the students with the skills in scientific computing, tools, and techniques that can be used to assist them in the dissertation later. In this course, students will learn to implement algorithms, construct codes, and perform the debugging using C++ and MATLAB programming. The programming skills acquired in this course will allow students to go beyond what is available in ready-built-in analysis tools, and code their own custom data processing, analysis and visualization for any science and engineering problem.

SSCM 5693 / MSCM 1233 Mathematical Analysis

This course begins with introducing the metric spaces which include open set, closed set, convergence, Cauchy sequences and completeness. These are followed by the normed spaces which cover vector space, normed space, Banach space, finite dimensional normed space and subspaces, compactness and finite dimension, linear operators, bounded and continuous linear operators, linear functionals, linear operators and functionals on finite dimensional spaces, Hahn-Banach theorem, open mapping theorem and closed graph theorem. The course ends with Banach Fixed Point Theorem which include contraction mapping

and error bound in iterations. The course also emphasizes on the applications of Banach Fixed Point Theorem to system of linear equations (Jacobi and Gauss-Seidel iterations), differential equations (Picard's existence and uniqueness theorem) and integral equations (Fredholm integral equation and Volterra integral equation).

SSCM 5713 / MSCJ 1523 Methods of Engineering Mathematics

This course introduces Appel's symbol, Vandermonde's theorem, Hypergeometric Series, Gamma Function, Analyticity, Limit formulas, Reciprocal of the gamma function, Duplication theorem, Euler's reflection formula, Solutions of various important differential equations expressible in terms of the hypergeometric series. Integral Transform: Laplace transform, Fourier transform and Mellin, Inversion Integral, Bromwich Integral & Calculus of Residues. Properties of transformations, application of integral transforms to initial or boundary value problems. z-transform, solving difference equation using z-transform and method of convolution.

SSCM 5423 / MSCJ 1533 Numerical Methods in Engineering

A general course of numerical methods in engineering. The first part covers the initial value problem (IVP), error analysis, single step, multistep method as well as the system of ordinary differential equation (ODE). The second part covers finite difference method (FDM) in boundary value problem (BVP). A simple irregular boundary is introduced. The third part covers the finite element method (FEM) with applications focus on heat problem as well as eigenvalues calculation for dynamic finite element analysis. The last part covers finite volume method (FVM) in two-dimension diffusion equation. Truncation error is discussed.

SSCM 5703 / MSCJ 1543 Advanced Partial Differential Equations

This course introduces the basic elements of the various solutions techniques for solving the partial differential equations. The solution methods include the method of characteristics, separation of variables, Laplace and Fourier transforms, perturbation and asymptotic methods. Topics include Laplace's equations, Green's functions and theorem. Each student will be required to do small project so that they gain experience in the implementation of the method for specific applications.

SYNOPSIS OF BIOLOGY COURSES

SSCT 1613 Microbiology

This course focuses on theory and fundamental concepts of microbiology involves the study of microorganisms with particular emphasis on the biology of bacteria, viruses, fungi and protozoan parasites. This course introduces students to develop basic skills related to microbiological techniques, particularly in aseptic techniques and microscopy which is synchronized with Microbiology Laboratory Course. Discussions are mainly on different classes of microorganisms especially bacteria: bacterial physiology and anatomy, nutrient requirements and physical factors influencing growth, metabolism and microbial genetics as well as metabolic diversity in microorganisms. A brief discussion on fungi and algae in relation to their benefit and applications also included. Students will be involved in discussion on physical and chemical control of microbial growth which is a part of controlling diseases caused by microorganisms, infectious diseases worldwide, understanding the environmental importance of microbes and to exploit them for food production, biotechnological and industrial applications. At the end of the topics, students will analyze the influence of microbiology and 21st century challenges and opportunities that arise from our changing relationship with and understanding of microbes. First Year Seminar is embedded in this course as part of the initiative on the 4.0 IR element.

SSCT 1611 Microbiology Lab

This course introduces the basic principles of microbiology examining the microbes that inhabit our planet and their effect on the biosphere. The objectives over the course of the semester are to train students to become proficient at laboratory skills and safety procedures. Students will also learn to follow experimental procedures. In this Microbiology Laboratory Course, students also going to develop skills of students to formulate answerable questions/hypotheses, predict expected results. Throughout the experiment and laboratory works, students will learn how to make careful observations, collect and analyze data, and draw appropriate conclusions which will be assessed in grouped-laboratory report every week. Active-learning opportunity in the laboratories should be grab by students to demonstrate good lab citizenry and the ability to work with others to carry out biological science experiments.

SSCY 1713 Cellular and Molecular Biology

This subject will facilitate students to understand and visualize processes in cell biology and those responsible for DNA transmission and expression hence mechanisms by which bacteria inherit genetic information as the blue print of life. The lectures will explain relationship between structure and function in molecular biology and how this relationship operates to control biochemical processes. Topics include macromolecules like DNA, RNA, and proteins and how processes like replication, transcription and translation operate, eukaryotic genetics. Students will cover related aspects such as mutation and mutagenesis, effects of mutation and how cells overcome mutation. Students will also learn about basic techniques in molecular biology as the basis for genetic engineering. PowerPoint and Video presentation by each group will be done at the end of the semester on designated topics.

SSCY 1432 Introduction to Biosciences

This course explores how biology is used in both academic and commercial settings within the fields of bioscience, taxonomy, pharmaceutical and clinical sciences. Topics will include applications of bioscience in microbes, plants, and animals, the human genome project and its relation to medical biotechnology, DNA forensics, and pharmaceutical drug discovery and delivery. The debate surrounding subjects such as cloning, stem cells, and genetically modified foods will also be discussed.

SSCM 1023 Mathematical Methods 1

The course revises and extends Matriculation and STPM topics such as differentiation and integration and includes topics such as complex numbers and differential equations, which may be new to many students. Topics covered include parametric equations, functions, polar coordinates, vectors, and complex numbers. Students will learn how to define functions, and plot the graphs, using the Cartesian as well as polar coordinates; solve problems involving complex numbers and vectors. Additional topics include limits and continuity, differentiation techniques and its applications, integration techniques including improper integrals. Upon completion, the students would have acquired some quite powerful tools of analysis. This is also an introductory course on differential equations. Topic includes first order ordinary differential equations (ODEs). Students will learn how to classify and solve first order ODEs.

SSCY 1103 Cellular Biochemistry and Metabolism

Pre-requisite: SSCY 1713 Cellular and Molecular Biology

This course focuses on the metabolic pathways involving the four major biomolecules found

in most living organisms: carbohydrates, lipids and proteins, nucleic acid. The students will first be introduced to the general overview of metabolism, redox reaction in energy generation process. The focus will be on the central metabolic pathways of carbohydrates, followed by selected metabolism of lipids and proteins. The integration and regulation of the carbohydrates, lipid and proteins metabolism will be discussed to understand how these biomolecules interact in the cell and how metabolic processes are regulated. Practical are arranged in separate sessions to give students sufficient experience to develop their skills in biochemical analysis.

SSCY 1011 Cellular Biochemistry and Metabolism Lab

In Cellular Biochemistry & Metabolism Laboratory Session, students will conduct experiment on qualitative and quantitative analysis of carbohydrates, lipids and protein. Students will learn to do data collection, combine numerical and graphical in data analysis and students will be guided on providing relevant explanation of research findings. Demonstration on main laboratory machines and equipment will also be conducted.

SSCY 1403 Biostatistic

Biostatistic is the application of statistical methods to the biological and life sciences data to ensure findings are supported by reliable statistical evidence. This course provides an introduction to biostatistics concepts and interpretations

including descriptive statistics, probability distributions, statistical inference and prediction models. Students will be exposed using statistical analysis software R.

SSCY 1123 Bioorganic Chemistry

This course focuses on basic theory in bio-organic chemistry. Bio-organic chemistry is the knowledge of organic chemistry for the biology major. The fundamental of organic chemistry is essential prior to understanding the biochemistry and biomolecules since each of biological compound comprise of organic molecules. An introduction of this subject includes fundamental of the framework of organic compounds and their functional groups. The topic on the basic structure of biological compounds such as proteins, carbohydrates, nucleic acid, and lipid are enclosed. The understanding on how to interpret infrared (IR) spectrum from IR spectroscopy will be covered in detail.

SSCC 1203 Analytical Chemistry

This course provides a basic introduction to quantitative chemical analysis, with emphasis on wet chemical methods. Topics include introduction to analytical chemistry, sampling, sample preparation, data analysis & method validation, gravimetric analysis and volumetric analysis.

SSCC 1891 Analytical Chemistry Practical

The subject introduces students to Good Laboratory Practices in classical (wet chemistry) methods. Experiments are designed to complement the topics covered in Fundamentals of Analytical Chemistry (SSCH 2243), which include gravimetric and volumetric techniques. Part of the course consists of a short laboratory project.

SSCY 2613 Mycology

Pre-requisite: SSCT 1613 Microbiology

This course emphasizes on the fundamental of fungi. The Mycological kingdom of fungi classification will be explained. This course will also introduce the structure of fungi, development of reproduction system, mechanisms of spore release and classification of fungi based on life cycle. The physiology of fungi in general and specific selected species will be taught in this course. The physiochemical factors that affected the growth and metabolism of fungi will be explained. Several techniques involved in fungi isolation and improvement will be highlighted in this course. Ethical and safety issue regarding handling fungi will be explained. Post genomics perspective in fungal genomics which involve fungi genetic analysis, genomic analysis, pre and post genomic era will be highlighted in this course. The interaction of species in community of fungi will be discussed. The benefits and disadvantages of fungi in economic, agriculture, medical and industrial will be explained. At the end of the course student should be able to explain the ethical issue in fungi application

SSCY 2633 Virology

Pre-requisite SSCT 1613 Microbiology

Viruses are diverse and ubiquitous; almost every lifeform in the five kingdoms of life can be infected with viruses specific to each kingdom. Despite such diversity, all viruses share common molecular denominators that underlies the process of its infection, replication and release. This course will introduce students to viruses' diversity, the molecular aspects of virus entry, replication and assembly. It covers

the mechanism that viruses use to manipulate hosts to multiply and cause diseases. The course will make use of contemporary issues in virology to explain virus-host interactions and current diseases.

SSCY 2713 Genetic Engineering

Pre-requisite: SSCY 1713 Cellular and Molecular Biology

This course encompasses the basic principles and techniques involved in genetic engineering. The introductory lecture will expose students to genetic engineering and its application in various sectors of the industry such as agriculture, medical, pharmaceutical, environmental, etc. The following lectures will revolve around techniques in genetic engineering, cloning of heterologous genes in the *E. coli* host which will include common procedures in molecular biology, enzymes important in molecular biology, plasmids and bacteriophage as cloning vectors, gene libraries preparation and screening for gene of interest. Basic principles on gene transfer to different types of cells will also be introduced. Before the semester ends, students are to produce a group assignment relevant to genetic engineering as a form of team-working experience. Peer group evaluation and self-reflection report are mandatory.

SSCY 2711 Genetic Engineering Lab

This course encompasses the basic principles and techniques involved in molecular biology which will enable students to apply these techniques in the genetic engineering laboratory. Students will have the opportunity to hands on PCR amplification, agarose gel electrophoresis, DNA ligation, preparation of competent cells, transformation, and lastly verify the clones of interest by plasmid DNA extraction and DNA restriction digestion.

SSCY 2733 Genetics

Genetics is the science of heredity. Various concepts and branches will be introduced. The course introduces the science of genetics, concepts of classical genetic, the basic procedures for the genetic analysis of microorganisms, molecular genetics (mutation and DNA repair), the genetics of bacteria and their viruses and population genetics (The Hardy Weinberg Principle, natural selection, random genetic drift and populations in genetic equilibrium).

SSCY 2803 Enzymology

Pre-requisite: SSCY 1103 Cellular Biochemistry and Metabolism

This course provides the knowledge related enzymes, including fundamental properties (characteristics) of enzymes, enzyme catalytic preferences, enzyme kinetics, structures, as well as their relation to each other. In simple term, enzymology refers to the branch of science concerned with the study of enzymes. This course will introduce several tools (experimental and computational) frequently used in enzymology.

SSCY 2801 Enzymology Lab

In simple term, enzymology refers to the branch of science concerned with the study of enzymes. This course provides hands-on experience in characterizing enzymes. This laboratory section will assist the students to develop technical skills.

SSCY 2903 Plant Physiology

Plant physiology is an integrative discipline that answers questions about plant physiology (their function) from seed germination to vegetative growth, maturation and flowering. In this course, several aspects of plant physiologies which include plant water relations, water transportation, transpiration & phloem transport as well as mineral requirements. The basis of nomenclature and herbarium techniques for plant conservation will also be discussed. The mechanism involve in photosynthesis, respiration and lipid pathways will also be discussed. This courses also emphasize the roles of plant hormones and phytochromes in plant development & flowering respectively and secondary metabolites in plant defense. Other than that plant adaptation to environmental stress was also discussed.

SSCY 2901 Plant Physiology Lab

Plant physiology laboratory focused on morphology of basic plant cells, identification of leaf arrangement (leave margin & basal pattern) and types of fruits. Practicals also include hands on and preparation of herbarium for plant conservation. The factors affecting germination and plant growth (plant hormone) was performed as well as water potential (Gravimetric and Chardakov Method) in plant cells. The extraction of pigments was performed for thin layer chromatography. Finally, the measurement of chlorophyll using spectrophotometer at different environments was conducted as well as experiment using LiCor photosynthesis system. Plant physiology laboratory focused on morphology of basic plant cells, identification of leaf arrangement (leave margin & basal pattern) and types of fruits. Practicals also include hands on and preparation of herbarium for plant conservation. The factors affecting germination and plant growth (plant hormone) was performed as well as water potential (Gravimetric and Chardakov Method) in plant cells. The extraction of pigments was performed for thin layer chromatography. Finally, the measurement of chlorophyll using spectrophotometer at different environments was conducted as well as experiment using LiCor photosynthesis system.

SSCY 2303 Animal Physiology

The course provides students with the foundation of physiology - a study of functions in the living body. It covers physiological event at the cellular level (cellular physiology) and systemic level (animal physiology). Lectures will focus on molecular, cellular, tissue and systemic processes to explain how the function of a structure at different levels interrelate. Foundation from animal physiology applies to other courses such as cellular biology, microbiology, immunology, and biochemistry. Students could use foundations obtained from this course in the fields of biomedical investigation, such as cancer biology and host-pathogen interaction at the cellular and systemic level.

SSCY 3313 Immunology

Introduces the basic concept of immunology and mechanism of immune response for better understanding on the development of immune system. Mechanism of natural and acquired immune, structure and function of antibody will also be discussed further. Upon completion, students should be able to define and describe the role of immune system against infection and disease and their

example. This course will discuss issues related to SDG3 Good Health and Well-being.

SSCY 3413 Research Methodology in Bioscience

This course will introduce students to research methodology so as to develop understanding of the research process as applied to biological sciences. Students will learn about an overview of research and objective, research problem identification, literature study and review, research designs, instrumentation and measurements, data collection, data presentation, statistical analysis, preparation of research proposals, writing research reports and scientific presentation skills. Qualitative and quantitative research methodology and analysis of a particular research problem is proposed. The written proposal will be presented and evaluated.

SSCY 3803 Bioinformatics

This course covers the principles and methodology for Bioinformatics. It focuses on the application of computational methods and tools to study biological problems. This course will introduce the principles, scope, application and limitations of computational tools in bioinformatics. Elements such as coding and programming are also included in this course as part of the IR 4.0 initiative.

SSCU 3902 Undergraduate Project I

Students are required to execute a project (research) under an identified supervisor in an agreeable field of chemistry and document their findings. Students will learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate expected results, write current findings, and references. Finally, students are required to submit a research proposal and a draft project/research report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Expected Findings, Conclusion and References. This course will address Sustainability and Development Goals (SDGs) in particular SDG 4 that focus on obtaining a quality education is the foundation to improving people's lives and sustainable development, SDG 5 that focus on Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world and SDG 10 that focus on reducing the inequalities, policies should be universal in principle, paying attention to the needs of disadvantaged and marginalized populations.

SSCY 4452 Bioethics in Research and Development in Bioscience

This course provides an introduction to bioethical principles used to make decisions when confronted with ethical issues involving the application and usage of bioscience. The goal is to develop a framework for the appreciation and understanding of ethical dilemmas within the molecular and environmental fields. This course begins with a brief overview of ethics, and then moves to develop and consider the moral values and principles relevant to biotechnology and bioethics. The course hopes to develop moral wisdom (knowledge about ethics and the ability to think ethically) and moral virtue (a stronger commitment to act morally). Students will also be introduced to fundamental bioethical review systems, including the theory of peer review and moral and ethical responsibilities of scientists.

SSCU 4904 Undergraduate Project II

Pre-requisite: SSCU 4902 Undergraduate Project I

Students are required to execute a project (research) under an identified supervisor in an agreeable field of chemistry and document their findings. Students will learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate results, analyze findings, draw conclusion, write references, and to suggest further research. Finally, students are required to submit a proceeding and a project or research report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Analysis of Findings, Conclusion, and References. This course will address Sustainability and Development Goals (SDGs) in particular SDG 4 that focus on obtaining a quality education is the foundation to improving people's lives and sustainable development, SDG 5 that focus on Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world and SDG 10 that focus on reducing the inequalities, policies should be universal in principle, paying attention to the needs of disadvantaged and marginalized populations.

SSCU 4918 Industrial Training (Practical)

Undergraduate students from the Faculty of Science are required to undertake a period of 6 months industrial training relevant to their fields of study. The industrial training will take place during semester 8 at appropriate industries, laboratories or research institutions. With exception of Biology and Biotechnology, students of the other academic programmes are expected to undertake non-research related activities during the internship training. The internship training allows students to apply and further develop their knowledge and skills in the workplace. Students are expected to secure the internship placement themselves under the supervision of the industrial training coordinators from each department. Successful completion of the industrial training is mandatory for graduation from any undergraduate degrees offered by the Faculty of Science UTM, in complying with the MOHE and MQA regulations for undergraduate programmes in both public and private colleges and universities.

SSCU 4914 Industrial Training (Report)

This course is to be undertaken concurrently with SSCU 4918. Students will be graded through logbook and final report submitted at the end of the internship by both industrial and faculty supervisors.

ELECTIVE COURSES : MODULE CELL AND MOLECULAR BIOLOGY

SSCY 3113 Bioenergetics

Pre-requisite: SSCY 1103 Cellular Biochemistry and Metabolism

In this course, energy transformations in biological systems will be discussed. Essential features of cell metabolism and thermodynamic principles underlying biological processes will be described to relate processes by which energy is made available. Since most of the energy generated by heterotrophs is derived from the oxidation of substrates and plants from photosynthesis, processes related to oxidative phosphorylation and photophosphorylation will be emphasized.

Generation and consumption of energy in central metabolic pathways of carbohydrates and lipid metabolism be illustrated and compared.

SSCY 3733 Gene Therapy

The course will introduce the students to the background and basic principles of gene therapy. Study the current gene therapy approaches and strategies includes variety of vectors useful for gene delivery and non-viral vectors. Among the diseases of interest use as a model are cystic fibrosis, cancer, ADA, AIDS and SCID. The advantages, limitation, ethical issues, clinical trial and future of gene therapy will also be discussed.

SSCY 3813 Protein Separation Techniques in Biotechnology

Pre-requisite: SSCY 2803 Enzymology

In this course, fundamental knowledge of protein structure as well as chemical characteristics of proteins will be discussed. Different techniques of extraction and purification using will be described. Methods for characterisation of purified proteins will also be discussed. The efficiency of the protein purification technique is then evaluated in order to maximize protein recovery and purity.

SSCY 3833 Structural Biology

This course will provide an understanding of basic and applied aspects of macromolecular structure including structure-function relationships and structure determination techniques. This course will provide introduction to the different Macromolecular structure determination techniques such as Protein X-ray crystallography, NMR spectroscopy, circular dichroism spectroscopy and cryo-electron microscopy. Finally, this course will provide the students with knowledge of the applications of structural biology in the areas of biotechnology and in particular in the field of drug design and discovery

SSCY 3343 Cancer Cell Signaling

Pre-requisite: SSCY 1103 Cellular Biochemistry and Metabolism

This course provides an overview of the current understanding of the biological roles of extracellular and intracellular signaling molecules. First, the structure and function of signaling molecules, their role in various cellular responses and their disposition within the cell will be discussed. The role of signaling molecules in cancer signaling pathways regulation as well as their physiological and pathophysiological roles in cancer will also be described. Through this, the paradigm of signal transduction biology - as to how signaling molecules, signal transduction and activation of cancer pathways are inter-played are highlighted. In the final section, the potential therapeutic use of signal transduction is discussed to address the age-old question - what does the future hold for the signaling molecules.

SSCT 3323 Stem Cells and Tissue Engineering

The purpose of this course is to introduce students to the fundamental of tissue engineering. Initial emphasis will be focus on stem cell biology, repairing damaged tissues and to develop a fundamental understanding of the relationships between cells and the artificial scaffolds. Exploitation of this understanding to manipulate cell and tissue properties rationally to alter, restore, maintain, or improve cell and tissue functions as well as to design bioartificial tissue substitutes.

SSCY 3763 Gene Expression Technology

This course is designed to expose the students in understanding the molecular mechanisms in the expression and regulation of gene in both prokaryotes and eukaryotes. A brief introduction will be included, and the overview of the molecular genetics will be discussed. Regulation and the control of gene expression will be discussed by using several selected operons as model.

SSCY 3103 Nutritional Biochemistry

Students are required to execute a project (research) under an identified supervisor in an agreeable field of chemistry and document their findings. Students will learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate expected results, write current findings, and references. Finally, students are required to submit a research proposal and a draft project/research report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Expected Findings, Conclusion and References. This course will address Sustainability and Development Goals (SDGs) in particular SDG 4 that focus on obtaining a quality education is the foundation to improving people's lives and sustainable development, SDG 5 that focus on Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world and SDG 10 that focus on reducing the inequalities, policies should be universal in principle, paying attention to the needs of disadvantaged and marginalized populations.

SSCT 4333 Nanobiotechnology

This course relates to the understanding of the concept of nanobiotechnology and its recent findings or application especially in biology and biotechnology area. Nanobiotechnology can also be defined as bionanotechnology or nanobiology that apply the concept of nanotechnology for biology purpose. This course will focus on the definition of nanobiotechnology, understand its concept, recent application and examples of nanobiotechnology such as carbon nanotubes, silver nanoparticles, nanocelulose etc. Finally, students will discuss the issues related to the emerging of nanobiotechnology in term of nanotoxicology issue and effects to human health and environment.

SSCY 4773 Metabologenic

This subject is designed to provide a brief overview of metabolomics and metagenomics and its applications. At its core, metabolomics is global analysis of all or a large number of cellular metabolites, which combines strategies to identify and quantify cellular metabolites using analytical technologies with the application of statistical and multi-variant methods for information extraction and data interpretation. Meanwhile, metagenomics is the study of a collection of genetic material (genomes) from a mixed community of organisms and usually refers to the study of microbial communities. Hence, Metabolomics is the correlation of metagenomics and metabolomics enabling large-scale identification of gene clusters responsible for the biosynthesis of expressed metabolites.

SSCY 4713 Genomics and Proteomics

Students will learn the fundamental concepts of genomics and proteomics. Lectures will cover the structure, function, and evolution of the human genome.

Strategies for large-scale sequencing projects. Human disease genes. Expression. Bioinformatics for the analysis of sequence data; approaches for determining gene expression patterns and functions. Protein/peptide separation techniques, protein mass spectrometry, bioinformatics tools, and biological applications, which include quantitative proteomics, protein modification proteomics, interaction proteomics, structural genomics and structural proteomics.

SSCY 4313 Toxicology

An introductory toxicology course emphasizing on principles and applications of toxicology, overview of toxic substances including basic description on how substances are absorbed, distributed and eliminated from the body. Exposure on toxicokinetic models and biotransformation processes. Discussion on toxicity in specific target organs and its mechanism. This course also covers techniques of measuring toxicity, analysis of toxicological data and risk assessment. Case studies focusing on toxicity effects of natural and chemical toxins on human health, animals and other biological systems will be discussed.

SSCY 4733 Synthetic Biology

Pre-requisite: SSCY 2713 Genetic Engineering

This course offers an introduction to synthetic biology. It is designed for final year students who have an interest in bioengineering at the cellular network level. Students will be introduced to the field of synthetic biology and its application in systems biology and applied engineering. Students will be taught in quantitative terms the basic principles of operation of regulation at the cellular level, including metabolic, signalling and gene networks; discover how cellular networks can be reengineered, applications in metabolic engineering; describe computer models of cellular networks systems and how these can be studied experimentally. By the end of the course, students will be able to explain the network's possible dynamic behavior.

ELECTIVE COURSES : MODULE ENVIRONMENTAL SCIENCES

SSCT 3213 Green Technology for Sustainable Environment

Green technologies are playing significant role in changing the course of nation's economic growth towards sustainability and providing an alternative socio-economic model that will enable present and future generations to live in a clean and healthy environment. This course highlights green technology that are available and had been applied for sustainable environment. The benefit of green technology to the environment will be elaborated in few selected topics including biological control and environmental conservation, biodynamic concept in agriculture, green technology in energy generation, rain water harvesting and water reuse, as well as biocomposting of solid wastes. At the end of this course, student should be able to analyse the impact of using green technology to the benefit of environment and human.

SSCT 3673 Bioprospecting of Industrial Microorganism

Pre-requisite: SSCT 1613 Microbiology

Bioprospecting of industrial microorganism course will introduce the students to the systematic identification, evaluation, and exploitation of the diversity of life in a certain place, and it aims to seek genetic resources for commercial purposes.

This course will be focused on the strategies to exploit culturable and nonculturable shares of the microbial biodiversity. Another method that has been used by research is the in-silico prospecting of genome sequences of microorganisms that are already available in databases. All of that intends to identify microorganisms, genes, enzymes, and/or metabolic pathways for further biotechnological applications in industry. The course also aims to address the following topics such as identification of potential industrial microbes, microbial growth requirements, enumeration techniques and preparation of stock culture. Isolation of microorganism under extreme environment such as strict anaerobes, hyperthermophiles, alkalophiles, hypersaline and acidophiles will be highlighted. The important biotechnological application and benefits of each microbe will also be discussed.

SSCY 3633 Extremophiles

This course will give a broad overview of how life could survive, thrive and flourish under conditions considered to be 'extreme' in the human sense. More specifically this course will describe the environments where these organisms reside and shed light, at the molecular level, on the mechanisms that enable these unique organisms to survive. Covering all known types of extremophiles (including thermophiles, psychrophiles, halophiles, acidophiles, piezophiles, and alkaliphiles). The potential biotechnological products and its applications will be emphasised. Comparative modelling and docking study on binding affinity of selective extremophiles will be assessed. The evaluation of this course will be based on the test, assignment, presentation and final exam.

SSCY 3253 Bioremediation and Biodegradation

This course provides basic knowledge of bioremediation and biodegradation of pollutants in the environment. The process by which microorganism are stimulated to rapidly degrade hazardous organic contaminants to environmentally safe levels in soils, subsurface materials, water, sludge and residues will be discussed. It will also highlight the future prospects for biological systems to replace chemical processes, resulting in decreased operation costs and reduced pollution as compared to physico-chemical treatment options.

SSCT 3243 Biosensor Technology

Pre-requisite SSCT 2823 Enzyme Technology and Biocatalysis (+Lab)

This course will discuss the fundamental principles and applications of biosensors. More specifically it will cover the following subjects: What is a sensor? How does a sensor become biological in nature? The history of biosensors. What are the components of a biosensor? What are the types of transducers used in biosensors? What are bioreceptor molecules? How are bioreceptor molecules attached to the transducers, i.e. immobilised? What are the most important factors that govern the performance of a biosensor? In what areas have biosensors been applied? In addition, this course also gives students practical exposure to biosensor construction for analyte detection.

SSCY 3643 Biofilm and Microbial Communities

This course aims to provide understanding of bacterial biofilms and its microbial communities. Students will describe and explain the basis of biofilm development in nature and chronic infections, as well as to understand and interpret the outputs of modern techniques in microbial biofilm research.

SSCY 3603 Phycology

Pre-requisite: SSCT 1613 Microbiology

This course provides an introduction into algae and its application in industry. Topics include the definition of algae, techniques in applied phycology, characteristic seaweed properties on morphology, life history, physiology, genetics and ecology are provided for the further understanding of healthy and continuous utilization of coastal environments and seaweed resources.

SSCY 3263 Biological Control and Environmental Conservation

This course discussed about principle and philosophy of biological control agents and methods in implementing this technique, in order to develop alternatives for conventional pesticides that may be more acute in some commodities than in others. Various specific aspects in this course are; i) the conceptual of agents (types and mechanisms) and targets on quantitative techniques, ecology and behavior of selected natural enemies, ii) measures focus on beneficial arthropods, entomopathogenic nematodes, viruses and microorganisms, iii) as well as on the interaction between crop, pest and beneficial organisms, iv) the future and factors that limit the biological control. The study case and current issues also will be discussed to guaranteed the student alert with the effectiveness and benefit of this application. It is useful in encouraging student ability in debating biological control function of cultural and natural ecosystem management

SSCY 4293 Environmental Quality Management

This subject will focus on the relationships between science, management, and policy, while providing scientific understanding of ecological and social systems, applicable in a management or policy-making context. Besides, it will deal with the regulation process and protection of the health of the earth, by promoting human behaviours that make a positive impact on the natural environment. Professionals in the field investigate problems, develop solutions, and work in teams to address various types of environmental crises. This subject address hot topic issues such as global warming, pollution, deforestation, soil erosion, landfills, or depletion of Earth's natural resources. Students will learn how to assess, manage and monitor the environmental effects of organisations, participate in multidisciplinary project work, as well as develop critical thinking and problem solving. This subject includes project-oriented group-work and dealing with common real-life issues.

SSCY 4753 DNA barcoding

This course aims to increase awareness on DNA barcoding application particularly for biodiversity applications. This course will introduce students to fundamental steps required in the DNA barcoding workflow and data analysis. Furthermore, students will be exposed to cutting edge technology using next generation sequencing (NGS) (metabarcoding, shotgun metagenome and whole genome assembly) that have been applied for biodiversity conservation. We will also discuss how this technology could complement conventional taxonomy to achieve better biodiversity conservation impact.

SSCY 4473 Ecology

This course will introduce students to the major concepts, principles and elements of ecology i.e. higher levels of the organisation of life on earth and the interactions between organisms and their environment in a hierarchy of levels of organization:

individuals, populations, communities, and ecosystems. Students will then examine ways in which ecology can be applied to solving crucial environmental problems like global climate change, sustainability, agroforestry, biodiversity and conservation, invasive species, ecotoxicology, biomonitoring and bioremediation, and restoration ecology. Case studies are examined in detail. While some sociological and economic issues are discussed, the emphasis is on the biological aspects of these crucial problems.

SSCY 4233 Solid Waste Management

The agricultural practice course is a course specifically designs for advanced learners in solving various issues in conventional agricultural practice using biotechnological approach. The course covers various issues in conventional agriculture such as application of pesticides that can create environmental pollution, usage of high plantation area etc and then, the sustainable agriculture approach especially using biotechnological approach will be covered. Other topics includes understanding and applying the concept of Good Agricultural Practices (GAP) and Good Handling Practices (GHP). Finally, students will be exposed to bioeconomy and entrepreneurship skill as well as innovation in agricultural business.

SSCY 4493 Environmental Toxicology

This subject emphasizing a multidisciplinary field of science concerned with the study of the harmful effects of various chemical, biological and physical agents on living organisms and ecosystem levels. The course also deals with toxicological aspects on human absorption, distribution and metabolism of foreign substances. During the course, transmission, exposure and health effects of toxic metals and organic pollutants is described and in connection with this how regulation of intake/exposure of such substances can take place through the setting of limit values and dietary advice., as well as the importance of air pollution in both indoor - and outdoor environment. Toxicological effects of contaminated soil are described with special emphasis on the importance for housing construction. More specialised studies are made during the course of large environmental disasters of hormone-disturbing pollutants and of pharmaceuticals in the environment.

SYNOPSIS OF BIOTECHNOLOGY COURSES

Programme core courses

SSCT 1613 Microbiology

This course focuses on theory and fundamental concepts of microbiology involves the study of microorganisms with particular emphasis on the biology of bacteria, viruses, fungi and protozoan parasites. This course introduces students to develop basic skills related to microbiological techniques, particularly in aseptic techniques and microscopy which is synchronized with Microbiology Laboratory Course. Discussions are mainly on different classes of microorganisms especially bacteria: bacterial physiology and anatomy, nutrient requirements and physical factors influencing growth, metabolism and microbial genetics as well as metabolic diversity in microorganisms. A brief discussion on fungi and algae in relation to their benefits and applications also included. Students will be involved in discussion on physical and chemical control of microbial growth which is a part of controlling diseases caused by microorganisms, infectious diseases worldwide, understanding the environmental importance of microbes and to exploit them for food production, biotechnological and industrial applications. At the end of the topics, students will analyze the influence of microbiology and 21st century challenges and opportunities that arise from our changing relationship with and understanding of microbes. First Year Seminar is embedded in this course as part of the initiative on the 4.0 IR element. There will be involvement of stakeholders from the industry in teaching and learning activities for early exposure to real world scenarios.

SSCT 1611 Microbiology Lab

This course introduces the basic principles of microbiology examining the microbes that inhabit our planet and their effect on the biosphere. The objectives over the course of the semester are to train students to become proficient at laboratory skills and safety procedures. Students will also learn to follow experimental procedures. In this Microbiology Laboratory Course, students also going to develop skills of students to formulate answerable questions/hypotheses, predict expected results. Throughout the experiment and laboratory works, students will learn how to make careful observations, collect and analyze data, and draw appropriate conclusions which will be assessed in grouped-laboratory report every week. Active-learning opportunity in the laboratories should be grab by students to demonstrate good lab citizenry and the ability to work with others to carry out biological science experiments.

SSCY 1713 Cellular and Molecular Biology

This subject will facilitate students to understand and visualize processes in cell biology and those responsible for DNA transmission and expression hence mechanisms by which bacteria inherit genetic information as the blueprint of life. The lectures will explain relationship between structure and function in molecular biology and how this relationship operates to control biochemical processes. Topics include macromolecules like DNA, RNA, and proteins and how processes like replication, transcription and translation operate, eukaryotic genetics. Students will cover related aspects such as mutation and mutagenesis, effects of mutation and how cells overcome mutation. Students will also learn about basic

techniques in molecular biology as the basis for genetic engineering. PowerPoint presentation by each group will be done at the end of the semester on designated topics.

SSCT 1412 Introduction to Biotechnology

An Introduction to Biotechnology is a basic biotechnology course for BSc in Biotechnology with Hons. It covers the basic concept of Biotechnology field that encompasses both basic science and engineering. The integration of biological elements and engineering is essential in biotechnology field to produce products or services for fields such as industry, medical, agriculture, environment, petroleum and forensic. Types of biotechnology fields and job related to biotechnology programme will be discussed in detail during lecture. The application of different technology for various biotechnology field will be explained in detail. The pro and contra effect of biotechnology will be discussed for ethical issue assignments. This lecture will also be an eye opener to students regarding selection of biotechnology module in year 3.

SSCY 1103 Cellular Biochemistry & Metabolism

This course focuses on the metabolic pathways involving the THREE MAJOR biomolecules found in most living organisms: carbohydrates, lipids and proteins. Students will first be introduced to the general overview of metabolism, redox reaction in energy generation process. The main focus will be on the central metabolic pathways of carbohydrates, followed by selected metabolism of lipids and proteins. The integration and regulation of the carbohydrates, lipid and proteins metabolism will be discussed to understand how these biomolecules interact in the cell and how metabolic processes are regulated. Practical are arranged in separate sessions to give students sufficient experience to develop their skills in biochemical analysis.

SSCY 1101 Cellular Biochemistry & Metabolism Lab

In Cellular Biochemistry & Metabolism Laboratory Session, students will conduct experiment on qualitative and quantitative analysis of carbohydrates, lipids and protein. Students will learn to do data collection, combine numerical and graphical in data analysis and students will be guided on providing relevant explanation of research findings. Demonstration on main laboratory machines and equipment will also be conducted.

SSCY 1403 Biostatistics

Biostatistic is the application of statistical methods to the biological and life sciences data to ensure findings are supported by reliable statistical evidence. This course provides an introduction to biostatistics concepts and interpretations including descriptive statistics, probability distributions, statistical inference and prediction models. Students will be exposed using statistical analysis software R.

SSCY 1123 Bioorganic Chemistry

This course focuses on basic theory in bio-organic chemistry. Bio-organic chemistry is the knowledge of organic chemistry for the biology major. The fundamental of organic chemistry is essential prior to understanding the biochemistry and biomolecules since each of biological compound comprise of organic molecules. An introduction of this subject includes fundamental of the framework of organic compounds and their functional groups. The topic on the basic structure of

biological compounds such as proteins, carbohydrates, nucleic acid and lipid are enclosed. The understanding on how to interpret infrared (IR) spectrum from IR spectroscopy will be covered in details.

SSCT 2513 Fermentation Technology

Pre-requisite: SSCT 1613 Microbiology, SSCY 1103 Cellular Biochemistry & Metabolism

The course will be emphasized on fermentation technology and bioreactor design for microbial, plant and animal cell cultures. The student will be exposed to the strain development and improvement, development of cost-effective medium for large scale fermentation. The differences between solid state fermentation and submerged fermentation will be discussed. The physiology and kinetic of microbial growth and product formation in batch, continuous and fed-batch cultures will be explained. The students will have a knowledge on a differences and kinetics of batch and continuous sterilization process. The kinetic of air sterilization and theory of fibrous filter will be explained. The relationship of oxygen uptake rate (QO_2) and Oxygen transfer rate (KL_a) will be explained. In this course, Teaching Research Nexus strategy is implemented as part of the initiative of 4.0 IR element. There will be involvement of stakeholders from the industry in teaching and learning activities for early exposure to real world scenarios.

SSCT 2511 Fermentation Technology Lab

Pre-requisite: SSCT 1611 Microbiology Lab, SSCY 1101 Cellular Biochemistry & Metabolism Lab

The course will be emphasized on practical fermentation technology and bioreactor design of SSF and FMF fermentation. During lab sessions students will involve handling batch, continuous and fed batch fermentations. The students will be involved in sampling and analysis of biomass (X), substrate utilization (S) and products (P). Students will prepare a group lab report for the assessment of the practical laboratory.

SSCY 2713 Genetic Engineering

Pre-requisite: SSCY 1713 Cellular and Molecular Biology

This course encompasses the basic principles and techniques involved in genetic engineering. The introductory lecture will expose students to genetic engineering and its application in various sectors of the industry such as agriculture, medical, pharmaceutical, environmental, etc. The following lectures will revolve around techniques in genetic engineering, cloning of heterologous genes in the E. coli host which will include common procedures in molecular biology, enzymes important in molecular biology, plasmids and bacteriophage as cloning vectors, gene libraries preparation and screening for gene of interest. Basic principles on gene transfer to different types of cells will also be introduced. Before the semester ends, students are to produce a group assignment relevant to genetic engineering as a form of team-working experience. Peer group evaluation and self-reflection report are mandatory.

SSCY 2711 Genetic Engineering Lab

Pre-requisite: SSCY 1713 Cellular and Molecular Biology

This course encompasses the basic principles and techniques involved in molecular biology which will enable students to apply these techniques in the genetic engineering laboratory. Students will have the opportunity to hands on

PCR amplification, agarose gel electrophoresis, DNA ligation, preparation of competent cells, transformation, and lastly verify the clones of interest by plasmid DNA extraction and DNA restriction digestion.

SSCT 2543 Product Recovery in Biotechnology

Pre-requisite: SSCT 2513 Fermentation Technology

This course will introduce students to the fundamental understanding of unit operations involved in product recovery for downstream processing which include cell disruption, cell separation and purification. It will present the process development and relevant aspects involved in the downstream processing in biotechnology industries. The course also will include the importance of product concentration, chromatography purification, product analysis and final product formulation. This course will join with SSCT 2823 Enzyme Technology and Biocatalysis as cornerstone courses.

SSCT 2541 Product Recovery in Biotechnology Lab

Pre-requisite: SSCT 2511 Fermentation Technology Lab

This course will introduce students to the fundamental understanding of unit operations involved in product recovery for downstream processing which include cell disruption, cell separation and purification. In the product recovery laboratory, students will conduct the experiment on cell disruption from different methods, estimation of protein concentration from Lowry and Bradford method, and experiment for enzyme purification.

SSCT 2823 Enzyme Technology and Biocatalysis

Pre-requisite: SSCY 1103 Cellular Biochemistry & Metabolism

This course provides a body of knowledge relevant to the principles of enzymology and techniques employed in the utilisation of enzymes. This course presents a basic introduction to the principles by which enzymes catalyse reactions and provide knowledge of the theory as well as applications of modern approaches to enzyme technology. Students will also be introduced to the economic and commercial considerations concerning the viability of enzyme technologies. Finally, this course serves to provide an awareness of the current and potential future applications of enzyme technologies. This course will join with SSCT 2543 Product Recovery in Biotechnology as cornerstone courses.

SSCT 2821 Enzyme Technology and Biocatalysis Lab

Pre-requisite: SSCY 1101 Cellular Biochemistry & Metabolism Lab

In this course, students will conduct experiment on detection and characterization of enzyme. Students will firstly conduct the qualitative screening of enzyme using zone diffusion assay. Students will then immobilize enzyme in alginate beads and the activity of immobilized enzyme will be measured. In addition, the effects of temperature, metal ions, and salt on enzyme activity will be assessed. Students will also perform SDS-PAGE to determine the molecular size of the partially purified enzyme.

SSCT 2703 Gene Expression and Regulation

This course is designed to expose the students in understanding the molecular mechanisms in the expression and regulation of gene in both prokaryotes and eukaryotes. A brief introduction will be included and the overview of the

molecular genetics will be discussed. Regulation and the control of gene expression will be discussed by using several selected operons as model.

SSCT 2423 Research Methodology in Bioscience

This course will introduce students to research methodology so as to develop understanding of the research process as applied to biological sciences. Students will learn about an overview of research and objective, research problem identification, literature study and review, research designs, instrumentation and measurements, data collection, data presentation, statistical analysis, preparation of research proposals, writing research reports and scientific presentation skills. Qualitative and quantitative research methodology and analysis of a particular research problem is proposed. The written proposal will be presented and evaluated.

SSCT 3353 Animal Tissue Culture Technology

The course will cover historical aspect of animal tissue culture, biology of cultured cells, design and layout of the cell culture laboratory, equipment's and handling of the tissue culture. Aseptic technique, general safety, culture vessels and media preparation & sterilization will be discussed.

SSCT 3913 Plant Tissue Culture Technology

The course will cover historical aspect of plant tissue culture, biology of cultured cells, design and layout of the plant tissue culture laboratory, equipment's and handling of the tissue culture. Aseptic technique, general safety, culture vessels and media preparation & sterilization will be discussed. Plant tissue culture topics will include somatic embryogenesis and organogenesis; the role of plant growth regulators, factor affects pathways (pollen/anther culture), characterization of embryogenic plant cell based on morphological and histology, somaclonal variation, use of bioreactor in tissue culture industry. There will also be involvement of stakeholders from the industry in teaching and learning activities for early exposure to real world scenarios.

SSCT 3411 Tissue Culture Technology Lab

This course provides knowledge and general practices of animal and plant tissue culture with their role and applications in plant biotechnology research. The topics covered in animal tissue culture include media preparation, sterile techniques, aseptic handling, initiation and routine maintenance of cells in culture, common contaminants of animal cell culture and biochemical assay -related to current biotechnology. The practical session of plant tissue culture emphasized on preparation of different type of media (MS, LS and N6) as well as plant growth regulator stock and sterile technique. The factor related somatic embryogenesis such as plant growth regulators (auxin and cytokinin), amino acids and carbohydrate on callusing as well as rooting. The cytokinin effect on direct shooting from leaves sections will be performed. Finally, the use of Scanning electron microscopy for morphological analysis of embryogenic plant cell will be performed.

SSCU 3902 Undergraduate Project I

Students are required to execute a research project under an identified supervisor in an agreeable field of biology/biotechnology and document their findings. Selected projects will be co-supervised by stakeholders from industry. Students will

learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate results, analyze findings, draw conclusion, write references, and to suggest further research. Finally, students are required to submit a research proposal and a draft project/research report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Expected Findings, Conclusion and References.

SSCY 3803 Bioinformatics

This course covers the principles and methodology for Bioinformatics. It focuses on the application of computational methods and tools to study biological problems. This course will introduce the principles, scope, application and limitations of computational tools in bioinformatics. Elements such as coding and programming are also included in this course as part of the IR 4.0 initiative.

SSCT 3403 Trends in Biotechnology

This course introduces to an overview on the recent trends in biotechnology covering broad aspect of applications ranging from the prospect of day-to-day life to different aspects in industries, including medicine, pharmaceuticals, food processing, agriculture and industrial waste management. The integration of industrial and environmental biotechnology highlights the production of commercially valuable products from agriculture, municipal and industrial wastes. Recent advancements in biochemical engineering, OMICS, genetic engineering tools and synthetic biology will also be discussed as they play important role in paving the way innovatively for achieving effective application of microbes and plants as well as in product improvement for the generation of economy through biotechnology. This course focuses on the multidisciplinary aspect in biotechnology which is one of the 4.0 IR initiatives. There will be involvement of stakeholders from the industry in teaching and learning activities including industrial visit for exposure to real world scenarios.

SSCU 4904 Undergraduate Project II

Pre-requisite: SSCU 3902 Undergraduate Project I

Students are required to execute a research project under an identified supervisor in an agreeable field of biology/biotechnology and document their findings. Selected projects will be co-supervised by stakeholders from industry. Students will learn to gather information on chosen topics through literature survey/review activities, construct research methodology, anticipate results, analyze findings, draw conclusion, write references, and to suggest further research. Finally, students are required to submit a proceeding and a project or research report comprising of Title, Introduction, Statement of Problem, Research Objectives, Literature Survey/Review, Research Methodology, Analysis of Findings, Conclusion, and References. At the end of the research project, students will present their research findings in a symposium (Biosciences Undergraduate Research Symposium). Industrial panel will be invited to evaluate students' presentations.

SSCT 4413 Bioethics in Research and Development

This course provides an introduction to bioethical principles used to make decisions when confronted with ethical issues involving the application and usage of biotechnology. The goal is to develop a framework for the appreciation and understanding of ethical dilemmas within the biotechnological, pharmaceutical

and medical fields. This course begins with a brief overview of ethics, and then moves to develop and consider the moral values and principles relevant to biotechnology and bioethics. The course hopes to develop moral wisdom (knowledge about ethics and the ability to think ethically) and moral virtue (a stronger commitment to act morally). Students will also be introduced to fundamental bioethical review systems, including the theory of peer review and moral and ethical responsibilities of scientists.

SSCU 4918 Industrial Training (Practical)

Undergraduate students from the Faculty of Science are required to undertake a period of 6 months industrial training relevant to their fields of study. The industrial training will take place during semester 8 at appropriate industries, laboratories or research institutions. With exception of Biology and Biotechnology, students of the other academic programmes are expected to undertake non-research related activities during the internship training. The internship training allows students to apply and further develop their knowledge and skills in the workplace. Students are expected to secure the internship placement themselves under the supervision of the industrial training coordinators from each department. Successful completion of the industrial training is mandatory for graduation from any undergraduate degrees offered by the Faculty of Science UTM, in complying with the MOHE and MQA regulations for undergraduate programmes in both public and private colleges and universities.

SSCU 4914 Industrial Training (Report)

This course is to be undertaken concurrently with SSCU 4918. Students will be graded through logbook and final report submitted at the end of the internship by both industrial and faculty supervisors.

Electives courses: Environmental Biotechnology Module

SSCT 3213 Green Technology for Sustainable Environment

Green technologies are playing significant role in changing the course of nation's economic growth towards sustainability and providing an alternative socio-economic model that will enable present and future generations to live in a clean and healthy environment. This course highlights green technology that are available and had been applied for sustainable environment. The benefit of green technology to the environment will be elaborated in few selected topics including biological control and environmental conservation, biodynamic concept in agriculture, green technology in energy generation, rain water harvesting and water reuse, as well as biocomposting of solid wastes. At the end of this course, student should be able to analyse the impact of using green technology to the benefit of environment and human.

SSCT 3513 Microbial Biotechnology

This course introduces students to microbial biotechnology, the use of microbes to generate useful products or to degrade wastes (bioremediation). Discussion includes the application of microbes in different types of industries such as medical, pharmaceuticals and food industries. Application of microbes in solid waste biorefinery and wastewater treatment will also be discussed. In this course students will be guided to collect data related to microbial biotechnology

application through online survey, interview, newspaper cutting, news headlines, etc. Continuous monitoring will be carried out throughout the process of data collection, data management and finally the preparation of video clips. The course also introduces students to the commercial aspects of biotechnology, such as patent searches, as a way to establish novelty for potential new ideas.

SSCT 3233 Biocatalysis and Biotransformation in Environmental Biotechnology

Pre-requisite: SSCY 1103 Cellular Biochemistry & Metabolism

This subject will facilitate students to understand and visualize biocatalysis and biotransformation processes in environmental biotechnology. In general, biocatalysis refers to the use of living (biological) systems or their parts to speed up (catalyze) chemical reactions. In biocatalytic processes, natural catalysts, such as enzymes, perform chemical transformations on organic and be used to replace chemical catalysts, and this has the advantage that toxic by-products of chemical catalysis are bypassed. This makes it cleaner and removes the need to clean up the toxins. Another advantage of using enzymes is its specificity and ability to function in mild conditions. Enzymes are larger than traditional chemical catalysts, therefore there are more contact points between the substrate and the enzyme. Being a biological molecule, enzymes are able to function in milder conditions; this means that the substrate and the newly formed molecules do not need to be protected during the reaction. Also, modifications can easily be made to the enzyme via protein engineering, so that it can work with a different substrate. The modern usage of biotechnologically produced and possibly modified enzymes for organic synthesis is termed chemoenzymatic synthesis; the reactions performed are chemoenzymatic reactions. Powerpoint presentation by each group will be done at the end of the semester on designated topics.

SSCT 3223 Environmental Biotechnology

Environmental biotechnology is the development, use and regulation of biological systems for remediation of contaminated environments (land, air, water), and for environment-friendly processes (green manufacturing technologies and sustainable development). In this course, emphasis will be channeled on various types of contamination, in air, water and soil. Treatment of polluted air, wastewaters, soil and its adverse effect to the environment and ways of treating it, remediation of soils contaminated with hazardous and toxic chemicals will be discussed. The use of microbes and microalgae to produce energy will also be highlighted. The importance of Environmental Biotechnology to society and the current understanding of Malaysia towards this area will be looked into. Furthermore, current trends and research in environmental biotechnology will be explored and discuss. The course combines lectures and group work, where the students will apply their knowledge to actual case studies from industrial literature. Academic service learning which is one of the IR 4.0 elements will be conducted as teaching and learning activity for this course.

SSCT 3203 Industrial Wastes Management

This course provides students with principle knowledge on waste management of different types of industrial wastes. Highlight will be given on the types of waste and their characteristics, pollution prevention technology and pollution reduction in various types of industry and industrial estate, including resource management

in both regional and local areas. Due to unplanned developmental activities as well as ever-increasing population, which has caused enormous strain on the environmental resources, societies across the world face several problems of environmental degradation. However, it is imperative to maintain a balance between the capacity of the environment and the quantum of sustainable utilization. This is only possible by understanding the environment in its totality and the principles of its scientific management.

SSCT 3243 Biosensor Technology

Pre-requisite: SSCT 2823 Enzyme Technology and Biocatalysis

This course will discuss the fundamental principles and applications of biosensors. More specifically it will cover the following subjects: What is a sensor? How does a sensor become biological in nature? The history of biosensors. What are the components of a biosensor? What are the types of transducers used in biosensors? What are bioreceptor molecules? How are bioreceptor molecules attached to the transducers, i.e. immobilised? What are the most important factors that govern the performance of a biosensor? In what areas have biosensors been applied? In addition, this course also gives students practical exposure to biosensor construction for analyte detection.

SSCT 4213 Heavy Metals Bioremediation

This course covers the basic principles of heavy metals bioremediation by microorganisms with emphasis on the general ways in which microbes interact with metals. Some bacteria have evolved mechanisms to detoxify heavy metals, and some even use them for respiration. Microbial interactions with metals may have several implications for the environment particularly in the bioremediation of heavy metals contaminated sites.

SSCT 4813 Multi-omics for Environmental Applications

Omic approaches involve the analysis of biomolecules and their interactions in an organism or in the environment (meta-omics). This course will highlight the multi-omics approach to research in environmental sciences and technology, investigating how microbial community, gene function, and metabolism are influenced by environmental conditions. The basic principles and workflows of metagenomics, metatranscriptomics, metaproteomics, and metabolomics experiments will briefly be discussed, building on the previous courses on genomics, proteomics and bioinformatics. Students will then be exposed to experimental design using next generation sequencing and metabolomics and how to address the challenges of manipulating and analysing population-level -omics data. Students will learn how to process data from raw meta-omic sequencing files through appropriate bioinformatic methods and approaches for subsequent integrative statistical analyses. This course will also enhance students' skills for critically evaluating and discussing the appropriate peer reviewed scientific articles related to the applications of various -omics approaches for environmental applications.

SSCT 4273 Environmental Bioengineering

This course highlights global environmental issues stemming from rapid economic activities mainly from industrial manufacturing processes, oil and gas industry, agro industry, deforestation, logistic and many others. These subsequently generate abundant and possibly unmanageable amount of wastes of different forms mainly

wastewater, gases and solid biomass. Sustainability in the processes, products generated towards environment, human and other life forms will be among the main issue discussed in this course. Application of technologies for solving the environmental issues will be discussed and evaluated towards sustainable environment, living and economic. At the end of this course, student will be able to differentiate between the used of technologies in industries that gives adverse effect to environment/human and the used of technologies that improve the quality of environment and human life.

SSCT 4233 Solid Waste Management

The agricultural practice course is a course specifically designs for advanced learners in solving various issues in conventional agricultural practice using biotechnological approach. The course covers various issues in conventional agriculture such as application of pesticides that can create environmental pollution, usage of high plantation area etc and then, the sustainable agriculture approach especially using biotechnological approach will be covered. Other topics includes understanding and applying the concept of Good Agricultural Practices (GAP) and Good Handling Practices (GHP). Finally, students will be exposed to bioeconomy and entrepreneurship skill as well as innovation in agricultural business.

Electives programme: Medical Biotechnology Module

SSCY 3313 Immunology

Introduces the basic concept of immunology and mechanism of immune response for better understanding on the development of immune system. Mechanism of natural and acquired immune, structure and function of antibody will also be discussed further. Upon completion, students should be able to define and describe the role of immune system against infection and disease and their example. This course will discuss issues related to SDG3 Good Health and Well-being.

SSCT 3653 Medical Microbiology

Pre-requisite: SSCT 1613 Microbiology

This course will introduce students to the microbial species that cause human diseases. The course will cover topics ranging from pathogenic and non-pathogenic microorganisms. Medical microbiology is designed to promote an understanding of the effects of microorganisms on the human body. The study includes the standard precautions necessary for health maintenance as well as infection control. Current topics including antibiotic resistance, public health threats, and global health will also be discussed.

SSCY 3733 Gene Therapy

The course will introduce the students to the background and basic principles of gene therapy. Study the current gene therapy approaches and strategies includes verity of vectors useful for gene delivery and non-viral vectors. Among the diseases of interest use as a model are cystic fibrosis, cancer, ADA, AIDS and SCID. The advantages, limitation, ethical issues, clinical trial and future of gene therapy will also be discussed.

SSCT 3523 Drug Design and Discovery

This course introduces students to the drug discovery and development pipeline from target identification through preclinical development and regulatory considerations that a pharmaceutical or biotechnology company goes through to discover a new therapeutic drug. It covers topics such as target selection, lead discovery using computer-based methods, combinatorial chemistry, safety evaluations, clinical trials and regulatory assessment. Along the way students will also learn about molecular recognition, computer-aided drug design, ADME and toxicology as applied to the development of new medicines.

SSCT 3323 Stem Cells and Tissue Engineering

The purpose of this course is to introduce students to the fundamental of tissue engineering. Initial emphasis will be focus on stem cell biology, repairing damaged tissues and to develop a fundamental understanding of the relationships between cells and the artificial scaffolds. Exploitation of this understanding to manipulate cell and tissue properties rationally to alter, restore, maintain, or improve cell and tissue functions as well as to design bioartificial tissue substitutes.

SSCT 3623 Medical Virology

Viruses are diverse and ubiquitous; almost every lifeform in the five kingdoms of life can be infected with viruses specific to each kingdom. Despite such diversity, all viruses share common molecular denominators that underlies the process of its infection, replication and release. This course will introduce students to viruses' diversity, the molecular aspects of virus entry, replication and assembly. It covers the mechanism that viruses use to manipulate hosts to multiply and cause diseases. The course will make use of contemporary issues in virology to explain virus-host interactions and current diseases.

SSCT 4333 Nanobiotechnology

This course relates to the understanding of the concept of nanobiotechnology and its recent findings or application especially in biology and biotechnology area. Nanobiotechnology can also be defined as bionanotechnology or nanobiology that apply the concept of nanotechnology for biology purpose. This course will focus on the definition of nanobiotechnology, understand its concept, recent application and examples of nanobiotechnology such as carbon nanotubes, silver nanoparticles, nanocelulose etc. Finally, students will discuss the issues related to the emerging of nanobiotechnology in term of nanotoxicology issue and effects to human health and environment.

SSCT 4353 Application of Biotechnology in Cancer

This course provides an overview of current biotechnological applications in cancer treatment. The course begins by introducing the history of cancer, types, categories and characteristics of cancer as well as the role of medical biotechnology. Chapters 3 through 5 will further discuss in detail the direct applications of biotechnology in cancer treatment which includes screening and diagnostic methods of cancer biomarkers. It also leads to the understanding the relationship of the possible cancer cell signalling pathways involved, mode of anticancer treatment as well as types of drugs for targeted therapies. Additionally, students are required to be able to critically discuss the current trends and future of Biotechnology in the treatment and management of cancer.

SSCT 4393 Enzymes in Medicine

Pre-requisite: SSCT 2823 Enzyme Technology and Biocatalysis

This course introduces students to the applications of enzymes in the medical field. This course will start off with the overview on enzymatic applications in both industry and medicine while the following topics will focus more on therapeutics use of enzymes with special emphasis on enzymes such as thrombolytic proteases, asparaginase, urate oxidase, deoxyribonuclease etc. the remaining topic will discuss the use of enzymes in medical diagnostics. At the end of the course, students should have an in depth understanding of the existing applications of enzyme in medicine and will be able to critically evaluate and propose enzymes for novel medical applications.

Electives programme: Agricultural Biotechnology Module

SSCT 3973 Application of Plant Tissue Culture

This course elaborates the principles and applications of plant tissue cell culture in industrial biotechnology. Applications of plant tissue culture covers plant genetic engineering, production of disease-free plants, and production of secondary metabolites. The course will also provide knowledge in genetically modified organisms (GMOs) regulations and laws in Malaysia.

SSCT 3933 Plant Biochemistry

This course covers the basic principles of molecular function of a plant with a strong emphasis on molecular, biological, functional and regulatory aspects of plant biochemistry. The course also introduces students to the various commercial application of plant biochemistry that contribute to the solution of agricultural problems.

SSCT 3953 MicroRNA in Plant Biology System

This course introduces the functions of microRNAs in the regulation of plant development and responses to the surrounding environment. MicroRNAs are an important class of molecules that can be found in diverse groups of organisms, including plants and animals, and the investigation of their roles is a highly dynamic and "hot" research topic. This course address four main aspects, namely: microRNA discovery, the regulatory roles of microRNAs in various developmental processes, in response to abiotic factors, and in the context of biotic stress response regulation.

SSCT 3703 Plant Molecular Biology

This course will expose students on how by understanding powerful molecular biology techniques at DNA, RNA and protein level can help elucidate plants' unique characteristics (functional genomics). Understanding the fundamentals in model plant; *Arabidopsis thaliana*; allow plants to be genetically engineered to create 'designer plants' (i.e. GMOs) to suit specific needs, such as high resistance crops which are robust to stressful environment and adaptable to climate change. The extensive genetic diversity that exists in plant populations enables the identification of DNA changes (i.e. genetic mutations) responsible for quantitative and qualitative variation in traits of interest, which will be useful in plant breeding and other biotechnology applications. Latest research trend such as Next

Generation Sequencing (NGS) for whole genome sequencing of plant genomes of non-modelled plants will also be discussed using selected research papers.

SSCT 3723 Molecular Techniques for Food Quality Control

This course aims to increase awareness on food quality and safety and discuss how molecular technology could help regulatory bodies to perform better in ensuring consumer's right and safety. This course will introduce students to various current molecular techniques (DNA barcoding, High Resolution Melting/HRM) and cutting edge technology including metabarcoding using next generation sequencing (NGS) that have been applied for food quality control. We will also discuss how this technology could complement with traditional and chemical methods to achieve better food quality control. Students will also be exposed on how food quality control is regulated in Malaysia and globally.

SSCT 3823 Plant Proteomics

Students will learn the aspects of proteomics in plant. The fundamental concept of proteomics, extraction methods for different application and data analysis will be covered. Several areas in plant proteomics will be included such as chemical proteomics, secretome, peptidomics and expression proteomics. Computational part in plant proteomics will also be covered and divided into gel-based and (Mass Spectrometry) MS-based approaches.

SSCT 4913 Biofertilizer

For a sustainable agriculture system, it is essential to use renewable inputs (fertilizer, pesticides, water etc.) which benefit the plant and cause no or minimal damage to the environment. One possible way is to reduce the use of chemical fertilizers and pesticides. Chemical fertilizers are being used in increasing amounts in order to increase the output in high yielding varieties of crop plants. Chemical fertilizers are industrially manipulated substances composed of known quantities of nitrogen, phosphorus and potassium, and their exploitation causes air and groundwater pollution by eutrophication of water bodies. Topics discuss in this course will closely related with SDG12 which is to ensure sustainable consumption and production patterns.

SSCT 4253 Phytoremediation

Students will be exposed to the use of plants and their associated microbes to remediate environmental pollution. This is including technologies used as well as biological mechanisms involved in pollutant uptake, accumulation and transformation. Phytoremediation on of various contaminants including organics and inorganics will be discussed. Application of phytoremediation and job market related to phytoremediation will also be discussed.

SSCT 4433 Agribusiness and Entrepreneurship

This course is designed to give students a background in the decision-making process, day-to-day management skills and financial management required to effectively operate an agribusiness. Through exploring business types, economics, marketing, and business planning management, students will be introduced to business communications. Students will develop a business plan where they will learn about financing, record keeping, accounting, staffing, and protecting your business, taxes and government regulations. Students then move into marketing,

investigating how to persuade others to buy their products and services and learn how to manage an existing business.

SSCT 4933 Plant GMO/GMP, Biosafety and Bioethics

This course introduces students to the potential application of GMO/GMP to human. Emphasis will be on the importance of GMO/GMP production and the ethical and safety aspects of handling the products. The course also exposes students to some methods and standards use to label and detect the GMO/GMP prior to consumption by users. In addition, the course covers the policies used by different countries to ensure ethical and safe measurements are taken by the producers, manufacturers and distributors of GMO/GMP. This course will discuss issues related to SDG 2 – Zero Hunger.

Electives programme: Industrial Biotechnology Module

SSCT 3613 Industrial Microbiology

Pre-requisite: SSCT 1613 Microbiology

This course emphasized on the application of microorganisms to various types of industries. The mechanism and processes of microbes at industrial level will be explained. Production of primary and secondary metabolites by microbes using fermentation technology in commercial scale. These include antibiotic production, brewing process in beverages industry, food production, microbial spoilage of food and factors influencing. Insight to the bioremediation / biodegradation in wastes treatment processes, and bio-recovery process will be explained. Microbes in petroleum industry will also be discussed. Current issue related with industrial microbiology will be highlighted and addressed in E-portfolio as part of the IR 4.0 elements.

SSCT 3673 Bioprospecting of Industrial Microorganism

Pre-requisite: SSCT 1613 Microbiology

Bioprospecting of industrial microorganism course will introduce the students to the systematic identification, evaluation, and exploitation of the diversity of life in a certain place, and it aims to seek genetic resources for commercial purposes. This course will be focused on the strategies to exploit culturable and nonculturable shares of the microbial biodiversity. Another method that has been used by research is the in silico prospecting of genome sequences of microorganisms that are already available in databases. All of that intends to identify microorganisms, genes, enzymes, and/or metabolic pathways for further biotechnological applications in industry. The course also aims to address the following topics such as identification of potential industrial microbes, microbial growth requirements, enumeration techniques and preparation of stock culture. Isolation of microorganism under extreme environment such as strict anaerobes, hyperthermophiles, alkalophiles, hypersaline and acidophiles will be highlighted. The important biotechnological application and benefits of each microbe will also be discussed.

SSCT 3533 Natural Product

This course introduces students to the fundamentals of natural products, which hold a special place in drug discovery having provided and inspired numerous

lifesaving medicines and medical breakthroughs, particularly in the treatment of infectious diseases, cancer, hypercholesterolemia and immunological disorders.

SSCT 3503 Biorefinery Technology

A biorefinery technology course will emphasize on the sustainable processing that integrates biomass conversion processes to produce marketable products (food, feed, fuels, chemicals, heat and power) from biomass. The biorefinery concept is analogous to today's petroleum refineries, which produce multiple fuels and products from petroleum. Industrial biorefinery have been identified as the most promising route to the creation of a new domestic bio based industry. In this course the student will be exposed to the sustainable processing of biomass to value added products. The criteria if selection of biomass selection and suitable pre-treatment (physical, chemical, enzymatic and microbial) will be discussed. The biorefinery concept is built on two different "platforms" to promote different product slates. The "sugar platform" is based on biochemical conversion processes and focuses on the fermentation of sugars extracted from biomass feedstocks. The "syngas platform" is based on thermochemical conversion processes and focuses on the gasification of biomass feedstocks and byproducts from conversion processes. The selection and criteria of microorganisms which involved in biorefinery will be identified. Student will have an exposure on the utilization of green technology, nanocellulose and global model of biorefinery.

SSCT 3523 Drug Design and Discovery

This course introduces students to the drug discovery and development pipeline from target identification through preclinical development and regulatory considerations that a pharmaceutical or biotechnology company goes through to discover a new therapeutic drug. It covers topics such as target selection, lead discovery using computer-based methods, combinatorial chemistry, safety evaluations, clinical trials and regulatory assessment. Along the way students will also learn about molecular recognition, computer-aided drug design, ADME and toxicology as applied to the development of new medicines.

SSCT 3543 Halal Industry Regulation, Management and Practices

This elective course is design for professional Halal executive or parties involved in Halal industry. The fundamentals concept of Halal based on Malaysia References and standard approved by JAKIM will be introduced for product and services certification. Certified Halal Trainers and industry will facilitate the candidate with step-by-step guide involving discussion and practical on Halal Assurance system. Regulation and Practices alongside with the ethics based on Malaysia Halal Standard will be acquainted. Upon completion the successful candidate will be awarded a professional certificate in Halal Executive.

SSCT 4513 Bioreactor Design

This course introduces students to the fundamental understanding of bioreactor design, scale up/down and operation. It will present the basic principles and relevant aspects of designing a bioreactor for various industrial applications. The course also will include the interaction of biological cells with the engineering environment within a bioreactor, the theoretical basis of process scale-up and scale down, and the impact of cell engineering on bioreactor design and operation.

SSCT 4533 Biopharmaceutical Technology

This course will introduce students to the fundamental understanding of whole biopharmaceutical process development that involve cell line selection and engineering, upstream and downstream biopharmaceutical processing and quality unit management in biopharmaceutical industries. It will present the process development and relevant aspects that involve in the biopharmaceutical production in industries. The course also will include the importance of biosimilar and monoclonal antibodies, different between microbial and mammalian cell bioreactor, clean room and current Good Manufacturing Practices (cGMP) requirement, quality assurance (QA) and quality control, (QC) and regulatory pathway that required in the biopharmaceutical industries. There will be an involvement of stakeholders from the industry in teaching and learning activities including industrial visit for exposure to real world scenarios.

SSCT 4553 Fungal Biotechnology

Fungi play a pivotal role in fundamental and modern processes of biotechnology. Nowadays, many processes such as baking, brewing and the synthesis of alcohols, antibiotics, enzymes, organic acid as well as the additional pharmaceutical product are carried out using fungal bioproducts. Due to recent advances in genomics and rDNA technology, yeast and fungi have attained the forefront position because of their present industrial purposes. In general, the term "mycotechnology" is used, which states about the various roles of fungi with the addition to its impact on biotechnology as well as economy.

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