UNDERGRADUATE GUIDE BOOK 2016/2017

FACULTY OF CHEMICAL & ENERGY ENGINEERING (FCEE)

UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Faculty of Chemical and Energy Engineering (FCEE)

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MESSAGE BY THE DEAN

In the name of God, the most gracious and most merciful.

I am very pleased to welcome all the new students to the UTM-Faculty of Chemical and Energy Engineering (UTM-FCEE).

Congratulations for being among the cream of the candidates to get the opportunity to study in one of the top chemical engineering schools globally. I am pleased to announce that our undergraduate intake Cumulative grade point average (CGPA) this year is among the highest in Universiti Teknologi Malaysia.

At the heart of the success of the UTM FCEE lies its academic and support staff who are relentless and innovative in their efforts to produce the best talents within an exciting, productive, challenging and sustainable learning environment. At UTM FCEE, we are committed in our mission to nurture you into a global citizen who are innovative and entrepreneurial.

I hope and pray that you will grab every opportunity to learn, explore and experience not only about the discipline and profession of chemical, petroleum, gas, bioprocess and nuclear engineering, but also the life virtues; and to work hard to bring your dreams into reality. Above all, I hope that the experiences will equip you with the right attitude to make a difference to the society and to ultimately contribute for the universal well being. Do make as many friends as possible, and enjoy your years in UTM.

The faculty guide book contains information about the faculty, programmes, courses offered as well as the rules and regulations on academic matters for undergraduate students. Please go through the contents and plan your academic journey wisely.

Remember the hadith by the Prophet s.a.w. “Whoever follows a path to seek knowledge, Allah will make the path to Jannah (Paradise) easy for them.” [Sahih Muslim 2699; Sunan Tirmidhi 2945].

On behalf of the faculty members, I wish you all the best in your studies and future undertakings.

Thank you and best regards,

Professor Dr. Zainuddin Abdul Manan
Dean
UTM – Faculty of Chemical and Energy Engineering
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INTRODUCTION OF FACULTY

1.0 BACKGROUND

Faculty of Chemical and Energy Engineering (FCEE) was established on the 1st October 2015 with the merging of Faculty of Chemical Engineering and Faculty of Petroleum and Renewable Energy Engineering. FCEE consists of four (4) departments, Department of Chemical Engineering, Department of Bioprocess and Polymer Engineering, Department of Petroleum Engineering and Department of Energy Engineering. FCEE offers five (5) undergraduate programmes,

- Bachelor of Engineering (Chemical)
- Bachelor of Engineering (Chemical-Bioprocess)
- Bachelor of Engineering (Chemical-Gas)
- Bachelor of Engineering (Petroleum)
- Bachelor of Engineering (Nuclear)

FCEE also offers niche programmes at graduate level (Master and Doctor of Philosophy) since 1988.

1.1 VISION

To be a referred global centre of academic and technological excellence in Chemical and Energy Engineering.

1.2 MISSION

Nurturing holistic entrepreneurial human capitals in the field of Chemical and Energy Engineering for the universal prosperity and well-being

1.3 OBJECTIVES

- To produce professional, ethical, competent, and resilient graduates in Chemical and Energy Engineering
- To be a reference centre of research and technology development based on Chemical and Energy Engineering
- To contribute in human capital development and universal peace and prosperity through product commercialization, technology

FACULTY ADMINISTRATOR

2.0 ADMINISTRATION OF THE FACULTY

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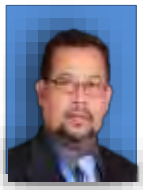

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3.0 ACADEMIC STAFF

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RESEARCH AND DEVELOPMENT

4.0 ABOUT RESEARCH AND DEVELOPMENT

UTM fosters a culture of collaboration across disciplines and encourages research over a multitude of boundaries. In line with this policy, research in the Faculty of Chemical and Energy Engineering (FCEE) has become almost borderless due to the breadth covered by our technical backgrounds and the fact that much of research activities ventured by the dedicated and well experienced researchers residing our laboratories converge with those of many other fields. In FCEE, research activities stretch along both macroscopic and microscopic frontiers of scale.

Looking towards molecular scale, various aspects of genetic engineering, bioinformatics and nanotechnology are being investigated. Examining molecular transport in living tissue, predicting the effects of molecular structure on material behaviour and properties, formulating cures for diseases as well as food supplements and healthcare products, our biotechnology researchers are continuing their efforts to facilitate human life.

At the other end, systems engineering researchers look at the various aspects of process plant design and operations from both technical and economic perspectives. Issues that hamper the profitability of process plant operations are addressed through research collaborations with local industries focusing on critical issues such as process control, optimisation, safety and plant design. In the search for better processing systems and strategies, both theoretical and empirical approaches are exploited. The use of statistics and artificial intelligence have facilitated the development of advanced control strategies as well as fault detection and diagnosis schemes that are required by modern process plants.

For energy related research, the current research structure has evolved since the program establishment in response to recruitment of a significant number of new academic staff and a substantial growth in research activities in both fundamental and applied studies, including gas transmission and distribution, combustion, applied dynamics, corrosion, storage and biomass engineering. Nuclear energy research area has been developed, concerning with the science of nuclear processes and their application to the development of various technologies. Nuclear processes are fundamental in the medical diagnosis and treatment fields, and in basic and applied research concerning accelerator, laser and superconducting magnetic systems. Utilization of nuclear fission energy for the production of electricity is the current major commercial application, and radioactive thermal generators power a number of spacecraft.

In between the two sides, varieties of innovations and inventions have emerged from various research activities offered by research groups in the faculty. Research in catalysis, separation technology, material science, gas engineering, nuclear engineering and environmental engineering continue to flourish. New inventions by some leading researchers have put the faculty in the limelight by winning numerous awards in product exhibitions at national and international levels.

The call for higher plant efficiency has also motivated developments of more intensified processes. By combining multiple processing approaches such as microwaves and heat transfer, electrochemistry and molecular separation, ultrasonic waves and magnetism, traditional process units are intensified to generate new processes that are not only compact but also efficient from both functional as well as operational perspectives.

FACILITIES

5.0 FACILITIES AT THE FACULTY

The faculty is equipped with various facilities in order to provide conducive teaching and learning environment. Currently, FCEE has 26 laboratories, a workshop, a mini library and qualified staffs to assist in teaching, research, consultation, publications and various forms of services. The laboratories include teaching laboratories for students to learn the practical aspects in chemical processes, research and service laboratories for research and consultancy activities of this faculty. Softwares such as BASIC, FORTRAN, PASCAL, C-LANGUAGE, HYSIS, MATLAB, ASPEN PLUS, CHEMSHARE DESIGN II, SUPERPRO, PLASCAM, FLACS, ECLIPSE, PETREL, T-NAVIGATOR, PROSPER, MBAL, Cfast v.6, PV Elite, Cadwork and Extensive Commercial Software Specialized in Petroleum Engineering Modelling and Simulation are also available to fulfil learning and research needs.

- Lecture Theatres, Halls, Classrooms and Laboratories
  FCEE has made continuous efforts to provide top class facilities for students. Each year, we raised the quality of our lecture theatres, classrooms and laboratories and increased the number of general purposes infrastructures in FCEE for the convenience of FCEE community. We believed that by providing state-of-the-art facilities it (1) may attract good students i.e. (undergraduates and postgraduates) world wide to study in our faculty, (2) promote interactive and exciting teaching and learning activity and last but not least, (3) it would facilitate a relaxing and comfortable teaching and learning enviroment at FCEE. The faculty is a free WiFi zone: the lecture theatres, classrooms and laboratories are fully covered by WiFi.

- Prayer Room
  Prayer rooms are available for the convenience of Muslim students to perform prayer. Two prayer rooms for the male students are located in N01-280-01 and in N11a. Meanwhile, a prayer room in N01-342-01 is allocated for the female Muslim students.

- Faculty Mini Library
  This is a mini library (resource centre) in the faculty, located at block N11a. It can accommodate 30 students at a time. This room is equipped with Internet and Audio Visual service for students. Reference materials, magazines and thesis from previous students, final year projects are also available. It is opened weekdays from 9.00 am until 4.00 pm.

- Computer Laboratory
  Sufficient internet ready computers are available in the Computer Lab, in block N21. This facility is provided to enable students to carry out their assignments and other academic-related matters.

STUDENT SOCIETIES

6.0 STUDENT SOCIETIES

Student societies are also set-up to encourage interactions among students and staffs and to inculcate positive genetic skills in students. Student Society has been set up in this faculty. These are Chemical Engineering Students Society, PRIM and BIOSS.

The society and club are located at block N05.

- **Bioprocess Student Society (BIOSS)**
  Bioprocess Student Society (BIOSS) is meant for bioprocess engineering students. This society encourages students to actively involved in activities nationally and internationally related to bioprocess engineering field and also social responsibilities.

- **Chemical Engineering Students Society (ChESS)**
  The society is meant for chemical engineering students of the faculty. This society is a platform for students to conduct activities related to their professional fields and voice their opinion concerning students' welfare. ChESS receives strong support from the institution of Chemical Engineering of Malaysia (ICheM) in conducting academic activities related to the chemical engineering field.

- **Gas Engineering Student Society (GESS)**
  GESS is a non-profit undergraduate organization that aims to enhance the campus life of over 100 chemical-gas engineering students through academic and social activities at FCEE. Their activies include industrial visit to gas processing and refiniries plants, educational forum and exhibition, first year camping program and yearly seminars which involved many participations from private companies and other local universities undergraduate participants.

  GESS is a student body for Chemical-Gas Engineering undergraduates chartered by UTM's Office of Student Affairs and Alumni (HEMA). With the support of Department of Gas Engineering, the club was established by the pioneering group of Chemical-Gas Engineering undergraduates in the early 90's. Since its establishment, the club strives to:

  (1) provide quality career, academic, and social services to its members through the organization of events, specially catering to the students needs.
  (2) enhance the premium Bachelor of Engineering (Chemical-Gas) program by closely working with the Faculty of Petroleum and Renewable Energy Engineering (FPREE) and oil and gas companies on various fronts.

  Over the years, GESS has been highly successful in evolving with its members. Many of the events organized by GESS have gained enormous support as well as accolades from its members, alumni, faculty, participated sponsors and industrial partners as they do find that these events are of mutual benefit to all parties involved. The important annual events that GESS have been organizing are as follows:

  (1) Freshmen Induction Camp.
  (2) Talk, Seminar, Workshop of different areas, such as self development, career, engineering and technology, and academic.
  (3) GESS Annual Dinner, GESS Alumni Night, and Grand Faculty Dinner (co-organized with FPREE and Department of Petroleum Engineering).
  (4) Global Outreach Programme.
  (5) Industrial visits.

The activities listed above are organized each year to cater the students' needs for academic, career and social services that they may not find in classrooms or from lecture. On top of the activities mentioned, the society also constantly looks for new and innovative ways to meet the needs of the

students more appropriately, such as an online databank of past years examination papers was created in 2010 to assist its members to prepare well for their examinations, etc.

Currently, GESS has 150 members. A board of committee is elected annually by its members in the club's general election to administrate the club's activities. As a student society, GESS depends greatly on volunteering students in helping to organize various events as well as for the contribution of ideas. In another word, GESS is a student body that provides a platform and opportunities for all of its members to take charge, practice to be leaders, and participate in achieving the club's mission.

- Nuclear Engineering Student Society (NESS)

  NESS was formed in 2014, has marked their success to local and international students in nuclear field by hosting invited speakers from around industry and government, professional development activities and workshops, student socials, a wide variety of intramural sports teams, and many other events throughout the year. One of the excellent achievement was they successfully organised Nuclear Youth Congress in 2014 by attracting 101 participant from 7 Malaysian universities and also 7 local and international speakers. It was also a history made as a new organization called the Malaysian Nuclear Youth Network (MNYN) which aims to become the driving force to the development of nuclear technology among youths in Malaysia has been launched during the congress.

  The Nuclear Engineering Student Society (NESS) is a student body for Nuclear Engineering undergraduates. NESS has also been accepted as a student chapter affiliated to Malaysian Nuclear Society (MNS). With the formation of NESS and with the support of the University and the Faculty, the society strives to:

  (1) provide quality career, academic, and social services to its members through the organization of events, specially catering to the students' needs.
  (2) enhance the Bachelor of Engineering (Nuclear) program by closely working with the Faculty of Petroleum and Renewable Energy Engineering (FPREE) and nuclear and nuclear related organizations on various fronts.

  During its brief existence, NESS has been actively involved in activities such as public relation exercises and getting involve in conferences both locally and overseas with participation of all members. These activities are supported by the University, the Faculty, faculty members and relevant organizations. In future important annual events that NESS will be organizing are as follows:

  (1) Freshmen Induction Camp.
  (2) Talk, Seminar, Workshop of different areas, such as self-development, career, engineering and technology, and academic.
  (3) NESS Annual Dinner and Grand Faculty Dinner (co-organized with FPREE, Department of Petroleum Engineering and Department of Renewable Energy Engineering).
  (4) Global Outreach Programme.
  (5) Industrial visits.

  Apart from the activities mentioned above, the society will also constantly look for new and innovative ways to meet the needs of the students, such as establish a network of similar societies from both in and out of the country to share knowledge and to explore possible collaboration in activities for the benefits of all.

  As NESS is a student body for Nuclear Engineering undergraduates, all undergraduates enrolled for the Bachelor of Engineering (Nuclear) in UTM will be automatically registered as a member of NESS and entitled for the benefits and services provided by GESS.

  Currently, NESS has 63 members. A board of committee is elected annually by its members in the club's general election to administrate the club's activities. The success of NESS depends greatly on the participation of its members in contributing ideas as well as organizing various events as. NESS, in effect is a student body that provides a platform and opportunities for all of its members to take charge, practice to be leaders, and participate in achieving the club's missions.

- UTM Society of Petroleum Engineers (SPE-UTM Student Chapter)

  The Society of Petroleum Engineers (SPE) is the largest individual-member organization serving managers, engineers, scientists and other professionals worldwide in the upstream segment of the oil and gas industry. Its global mission is to collect, disseminate, and exchange technical knowledge concerning the exploration, development and production of oil and gas resources and related technologies for the public benefit and to provide opportunities for professionals to enhance their technical and professional competence. Based in the United States of America, is also known as SPE Dallas. The organization actively offers a unique opportunity to contribute to the profession through programs and activities driven by dedicated members.

  The SPE-UTM Student Chapter is one of the 230 student chapters around the world. With a total of more than 300 members, it actively provides its petroleum engineering members the highest quality lifelong learning and continuous personal and professional growth to meet the industrial demand. In retrospect, SPE-UTM was originally known as Petro Club in 1974. In 1998, the club members made a unanimous decision to affiliate the Petro Club to SPE International as one of its branches in Malaysia. Since then, the club was rebranded to SPE-UTM Student Chapter and continues to strengthen its relationship with SPE-Kuala Lumpur, SPE-Asia Pacific as well as the major oil and gas players, such as Petronas, Shell, Talisman, Hess Oil, Murphy Oil, Baker Hughes, Schlumberger, etc.

  SPE-UTM Student Chapter offers many ways for members to connect with other members to learn, benefit and get involved. It provides a platform for members to communicate and collaborate to discuss industry topics in a technical interest group. It also allows members to speak to oil and gas professionals about their career guidance. Indirectly SPE members are given exposure and training in developing their generic skills, self-esteem and teamwork skills which is important to ease their initiation into the industry.

  Among the major programs organized by SPE-UTM Student Chapters are Oil & Gas Symposium (OGS), Shell Inter-varsity Student Paper Presentation Contest (SSPEC), and Oil & Gas Technology Expo & Conference (OGTEC). This is followed by Global Outreach Programs (GOP) to Indonesia, Singapore, China, Australia, Vietnam, Cambodia and Thailand. SPE-UTM members also are active in participating international events such as International Petroleum Technology Conference (IPTC) in Bangkok, Thailand, and Young Professional Engineers (YPE), Oil Expo, Oil & Gas International Parade (OGIP) in Jakarta, Indonesia to list a few.

  Since its establishment, SPE-UTM Student Chapter has been made the proud recipient for the most Outstanding Student Chapter Award for the year of 2007, 2008, and 2009. This is followed by the Gold Standard Award for the year of 2010, 2011, 2012, 2013, 2014 and 2015. On top of that, SPE-UTM Student Chapter also was awarded with the Past President Award for year 2011. For more information please visit our website www.speutm.org.

ACADEMIC ADVISOR

7.0 ACADEMIC ADVISOR

An academic advisor is assigned to students to assist them in their course and career planning to provide advice degree requirements and options, to provide advice on academic policies and procedures and to help them reach their academic goals.

Productive academic advising is a collaborative activity in which both the student and advisor have particular responsibilities. Having faculty-student contact at least once per semester is especially important because:

- Informal student-faculty contact can enhance the quality of the undergraduate experience.
- Course offerings and curricula requirements are sometimes subject to change.
- Undergraduate Plan of Study and Graduation Requirements sometimes need review and/or change that advisors can often be helpful with.
- Regular contact with an advisor will help provide a good source for recommendations later in your career.

Advisor's Responsibilities

- To be accessible to students throughout the year during designated office hours. Names of alternate advisors should be posted during extended absence of an advisor from campus.
- To set aside designated times for registration advising and individual discussions.
- To be knowledgeable about curriculum requirements, academic policies and procedures, referrals and resources on campus, and career opportunities in the major field.
- To guide students through academic programs that will complement their personal, educational and professional interests.

Student's Responsibilities

- To know your advisor's office hours and advising schedule
- To make an appointment and prepare for registration advising by reviewing the Curriculum, Class-Hour Schedule, and Pre-requisite requirements.
- To formulate questions regarding curriculum, course selections, career options, etc.
- To be aware of academic and personal needs and to seek assistance when needed.
- To understand that the role of your advisor is to *advise*, not to make decisions for you. Final decisions should be made by you, with advisement, since it's your education.

ACADEMIC CALENDAR

8.0 ACADEMIC CALENDAR

CALENDAR FOR 2016/2017 ACADEMIC SESSION
UNIVERSITI TEKNOLOGI MALAYSIA
DEGREE PROGRAMME

28 August 2016	Registration of New Students
28 Aug -3 Sept 2016	Student Orientation Week
2&3 Sept 2016	Course Registration for Semester I, 2016/2017 Academic Session

SEMESTER I 4 Sept 2016 - 11 Feb 2017 (23 weeks)	
4 Sept – 27 Oct 2016	Lectures Semester I (First Half) (8 weeks)
7 Sept 2016	*Senate Meeting
3 Oct 2016	*Senate Meeting
22 Oct – 24 Oct. 2016	*UTM 57th Convocation Ceremony
28 Oct - 5 Nov 2016	Mid-Semester Break, Semester I (1 week)
6 Nov – 15 Dec 2016	Lectures Semester I (Second Half) (6 Week)
2 Nov 2016	*Senate Meeting
4 Dec -15 Dec 2016	Courses Pre- Registration for Semester II, 2016/2017 Academic Session (UG)
7 Dec 2016	*Senate Meeting
16 Dec -24 Dec 2016	Revision Period Semester 1 (1 week)
26 Dec 2016 -12 Jan 2017	Final Examination for Semester I (3 weeks)
4 Jan 2017	*Senate Meeting
13 Jan – 11 Feb 2017	Final Break for Semester I (4 weeks)
8 Feb 2017	*Senate Meeting
12 Feb - 23 Feb 2017	Special Examinations for Semester I, 2016/2017 Academic Session
6 Feb - 8 Feb 2017	Course Registration of New Students for Semester II, 2016/2017 Academic Session (PG)
UG : 8&9 Feb 2017	Course Registration Semester II, 2016/2017 Academic Session (UG)
PG: 9 Feb - 23 Feb 2017	Course Registration Semester II, 2016/2017 Academic Session (PG)

SEMESTER II 12 Feb 2017 – 31 August 2017 (29 weeks)	
12 Feb – 30 Mar 2017	Lectures Semesters II (First Half) (7 weeks)
8 Mar 2017	*Senate Meeting
31 Mar – 8 April 2017	Mid-Semester, Break Semester II (1 week)
5 Apr 2017	*Senate Meeting
9 April – 25 May 2017	Lectures Semester II (Second Half) (7 weeks)
29 April – 30 April 2017	*UTM 58th Convocation Ceremony
10 May 2017	*Senate Meeting
14 May – 25 June 2017	Course Pre- Registration for Semester I, 2017/2018 Academic Session (UG)
26 May – 3 June 2017	Revision Period Semester II (1 Week)
4 June – 22 June 2017	Final Examination for Semester II (3 weeks)
7 June 2017	*Senate Meeting
23 June – 31Aug 2017	Final Semester Long Vocation (10 weeks)
5 July 2017	*Senate Meeting
9 August 2017	*Senate Meeting
23 July – 3 Aug 2017	Special Examination for Semester II, 2017/2018
29& 30 Aug 2017	Registration of Course for Semester I, 2016/2017 Academic Session (UG)

SHORT SEMESTER 2 July 2017 – 24 August 2017 (10 weeks)	
23 June - 30 June 2017	Final Break fot Short Semester (1 Week) 2016/2017 Academic Session
28 & 29 June 2017	Registration of Course for Short Semester, 2016/2017 Academic Session
2 July – 24 Aug 2017	Lectures short Semester (8 Weeks)
25 Aug – 31 Aug 2017	Final Break for Short Semester (1 Week) 2016/2017 Academic Session

PROGRAMME OF STUDY

9.0 PROGRAMME OFFERED

The Faculty is currently offering two undergraduate programmes:

1. Bachelor of Engineering (Chemical)
2. Bachelor of Engineering (Chemical-Bioprocess)
3. Bachelor of Engineering (Chemical-Gas)
4. Bachelor of Engineering (Petroleum)
5. Bachelor of Engineering (Nuclear)

Intake Requirements for Full Time Bachelor Programmes

1. Matriculation Candidates

General University Requirements

- Pass SPM/equivalent with good results
- Pass Malay Language and Mathematics with distinctions at SPM / equivalent level
- Pass KPM Matriculation Certificate/UM Fundamental Science with at least:
  - a CGPA of 2.00 and
  - pass all major courses
- Fulfil the special requirements for a particular course
- Have sat for the Malaysian University English Test (MUET)

Special Requirements Based On Course

- Pass SPM/equivalent with distinction in Mathematics and Physics
- Pass KPM Matriculation Certificate/UM Fundamental Science with minimum Grade B- in Mathematics, Chemistry/Engineering Chemistry, Physics/ Engineering Physics/ Biology and obtained a CGPA of at least 3.00.
- Candidate must not be physically handicapped which makes him/her unable to conduct experimental/practical work.

2. STPM Candidates

General University Requirements

- Pass SPM/equivalent with good results
- Pass Malay Language and Mathematics with distinction at SPM / equivalent level
- Pass STPM/equivalent with at least:
  - Grade E in General Knowledge/General Paper
  - Grade E in 2 of the required courses
- Have sat for the Malaysian University English Test (MUET)

Special Requirements Based On Course

- Pass SPM/equivalent with distinction in Mathematics and Physics
- Pass with a Grade B- in Additional Mathematics or Advanced Additional Mathematics, Chemistry and Physics/ Biology and obtained a CGPA of at least 3.00.
- Candidate must not be physically handicapped which disable them from conducting experimental work.

9.1 BACHELOR OF ENGINEERING (CHEMICAL)

Chemical Engineering is a field that is expanding widely throughout the world. The expertise is greatly needed to fulfil the demand for carrying the task that cannot be performed by the mechanical engineers and chemists. This field has matured and currently covers many aspects of engineering such as systems design and processing of agricultural products, petroleum and petrochemicals, polymers, pharmaceuticals, biofuel, biochemicals and many more. In the current state of the world, where resources are limited and sustainable development is a major challenge, the requirement for expertise in chemical engineering is even more crucial.

In addition to fundamental fields such as science and mathematics, humanities and social sciences and basic engineering, there are four major areas in the Bachelor of Chemical Engineering course. These are separation technology, reaction engineering, environmental engineering and process systems engineering.

In separation technology, students are exposed to processes and unit operation equipment in chemical engineering. To understand separation processes, a strong grasp on transport phenomena, which include momentum transfer, mass and heat transfer, is necessary. Mass and heat transfer theories are essential in designing or choosing a suitable heat exchanger to be utilized in a chemical plant. Meanwhile, the unit operation subject covers theories and design of major equipment in the separation of liquid-liquid, gas-liquid, solid-liquid and solid-gas systems. Among the equipment are distillation, evaporation, drying, absorption, leaching and other separation techniques such as membrane technology and filtration. Knowledge in separation theory and unit operations is necessary in designing an optimum and safe plant.

Chemical engineering also focuses on the thermodynamics and chemical reaction aspects apart from designing a reaction system. Amongst the topics discussed are reaction kinetics in a reactor, types of reactor and reactor design. The students will learn chemical engineering thermodynamics aspects, which elucidate the characteristics of pure fluid, thermal effects, fluid thermodynamics characteristics, homogeneous thermodynamics characteristics, phase equilibrium and chemical reaction equilibrium. The knowledge will consequently be used in learning chemical reaction of processes. Another important aspect in chemical engineering is environmental safety. Environmental engineering courses cover types of air and water pollution, and also analytical method for pollution measurement, waste treatment and waste management. The workers safety aspects will also be introduced.

In process systems engineering, mass and energy balances is the fundamental subject. In this subject, the students will be introduced to the processes in chemical engineering as well as the calculation method for mass and energy balances for different processes. This includes the processes that have chemical reactions and also processes with physical transformations only. The skill in calculating mass and energy balances is very important in many other chemical engineering courses.

The crux of the chemical engineering course is plant design and synthesis, which includes the selection of process, constructing flow sheets, mass and energy balance, detailed design, selection of equipment and raw materials, process control, operational instruction, cost and economics and also environmental and safety aspects in a plant. Students are also required to complete a processing plant design project in groups. Here, all the techniques learnt in the previous years will be integrated in proposing a design for an assigned plant.

Apart from chemical engineering theories, students are also exposed to practical aspects of the field. Every area mentioned before has its own practical or laboratory sessions. The students are also required to

prepare a project report to train them to integrate technical knowledge with communication and management in carrying out a task. For the group exercise, the students are required to complete a plant design as mentioned before. In addition, students will also carry out a bachelor's level research project, in which they will individually work under the supervision of a lecturer. At the end of the design and research work, the students are required to prepare a thesis and give an oral presentation, which will be evaluated by internal and external examiners.

The UTM curriculum requires students to undergo industrial training for 12 weeks during the semester break after the third year of education. A written report about the work done and experiences during the training must be presented at the end of the training period.

Career Opportunities

Chemical engineers are universal engineers, who are versatile and capable of performing many types of tasks. They can be assigned in various sectors of industries including banking, insurance, administration and business. However, many are working in the industry as production and process engineers, maintenance engineers and project engineer. With their ability spanning these three important aspects, many chemical engineers have been promoted to the position of plant manager, which manages the whole processing plant. The industrial sectors that need many chemical engineers are petroleum and petrochemicals, palm oil and oleo chemicals, rubber and plastics, pharmaceuticals and medicine, food and electronics. Here the chemical engineers' job is to ensure the design and the operation is carried out in an optimum condition, economical, safe as well as environmentally friendly manner.

With rapid development in the process industry, the need for chemical engineers in sectors supporting the industry is also becoming more important. For example, the demand for chemical engineers in banking and insurance industry is increasing. A chemical engineer is needed in the management and marketing of raw materials, products and main equipment and instrumentation, which are related to the processing industry. Many engineering consulting companies are also opened and this gives more career opportunities for the newly graduating chemical engineers.

Chemical engineers are needed in semi-government sectors such as in MIDA and the Department of Environment. They are also desired in research institutions such as in MPOB, MARDI and RRI. In institutions of higher learning, chemical engineers with PhDs are highly in demand.

For students in the Bachelor of Chemical Engineering program, the tendency towards any specific industry can be fulfilled by choosing the right optional courses. This will provide them with additional suitable expertise for the industry.

Chemical Engineering Laboratories

1. Process Design Laboratory
2. Process Control Laboratory
3. Particle Technology Laboratory
4. Chemical Reaction Engineering Laboratory
5. Unit Operation Laboratory
6. Environmental Engineering Laboratory

Program Specifications for Bachelor of Engineering (Chemical)

1.	Programme Name	Bachelor in Chemical Engineering	
2.	Final Award	Bachelor of Engineering (Chemical)	
3.	Awarding Institution	Universiti Teknologi Malaysia	
4.	Teaching Institution	Universiti Teknologi Malaysia	
5.	Programme Code		
6.	Professional or Statutory Body of Accreditation	Board of Engineers Malaysia (BEM)	
7.	Language(s) of Instruction	English and Bahasa Melayu	
8.	Mode of Study (Conventional, distance learning, etc)	Conventional	
9.	Mode of operation (Franchise, self-govern, etc)	Self-governing	
10.	Study Scheme (Full Time/Part Time)	Full Time	
11.	Study Duration	Minimum : 4 yrs Maximum : 6 yrs	
	Type of Semester	No. of Semesters	No. of weeks per semester
	Normal	8	14
	Short	4	8
12. Entry Requirement		Matriculation or STPM with minimum of B- in Mathematics/ Additional Mathematics/ Further Additional Mathematics, Chemistry/ Engineering Chemistry and Physics/ Engineering Physics/ Biology with CPA 3.00 and not physically handicapped which makes him/her unable to conduct experimental/ practical work.	

13. Programme Educational Objectives

PEO 1 Graduates perform competently in chemical and bioprocess industries and become important contributors to national development.

PEO 2 Graduates become creative, innovative and adaptable engineers as leaders or team members in their organisations and society.

PEO 3 Graduates contribute professionally towards the environmental well-being and sustainable development.

Program Specifications for Bachelor of Engineering (Chemical)

14. Programme Learning Outcomes (PLO)		
Intended Learning Outcomes	**Teaching and Learning Methods**	**Assessment**
Technical Knowledge and Competencies		
PLO1 Apply general knowledge, sciences, chemical engineering principles to solve complex chemical engineering problems		
Ability to apply general knowledge, sciences, chemical engineering principles to solve complex chemical engineering problems	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, reports, problem-based exercises, group projects, and independent projects.
PLO2 Investigate, design and conduct experiments, analyze and interpret data, and apply the research skills to solve complex engineering problems		
Ability to investigate, design and conduct experiments, analyze and interpret data, and apply the research skills to solve complex engineering problems	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports and, laboratory reports and skill, presentations, individual research project and exercises.
PLO3 Design a system or process for solving complex chemical engineering problems to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations		
Ability to design a system or process for solving complex chemical engineering problems to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.
PLO4 Inculcate modern computational techniques and skills to solve complex chemical engineering activities.		
Ability to inculcate modern computational techniques and skills to solve complex chemical engineering activities.	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, presentations, design project, individual research project, computer project and assignment
PLO5 Responsibly act as well as response to the societal health, safety, environment, legal and cultural issues that are relevant to the professional chemical engineering practice		
Ability to responsibly act as well as response to the societal health, safety, environment, legal and cultural issues that are relevant to the professional chemical engineering practice	Group projects, group discussion, problem-based learning, cooperative and collaborative learning, tutorials, undergraduate project, and design project.	Written assignments, laboratory reports, essays, thesis, forum and oral presentations.

Intended Learning Outcomes	Teaching and Learning Methods	Assessment
Generic Skills		
PLO6 Practice professional chemical engineering knowledge for sustainable development.		
Ability to practice professional chemical engineering knowledge for sustainable development.	Lectures, industrial training, undergraduate project, field development project, cooperative learning, and problem-based learning.	Group reports and presentations, learning logs/journal, peer and lecturer evaluations.
PLO7 Integrate the first principles of mathematics, natural sciences and chemical engineering for solving complex engineering problems through creative, innovative, lateral and critical thinking skills.		
Ability to integrate the first principles of mathematics, natural sciences and chemical engineering for solving complex engineering problems through creative, innovative, lateral and critical thinking skills.	Lectures, tutorials, seminars, laboratory works, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory skill reports, presentations, design project, individual research project and peer assessment.
PLO8 Communicate effectively through written and oral modes to all levels of society.		
Ability to communicate effectively through written and oral modes to all levels of society.	Group projects, group discussion, problem-based learning, cooperative and collaborative learning, tutorials, undergraduate project, and design project.	Written assignments, laboratory reports, essays, thesis, forum and oral presentations.
PLO9 Work independently, and as a member or a leader in a team to manage project in multi-disciplinary environment		
Ability to work independently, and as a member or a leader in a team to manage project in multi-disciplinary environment.	Industrial training, undergraduate project, design project, co-operative learning, and problem-based learning.	Group reports and presentations, learning logs/journal, peer and lecturer evaluations.
PLO10 Work ethically according to the norms of chemical - engineering practice.		
Ability to work ethically according to the norms of chemical - engineering practice.	Lectures, industrial training, undergraduate project, field development project, cooperative learning, and problem-based learning.	Group reports and presentations, learning logs/journal, peer and lecturer evaluations.
PLO11 Acquire knowledge and engage in life-long learning.		
Ability to acquire knowledge and engage in life-long learning.	Industrial training, industrial visit, undergraduate project, design project, and problem-based learning	Industrial training report, self-directed learning report, learning portfolios/ journal, and project report and presentation.
PLO12 Acquire entrepreneurship skills and business insights.		
Ability to acquire entrepreneurship skills and business insights.	Lectures, class projects, industrial training, undergraduate project, and design project.	Forum, presentations, assessment by industrial supervisor, test and examinations

15. Classification of Courses			
No.	**Classification**	**Credit Hours**	**Percentage**
i.	University a. General b. Language c. Co-Curriculum	 12 6 2	14.8 %
ii.	Faculty Core	40	29.6 %
iii.	Programme Core	66	48.9 %
iv.	Programme Elective	9	6.7 %
	Total	**135**	**100 %**

Classifications based on field
(others please refer to the Statutory Body guidelines)

No.	**Classification**	**Credit Hours**	**Percentage**
A	Engineering Courses (a) Lecture (b) Laboratory/Workshop (c) Industrial Training (d) Final Year Project	 72 6 5 6	65.9 %
	Total credit hours for Part A	89	
B	Related Courses (a) Applied Science/Maths/Computer (b) Management/Law/Humanities/Ethics (c) Co-Curriculum (d) Others	 26 18 2 -	34.1 %
	Total credit hours for Part B	46	
	Total Credit Hours for Part A and B	**135**	**100 %**
16. Total credit hours to graduate		**135 credit hours**	

17. Programme structures and features, curriculum and award requirements

This programme is offered on full-time mode and is based on a 2-Semester Academic Session with several courses being delivered and assessed in each semester. Assessment is based on coursework, final examination and final year project.

Award requirements:

To graduate, students should:

- Achieve a total of 135 credit hours with minimum CPA of 2.00

Core Courses for Minor in Chemical Engineering

For students from different approved programmes who wish to have a Minor in the Chemical Engineering Programme, they must complete 21 credit hours of selected courses.

	Courses			
No	Code	Name of Courses	Credit	Pre-requisite
1.	SKKC 1113	Mass Balance	3	
2.	SKKC 2133	Energy Balance	3	SKKC 1113
3.	SKKC 2253	Chemical Engineering Thermodynamics	3	
4.	SKKC 3323	Separation Processes	3	SKKC 2133
5.	SKKC 3263	Chemical Reaction Engineering	3	SKKC 2253
6.	SKKC 4143	Plant Design	3	SKKC 3263
7.	SKKC 4563	Process Safety & Operability	3	
Total Credits for Minor			21	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 1	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKC 1511	Industrial Seminar & Profession	1	
	SKKC 1523	Introduction to Engineering	3	
	SKKC 1213	Statics	3	
	SKKC 1533	Introduction to Computer Programming	3	
	SSCE 1693	Engineering Mathematics I	3	
	SKEU 2003	Electrical Technology	3	
	ULAB 1122	Academic English Skills	2	
		Subtotal	**18**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKC 1113	Mass Balance*	3	
	SKKC 1223	Thermodynamics	3	
	SKKC 1121	Engineering Drawings	1	
	SSCE 1993	Engineering Mathematics II	3	
	SSCK 1603	Organic Chemistry: Functional Group	3	
	SSCK 1831	Organic Chemistry Practical	1	
	UICI 1012	Islam & Asian Civilization	2	
		Subtotal	**16**	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL)
4 YEAR PROGRAMME, INTAKE 2016/2017

Y E A R 2	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SSCE 1793	Differential Equations	3	
	SSCK 2613	Organic Chemistry: Biomolecules	3	
	SKKC 2133	Energy Balance*	3	SKKC 1113
	SKKC 2233	Fluid Mechanics	3	
	SKKC 2243	Materials Engineering	3	
	SKKC 2711	Fluid Mechanics Laboratory	1	
	ULAB 2122	Advanced Academic English Skills	2	
		Subtotal	**18**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SSCK 1203	Analytical Chemistry for Engineering	3	
	SSCK 1891	Analytical Chemistry Practical	1	
	SKKC 2253	Chemical Engineering Thermodynamics	3	SKKC 2133
	SKKC 2313	Transport Processes*	3	SKKC 2123
	SKKC 2721	Thermodynamics and Material Eng. Laboratory	1	
	SSCK ###3	Physical Chemistry (Quantum)	3	
	UHAS1172 /UHAS1162	Dinamika Malaysia / Arts, Custom and Beliefs (International Student)	2	
	UKQ ###2	Co-curriculum		
		Subtotal	**18**	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL)
4 YEAR PROGRAMME, INTAKE 2016/2017

Y E A R 3	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKC 3543	Numerical Method & Optimization	3	
	SKKC 3263	Chemical Reaction Engineering	3	SKKC 2253
	SKKC 3323	Separation Processes*	3	SKKC 2313
	SKKC 3413	Pollution Control Engineering	3	
	SKKC 3731	Pollution Control and Reaction Laboratory	1	
	SKKC 4##3	Elective 1	3	
	UHAS ###2	Entrepreneurship & Enterprise Development Cluster	2	
		Sub total	**18**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKC 3553	Process Control & Instrumentation*	3	SSCE 1793
	SKKC 3333	Unit Operations & Industrial Processes	3	
	SKKC 3741	Separation Processes Laboratory I	1	SKKC 3323
	SKKC 3812	Undergraduate Project I	2	
	SKKC 3343	Engineering Economics and Project Management	3	
	SKKC 3751	Process Control Laboratory	1	
	ULAB 3162	English for Professional Purposes	2	
		Subtotal	**15**	
	SEMESTER 3			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKC 3915	Industrial Training	**5**	
		Subtotal	**5**	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 4	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	UICI 2022	Science, Technology and Mankind	2	
	SKKC 4761	Separation Processes Laboratory II	1	SKKC 3323
	SKKC 4143	Plant Design*	3	SKKC 3323
	SKKC 4824	Undergraduate Project II	4	SKKC 3812
	SKKC 4##3	Elective 2	3	
	U### ###2	Self, Community Dev. Cluster # / Malay Language (For Int. Student)	2	
		Subtotal	**15**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKC 4563	Process Safety & Operability	3	
	SKKC 4834	Plant Design Project**	4	SKKC 4143
	SKKC 4##3	Elective 3	3	
	U### ###2	Innovation & Creativity Cluster	2	
		Subtotal	**12**	
		TOTAL CREDIT	**135**	

*** - cornerstone; ** - capstone course**

ELECTIVE COURSES - STREAMING (CHOOSE one STREAM only)

1)Advanced Materials
- SKKC 4013 Polymer Composites
- SKKC 4023 Smart Materials
- SKKC 4033 Biomaterials

2)Polymer Science and Technology
- SKKC 4613 Fundamentals of Polymer
- SKKC 4623 Polymer Physics and Properties
- SKKC 4633 Polymer Rheology and Processing

3)Bioprocess Engineering
- SKKC 4653 Downstream Bioprocessing
- SKKC 4663 Pharma and Nutraceutical Engineering
- SKKC 4673 Food Process Engineering

4)Energy Management
- SKKC 4123 Sustainable Energy Management
- SKKC 4173 Thermal Energy Management
- SKKC 4213 Renewable Energy

5)Occupational Safety and Health
- SKKC 4513 OSH Legislations and Management
- SKKC 4523 Industrial Hygiene
- SKKC 4533 Human Factors in Process Industry

6)Environment
- SKKC 4413 Environmental Management
- SKKC 4423 Waste Management
- SKKC 4433 Environmental Sustainability

7) Oil and Gas
- SKKC 4713 Introduction to Oil & Gas Industry
- SKKC 4723 Refinery & Petrochemical Technology
- SKKC 4733 Gas Transportation and Storage

18a. Mapping of Programme Learning Outcomes to Courses													
CORE COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Course	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010	PL011	PL012
CORE COURSES													
SSCE 1693	Engineering Mathematics I	a						1					
SSCE 1993	Engineering Mathematics II	a						1					
SSCE 1793	Differential Equations	a						1					
SSCK 1603	Organic Chemistry : Functional Group	a					b						
SSCK 1831	Organic Chemistry Practical	a	b				b						
SSCK 1203	Analytical Chemistry for Engineering	a						1					
SSCK 1891	Analytical Chemistry Practical	a	b				b	1					
SSCK 2613	Organic Chemistry: Biomelecules	a						1					
SSCK ***3	Physical Chemistry (Quantum)	a						1					
SKEU 2003	Electrical Technology	a			b			1					
SKKC 1511	Industrial Seminar & Profession	a			b	b						1	
SKKC 1213	Statics	a				a		1					
SKKC 1523	Introduction to Engineering	a					a		1	1	2	2	
SKKC 1533	Introduction to Computer Programming	a			a							1	
SKKC 1113	Mass Balance	a		a								1	
SKKC 1223	Thermodynamics	a			b					1			
SKKC 1121	Engineering Drawing	a			b			1					

CORE COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CORE COURSES													
SKKC 2133	Energy Balance	a		a								1	
SKKC 2233	Fluid Mechanics	a		b				1					
SKKC 2243	Material Engineering	a					b					1	
SKKC 2721	Fluid Mechanics Laboratory	a	a							1	1		
SKKC 2253	Chemical Engineering Thermodynamics	a			b							1	
SKKC 2313	Transport Processes	a		a								1	
SKKC 2711	Thermodynamics and Material Engineering Laboratory	a	a						1	1	1		
SKKC 3543	Numerical Methods and Optimization	a			b							1	
SKKC 3263	Chemical Reaction Engineering	a			b							1	
SKKC 3323	Separation Processes	a		a	b							1	
SKKC 3413	Pollution Control Engineering	a		a		b					1		
SKKC 3731	Pollution Control and Reaction Laboratory	a	a							1	2		
SKKC 3553	Process Control and Instrumentation	a		a	a					1			
SKKC 3333	Unit Operations and Industrial Processes	a		a					1	1			
SKKC 3741	Separation Process Laboratory I	a	a							1	2		
SKKC 3812	Undergraduate Project I	a		a		b		2	1			1	1
SKKC 3343	Engineering Economics and Project Management	a		a									1

CORE COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CORE COURSES													
SKKC 3915	Industrial Training	a				a	b	1	1	2	1	1	2
SKKC 4751	Process Control Laboratory	a	a	a				1		1	1		
SKKC 4761	Separation Process Laboratory II	a	a							1	2		
SKKC 4143	Plant Design	a		a	b				1				1
SKKC 4824	Undergraduate Project II	a	a	a	b	b		2	1		1	1	
SKKC 4563	Process Safety & Operability	a				a			1				
SKKC 4834	Plant Design Project	a		a	a	a	b	1	1	1	1	1	1
	Jumlah	41	9	16	12	7	7	17	9	11	10	13	6

UNIVERSITY COMPULSORY COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Course	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010	PL011	PL012
UNIVERSITY COMPULSORY COURSES													
ULAB 1122	Academic English Skills	b							1				
UICI 1012	Islamic and Asian Civilizations	b							1				
UKQ ***2	Co Curriculum								1	1	1		
U*** ***2	Innovations and Creativity	b							1		1		
ULAB 2122	Advanced Academic English Skills	b							1				
UHAS 1172	Dinamika Malaysia/ Arts, Custom and Beliefs (International Student)	b								1	1		
UICI 2022	Science, Technology and Mankind	b							1				
ULAB 3162	English for Professional Purposes	a							1				
U*** ***2	Self, Community Dev. Cluster Malay Language (For International Student)	a							1		1		
UHAS 3**2	Entrepreneurship Cluster	a											1
	Jumlah	9	0	0	0	0	0	0	8	2	4	0	1

Technical Skills : a = major contribution to outcome
b = moderate contribution to outcome

Generic Skills : 1 = substantial (with assessment)
2 = not substantial (introduce)

ELECTIVE COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
STREAMING COURSES													
SKKC 4013	Polymer Composites	a					b					1	
SKKC 4023	Smart Materials	a					b		1			1	
SKKC 4033	Biomaterials	a					b					1	
SKKC 4613	Fundamentals of polymer	a					b			1			
SKKC 4623	Polymer physics and properties	a					b	1					
SKKC 4633	Polymer rheology and processing	a		a				1					
SKKC 4643	Rubber and Latex Technology	a					b		1				
SKKC 4653	Downstream bioprocessing	a		a			b		1			1	
SKKC 4663	Pharma and Nutraceutical Engineering	a		a					1				
SKKC 4673	Food Process Engineering	a		a					1				
SKKC 4123	Sustainable Energy Management	a				a	b		1		1		1
SKKC 4173	Thermal Energy Management	a				a		1				1	
SKKC 4213	Renewable energy	a					a					1	
SKKC 4233	Hydrogen & fuel cell technology	a			b				1			1	
SKKC 4513	OSH Legislations and Management	a					b				1		

ELECTIVE COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
STREAMING COURSES													
SKKC 4523	Industrial Hygiene	a		a							1		
SKKC 4533	Human Factors in Process Industry	a					b		1				
SKKC 4413	Environmental Management	a				a						1	1
SKKC 4423	Waste Management	a				a			1				
SKKC 4433	Environmental Sustainability	a				b				1			1
SKKC 4713	Introduction to oil & gas industry	a		a				1					
SKKC 4723	Refinery & Petrochemical Technology	a					b		1				
SKKC 4743	Petroleum Production engineering	a					b			1			
SKKC 4733	Gas transportation and Storage	a		a				1	1				

Legend: a: major contribution; b: minor contribution; 1: assess; 2: address

18b. Mapping of Programme Learning Outcomes to MQA Requirements									
FACULTY'S PROGRAMME OUTCOMES		MQA PROGRAMME OUTCOMES							
		Knowledge	Practical Skills	Critical Thinking and Problem-solving Skills	Communication, leadership and team skills	Social Skill and Responsibilities	Ethics, Professionalisme, and Humanities	Life-long Learning and Information Management	Entrepreneurship and Management Skill
		D01	D02	D03	D04	D05	D06	D07	D08
PLO 1	Ability to apply general knowledge, sciences, chemical engineering principles to solve complex chemical engineering problems	✓							
PLO 2	Ability to investigate, design and conduct experiments, analyze and interpret data, and apply the research skills to solve complex engineering problems.			✓					
PLO 3	Ability to design a system or process for solving complex chemical engineering problems to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.						✓		
PLO 4	Ability to inculcate modern computational techniques and skills to solve complex chemical engineering activities.	✓	✓	✓					
PLO 5	Ability to responsibly act as well as response to the societal health, safety, environment, legal and cultural issues that are relevant to the professional chemical engineering practice.					✓	✓		
PLO 6	Ability to practice professional chemical engineering knowledge for sustainable development.						✓		
PLO 7	Ability to integrate the first principles of mathematics, natural sciences and chemical engineering for solving complex engineering problems through creative, innovative, lateral and critical thinking skills.	✓	✓						
PLO 8	Ability to communicate effectively through written and oral modes to all levels of society.				✓				
PLO 9	Ability to work independently, and as a member or a leader in a team to manage project in multi-disciplinary environment.				✓				
PLO 10	Ability to work ethically according to the norms of chemical - engineering practice.						✓		
PLO 11	Ability to acquire knowledge and engage in life-long learning.							✓	
PLO 12	Ability to acquire entrepreneurship skills and business insights.								✓

19. Our Uniqueness

a) Besides the emphasis on technical knowledge, the student is trained to acquire soft skill such as communication, team work, leadership, long life learning and entrepreneurship through problem based learning and co-curriculum activities.
b) The faculty has produced the most chemical engineering graduates in Malaysia since the establishment of Chemical Engineering Department in 1983; therefore it has the largest Chemical Engineering alumni in Malaysia.
c) The faculty also possessed well-equipped laboratory facilities and experience academic staff.

20. Career Prospects and Career Paths

Graduates of the programme can work as engineers in the oil and gas, petrochemical, pharmaceutical, environmental, food, polymer and chemical-related industries. Graduates may elect to get higher degrees to be researchers and academicians. They can also work as researchers in research institutes and as consultants in engineering design and environmental management firms. Other than purely technical fields, graduates have the opportunity to go into the business and management line, like banking, finance, and marketing. Their career path can also be directed towards becoming managers and directors of chemical or chemical-related industrial companies.

21. Cross Campus Program

Students are given an opportunity to enrol few courses in participating universities and the grades and credits (up to 1/3 of the total credits of the curriculum) can be transferred. At the moment, there are four participating universities i.e. Universiti Teknologi Malaysia, Universiti Sains Malaysia, Universiti Malaya and Universiti Malaysia Sarawak.

22. UTM Professional Skills Certificate

All undergraduates undergoing bachelor degree programmes are required to enrol for and follow four short courses and one test during their studies in UTM to obtain the *UTM Professional Skills Certificate* as part of the requirements for graduation. Those are:-

i. How to Get Yourself Employed (HTGYE)
ii. ISO 9001:2008 Quality Management System Requirement (ISO)
iii. Occupational Safety and Health Awareness (OSHA)
iv. How to Manage Your Personal Finance (HTMYPF)
v. Test of English Communication Skills for Graduating Students (TECS)
    a. Paper I – Oral Interaction
    b. Paper II – Writing

23. Facilities Available

List of laboratories:

i. Fluid Mechanics Laboratory
ii. Thermodynamic & Strength of Material Laboratory
iii. Pollution Control Laboratory
iv. Separation Process I Laboratory
v. Separation Process II Laboratory
vi. Process Control Laboratory
vii. Chemical Reaction Engineering Laboratory
viii. Computer-Aided Design Laboratory

ix. Environmental Engineering Laboratory
x. Computer Laboratory
xi. Organic Chemistry Laboratory
xii. Analytical Chemistry Laboratory

List of other special facilities/equipments:

i. Teaching facilities include fully air-conditioned lecturer rooms / halls & theatres equipped with audio-visual support
ii. Faculty's resource centres
iii. Canteen
iv. Photocopy centre
v. Institute Bioproduct & Development (IBD)

24. Support for Students and Their Learning

Personal Support

- Academic Advisor
- Counselling

Infrastructure Support

- Internet access
- e-learning
- Digital library
- Health care and Recreational

Financial Support

- Some financial support via Research Grants
- Perbadanan Tabung Pendidikan Tinggi Negara (PTPTN

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

i. Students performance in terms of:
   - KS/KB

ii. Employability
   - Exit survey
   - Alumni survey
   - Market survey

iii. Lecturer's performance
   - Teaching evaluation by students (Online)
   - CPA
   - Graduating students performance
   - GOT
   - Completion rate
   - Analysis of course performance

iv. Curriculum review
- Faculty academic committee
- Laboratory attachment training survey
- Postgraduate survey
- External examiner reports
- CO achievement survey by students
- Students e-Portfolio
- Generic skills evaluation (Performance Criteria Report)

v. Delivery system
- Academic Quality Assurance Committee
- AKNC audit report
- MQA standard

26. Regulation of Assessment

a. Summary of grades, marks and their interpretation

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. Assesment Tools

Measurement Tools	Learning Outcomes												Duration	Action by
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12		
Exam, quizzes, peer teaching	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Continuous	Lecturer, student
e- Portfolio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Continuous	Student
Course Outcome Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Lecturer
Course Outcome Report	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Lecturer
Research Project Survey	✓	✓		✓	✓	✓		✓	✓			✓	End of sem	Faculty
PO Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Faculty
Industry Attachment Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	End of session	Faculty
Alumni Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once/3 years	Head of Dept
Employer Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once/3 years	Head of Dept

SYNOPSIS OF CHEMICAL ENGINEERING COURSES

First Year

SKKC 1511 Industrial Seminar and Profession

This course introduces students to the basic chemical engineering knowledge and working environment through workshops and seminars by respective personnel(experts, engineers, lectures, alumni, senior students etc.) and also industrial visit to various chemical plants in Malaysia. Students need to prepare leraning portfolios which contain summaries and reflections of all the seminars, workshops and industrial visit that they have attended.

SKKC 1533 Introduction to Computer Programming

The main objective of this course is to provide the students the foundation of programming skills as a tool for solving problems in chemical engineering. It helps students to feel justifiably confident of their ability to write small programs that allow them to accomplish useful goals. This course includes the coverage of basics and application of MATLAB software for solving simple arithmetic operations with arrays, two-dimensional plotting and programming using flow control commands with conditional statements and loops. With this foundation of basic programming skills, the course provides opportunities to explore advanced topics for solving complex chemical engineering problems.

SKKC 1213 Statics

Composition and resolution of vector – in particular a force acting in a particle: difference between a vectors, resolutions of a vector, and resultany of several forces. Equilibrium of a particle: two forces, three forces, and more than three forces. Friction: law of friction, friction angle, particle equilibrium on rough horizontal and inclined plane. Statics of a rigid body, parallel forces and center of gravity, parallel lamina rectangle and triangle, moment and coupled forces. Plane forces directory. Equlibrium of a rigid body: three forces, more than three forces including friction. Conditions for rolling and slipping.

SKKC 1113 Mass Balance

This course introduces students to the chemical engineering and chemical processes, process and the fundamental operations of chemical process equipment. It also provides students with the basic principles of chemical engineering material balances as well as calculation techniques to solve material balance problems for chemical process systems and equipment.

SKKC 1223 Thermodynamics

Thermodynamics is an important basic engineering subject where concepts such as systems, boundaries, mass, heat, work and energy are introduced. These concepts are then related using the 1st and 2nd Law of Thermodynamics. In this subject properties of common substances such as water, air and general working fluids are introduced using property tables and basic state equations. These concepts are applied in many engineering equipments, basic refrigeration and power cycles. Such basic concepts are vital because they form the fundamentals for future chemical engineering subjects.

SKKC 1121 Engineering Drawing

This course introduce students to Computer Aided Drawing tools. The topic covered include Computer Aided Drawing, Computer Aided Command, Geometry, Geometry, Orthographic Drawing, Isometric Drawing, Sectional Drawing and Flowchart Drawing.

SKKC 1523 Introduction to Engineering

Overview of engineering the profession and its requirements in the Malaysian scenario. Communication (oral and written) and teamwork skills. Mind mapping, learning styles and time management. Basic calculations and unit conversions. Create an engineering graph and solving iterative problems using computer. Ethics. Seminar. Plant visits. This course employs Cooperative Learning and grooms students with skills for Problem-based Learning.

Second Year

SKKC 2133 Energy Balance

Pre Requisite: SKKK 1113 Mass Balance

This course introduces students to the chemical engineering profession and the fundamental operations of chemical process equipment. It also provides students with the basic principles of chemical engineering energy balances as well as calculation techniques to solve the material and energy balance problems for chemical process systems and equipment.

SKKC 2243 Materials Engineering

Introduction to Material Science, Atomic structure and inter-atomic bonding, Crystal Structure, Solidification and Crystalline imperfections in solids, Phase Diagrams, Engineering alloys, Mechanical properties, Stress and Strain under axial loading, Torsion, Shear, Analysis and design of beam for bending, Transformation of stress and strain, Beam Deflection of Beams.

SKKC 2233 Fluid Mechanics

Physics of fluid: what is fluid, some difinitions, surface tension, compressible and incompressible flow, classes of flow, and physical classfification. Fluid statics: pressure, differential equations of fluid statics, manometry, fluid force on submerge bodies, buoyancy and stability of floating bodies, and liquid in relative equilibrium. Fluid in motion: continuity equation, energy and mass equilibrium, Euler, Bernoulli and Momentum equations. Friction in fluid flow: velocity profile in pipes, roughness, friction factor, Moody chart. Flow measurement: venturi and pitot tube, orifice, notches and weirs. Pump and pumping: principle, types, selection, and application of pumps. Dimensional analysis, similitude in fluid mechanics, parameters of incompressible and compressible flow.

SKKC 2253 Chemical Engineering Thermodynamics

Pre Requisite: SKKC 2133 Energy Balance

Volumetric properties of pure liquid, heat effects, thermodynamics properties of fluids, properties relationship for homogeneous mixture, phase equilibrium and chemical reaction equilibrium.

SKKC 2313 Transport Processes

Pre Requisite: SKKC 21233 Energy Balance

Fundamentals of mass transfer, rate equation for molecular diffusion, mass transfer at boundary layer, mass transfer between phases, mass transfer rate at simple surface geometry, simultaneous mass transfer and chemical reaction. Also included is heat transfer theory, conduction, steady state conduction in two dimensions, steady state conduction with convection to environment, unsteady-state conduction, convection, radiation heat transfer, heat exchanger design.

SKKC 2721 Thermodynamics and Materials Engineering Laboratory

Pre Requisite: SKKC 1113 Material Engineering, SKKC 2133 Energy Balance

Experiments performed in this laboratory include boiler tests, diesel engine performance test, equilibrium test, energy (heat engine), tensile test, metal metalography, determination of Young modulus, air compressor, cooling system, torsion testing, stress and strain analysis.

SKKC 2711 Fluid Mechanics Laboratory

The course covers seven fluid mechanics-related experiments which are friction losses in pipe, stability of floating body, jet impact, flow measurement, centifugal pump, forced vortex flow, and calibration of bourdon tube pressure gauge.

Third Year

SKKC 3543 Numerical Methods & Optimization

This course introduces students to some numerical techniques in solving chemical engineering problems that could not be solved analytically. Students will be exposed to the numerical solution for root of equation, simultaneous algebraic equation, curve fitting, ordinary differential equations, numerical differentiation and integration problems. MATLAB programming language will be implemented with the intention of illustrating the nuance of the methods, and showing more realistically how the methods are applied for problem solving.

SKKC 3263 Chemical Reaction Engineering

Pre Requisite: SKKC 2253 Chemical Engineering Thermodynamics

Topics in this course are: introduction to homogeneous reaction kinetic, batch reactor data analysis, introduction to reactor design, single reactor design, reactor design for single reaction and multiple reactor, temperature and pressure effect, nonideal flow, introduction to heterogeneous reaction system design, types of reactor test, catalytic reaction.

SKKC 3323 Separation Processes

Pre Requisite: SKKK 2313 Transport Processes

Introduction to unit operations in chemical engineering: evaporation, liquid-liquid separation, liquid vapour separation, liquid-liquid extraction and leaching. Also covered are particle characterisation, pneumatic conveyingof bulk solid, size reduction of solids, crystallisation, solid-liquid separation, filtration, membrane separation processes and drying.

SKKC 3333 Unit Operations and Industrial Processes

This course introduces different types of unit operations and separation processes involved int he chemical industries such as particle technology, crystallization, solidliquid separation, drying and evaporation. All of the topic is illustrated by detail examples and is accompanied by homework exercises.

SKKC 3413 Pollution Control Engineering

This course introduces the cause, effect and method to control pollution from industries. The course covers the three major categories of industrial pollution; water pollution, air pollution and industrial waste management. In the first part, the course includes the source and types of water pollutions, environmental regulations pertaining to waste water discharge, and techniques to treat waste water before discharging to the environment. The second part of the course covers the source and effect of air pollution, regulations requirement for air pollution control, and technology to control air pollution emission from industries. The thied part covers the management of industrial waste that incudes definition of scheduled waste regulations and techniques to manage the waste.

SKKC 3731 Pollution Control and Reaction Laboratory

Experiments performed in this laboratory are: acidity and alkalinity, biological oxygen demand (BOD), coagulation and flocculation, ambient air quality monitoring, the use of direct spectrophotometer, conductivity measurement, sludge index, water sampling. To test the saponification reaction, iodine reaction, esterification reaction, continuous stirred tank reactor and biodiesel production.

SKKC 3553 Process Control and Instrumentation

Pre Requisite: SSCE 1793 Differential Equations,

This course covers the fundamentals of dynamic process modelling, dynamic process behaviours and process control. Although more concentration is given to lumped parameter systems modelling, distributed parameter systems is introduced. Feedback control system design, analysis and tuning are dealt with in detail. Also included are model estimation techniques for first order plus deadtime (FOPDT) systems.

Other commonly found control structures, such as feedforward, ratio, split-range and cascade control, and plant-wide control systems deign are taught qualitatively. This course employs Active Learning (AL).

SKKC 3741 Separation Processes Laboratory I

Pre Requisite: SKKC 3323 Separation Processes

Evaporation operation, distillation operation, gas-liquid absorption operation, drying operation, liquid physical and chemical properties identification and heat transfer.

SKKC 3812 Undergraduate Project I

A first stage of the Undergraduate Project which involve in preliminary studies and planning on how to carry out the study given to the student. The works include literature review, problem and scope identification, objective and method determination.

SKKC 3343 Engineering Economics and Project Management

The engineering economy study involves computing a specific economic measure of worth for estimated cash flows over a specific period of time. Project Management is the art of planning, scheduling, and controlling of project activities to achieve performance, cost, and time objectives, for a given scope of works, while using resources efficiently and effectively.

SKKC 3915 Industrial Training

A 12-week training in industry. The main rational of introducing the programme is to provide UTM students with exposure to practical aspects of industry and their work practices. During the programme, the students will have the opportunity to relate their theoretical understanding to the real application in industry and to develop skills in work ethics, management, communication and human relations.

SKKC 3751 Process Control Laboratory

Experiments performed in this laboratory include: PLC, introduction to transducers and instrumentation, control of a heat exchanger, liquid level control, analysis of dynamic response, and controller tuning.

Fourth Year

SKKC 4761 Separation Processes Laboratory II

Pre Requisite: SKKK 3323 Separation Processes

Solid-liquid leaching, adsorption, particle analysis, filtration and fluidized bed.

SKKC 4143 Plant Design

Pre Requisite: SKKC 3323 Separation Processes

Introduction to process plant synthesis where design of each individual unit operation are combined with the objective of optimising the raw material and energy use for processing, cost factor and economics, environmental and also safety factor. Selection of reactor design, selection of separator design, reaction-separation system synthesis and also heat exchanger network synthesis, process safety, waste minimisation.

SKKC 4563 Process Safety and Operability

This course in intended to important insights on safety and operability of chemical plant opertions. It reveals the current state of the art technology adopted by process industries to deal with ever-increasing demand to make the plant safer, environmentally behign and profitable. Techniques to evaluate the adequateness of the layer of protection adopted by the process plant shall be mastered. The course also offers systematic method for troubleshooting plausible root causes of operational problems and deciding appropriate corrective actions. It also feature extensive use of project-based learning, discussions and oral presentations and written reports.

SKKC 4824 Undergraduate Project II

Pre Requisite: SKKC 3812 Undergraduate Project I

Students are required to do research project where they are required to collect data from the apparatus in laboratory and pilot plant under the supervisor of a lecturer. The use of computer is also emphasised. Students are required to submit a report at the seminar at the end of the project.

SKKC 4834 Plant Design Project

Pre Requisite: SKKC 4143 Plant Design

Students are divided into groups. Each group will be given a design topic and will be under the supervision of a lecturer. The design project involves process selection, building the process flow diagram (PFD), material and energy balances, detailed equipment design, equipment selection and material of construction, equipment control, operational instruction, economics and costing.

SYNOPSIS OF ELECTIVE COURSES

SKKC 4013 Polymer Composites

This course introduces students to composite materials in general and emphasizes on fibre reinforced polymer composite. The types of reinforcement, the types of matrices as well as other constituents are discussed in detail. It will also cover the manufacturing techniques of composite fabrication and identifying products that can be made from different techniques. The course will further explain the factors affecting the strength of polymer composite. Students should be able to apply the knowledge and the fundamental concepts on how to design successful polymer composite based products. At the end of the course students will gain some knowledge of the main types of nanocomposite materials and their specific physical and chemical properties required in applications.

SKKC 4023 Smart Materials

Smart materilas are characterized by new and unique properties that can be altered in response to environmental stimuli. Applications of smart materials are diverse, including smart sensors, solar energy conversion devices energy management and energy saving systems and biomedical devices. This course will provide deeper understnding of smart materials and smart microstructures, as well as of the increased functionality of both inorganic and organic materials. This course also covers on the material synthesis as well as microstructure and properties relationships.

SKKC 4033 Biomaterials

This course introduces students to the field of materials used in the design of medical devices, and to augment or replace soft and hard tissues. Discussion of bulk properties, applications, and in vivo behavior of different classes of natural and synthetic biomaterials. Analysis of biological response and biocompatibility, degradation and failure processes of implantable biomaterials/devices. Overview of regulatory compliance and performance requirements for commercialization of biomaterials and medical devices.

SKKC 4613 Fundamentals of Polymer

Basic terminologies, principles on polymers and structural relationship towards polymer classification are discussed. An overview on the polymer industry is elaborated together with its impact on human life. Molecular weight relationships toward polymer properties and its implication are briefly presented. This course emphasis specifically on the advanced of polymer synthesis including step-growth, chain-growth and co-ordination polymerizations. Kinetic for the polymerization mechanism is described and its relationship to molecular weight is explained in details. The limitations and application for each polymerization mechanism are discussed. The polymerization systems used for the polymerization process are discussed together with their advantages and the disadvantages. Finally, this course also exposed students to the pilot scale set-up of the polymerization systems.

SKKC 4623 Polymer Physics and Properties

This course is designed to expose students to the properties of polymer which have great importance. It will emphasize on the mechanical properties, electrical properties, chemical resistance, degradation effects and flammability properties, A strong emphasis will be given on the mechanical properties which include viscoelastic behaviour, tensile, flexural and impact properties. Long term test using creep deformation is also included. At the end of the course the student should be able to explain the interrelation between polymer properties, structures and applications. The students should also be able to describe the appropriate test and characterization for each property.

SKKC 4633 Polymer Rheology and Processing

This course introduces students to some major theories in polymer rheology, their applications in polymer processing and the basic principles of extrusion, injection moulding and other major processing methods. Topics include fundamental flow properties, Newtonian and non-Newtonian analyses, and methods of determination of rheological properties of polymer melts and solutions, structure-flow behaviour relationships, visco-elastic fluid theory, application to extrusion, injection moulding and other processes. The basic mathematical modelling and engineering design analysis of extruder screws and injection moulds will also be described.

SKKC 4653 Downstream Bioprocessing

The aim of the course is to provide an overview of the various downstream processes involved in the production of bioproducts such as food, beverages, ntibiotics, antiferons, vitamins, insulins, citric acid and others. The unique natures of biomolecules make their separation processes different from conventional chemical processes. In addition, the application of mass transfer, mass balances, and thermodynamics principles are combined with life sciences so as to develop, impart and vary the biotechnology purification techniques. The various bioseparation techniques include centrifugation, microfiltration, ultrafiltration, adsorption, chromatography, electrophoresis, and many more. Students will be tested in their ability on understanding on the subject based on the ability to answer test, quizzes, totorials, assignments and final examination. In additional class presentation based on the project also will be carried out during end of semester.

SKKC 4663 Pharma and Nutraceutical Engineering

This course introduces students to some aspects of pharmaceutical and nutraceutical engineering. Students willbe exposed to the fundamental elements, including physicochemical and biopharmaceutical of drugs formulation, drug delivery system, pharmaceutical microbiology and nutraceutical considerations. In the end of lectures, students will be able to understand the theory aspects and some applications in pharmaceutical and nutraceutical engineering.

SKKC 4673 Food Process Engineering

This course introduces students to some major principles, concepts and applications in handling, processing and packaging of foods including the design of process equipment. The course will also provide practice in case studies, carrying out an industrial visit project to observe the application of knowledge in food industries and setting informative research on the business planning of selective food processing operations.

SKKC 4123 Sustainable Energy Management

This course presents the principles for a holistic approach for energy management in an company setting. It provides strategies and methodologies for setting up a sustainable energy management system in a company and for implementing state-of-the-art energy conservation measures usingvarious analysis tools, involving various process equipment, for thermal as well as electrical energy systems.

SKKC 4173 Thermal Energy Management

This course presents the principles and methodology to analyse thermal energy equipment in the industries. The course will cover the fundamentals of fuels and combustion, boiler, steam syetem, fuenace, cogeneration, heat integration and waste heat boilers.

SKKC 4123 Renewable Energy

The course gives an overview of the use of renewable energy for a sustainable energy demand. Currentsources of energy such as coal and petroleum are also reviewed as well as potential leading renewable energies. The course covers the principles and utilization of biomass and biofuel, municipal solid waste (MSW) and refuse derived fuel (RDF), solar (thermal and photovoltaic), hydro, wind and ocean for generating heat and electricity. Issues relevant to environmental considerations, evaluation of benefits and drawbacks, energy efficiency and energy storage are also discussed.

SKKC 4513 OSH Legislations and Management

This course introduces the principles of OSH Legislations and Management. The course comprises of extensive industrial case studies assigned as group and individual project work.

SKKC 4523 Industrial Hygiene

This course covers the fundamentals of industrial hygiene, which is also termed as occupational hygiene. Industrial hygiene is generally defined as the art and science dedicated to the anticipation, recognition, evaluation, communication and control of environmental stressors in, or arising from, the workplace that may result in injury, illness, impairment, or affect the well-being of workers and members of the community. The concept stems out from construction, mining and manufacturing industries, and is particularly familiar among process industries. The course is started by introducing the students to industrial hygiene field of area. Then different categories of hazards are covered so that students may understand the source or problems/hazards. Fugitive emission, which is the main source of background exposure to workers in process industries, is dealt with in detail. Finally the assessment and control measure of the hazards are also presented.

SKKC 4533 Human Factors in Process Industry

Human factors (Ergonomics) is the scientific discipline concerned with the understandingof interactions among humans and other elements of a systems, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

SKKC 4413 Environmental Management

This course covers management strategies to enhance the quality of water, air and noise system. Various management options are evaluated. Student will be exposed to the Environmental Assessment methods and the use of models in assessing environmental impacts.

SKKC 4423 Waste Management

The course includes sources, generation and characteristics of industrial and municipal wastes, analysis of collection systems, handling and disposal practices of municipal wastes, significance of industrial wastes as environmental pollutants, pollution prevention and techniques for processing, treatment and disposal of industrial wastes.

SKKC 4433 Environmental Sustainabality

This course introduces student to issues of environmental management. The course includes discussion on the fundamental of environmental cycle, concept of sustainability, environmental consequences of coastal and inland developments. At the end of the course students should be able to apply the knowledge by associating environmental problems that arise with poor management of environmental sensitive area. The students should be able to work in a team to demonstrate the project development practices related to the environmental enhancement.

SKKC 4713 Introduction to Oil & Gas Industry

This course in intended to expose students to the major stages in the life of an oil or gas field; from exploration, production, and finally to processing and demonstrate the link between the many disciplines involved. The contents of the course cover comprehensive introduction to the upstream and downstream that include basic methods, concepts and current and emerging technologies used and as well as issues related to operations, safety and environment.

SKKC 4723 Refinery & Petrochemical Technology

This course presents the principles for chemical and physical processing in the Petrochemical and Refinery technologies. In particular, it emphasizes on the purpose of the process, understanding reaction chemistry, and their application. The course requires extensive information seeking assigned as group and individual project work.

SKKC 4733 Gas Transportation and Storage

This course enables students to develop and advanced knowledge in gas transportation and storage facilities. The course covers a widerange of scope which includes the flow principles, operation and construction and maintenance. Sustainability of supply and storage system is well reviewed to incorporate state-of-the-art technology. The course also integrates the standards design of transportation system and relevant code of practices. Malaysian standard requirements are also highlighted extensively.

9.2 BACHELOR OF ENGINEERING (CHEMICAL – BIOPROCESS)

Bioprocess Engineering is an engineering discipline where biotechnology and natural based products research are being transformed to industrial setting to fuel the current and future world economic powerhouses. In this program, various engineering principles especially chemical and bioprocess are applied to design, develop and evaluate processes that utilize biological based materials (e.g: animals, plants, microorganisms) to produce products. Throughout our four years of intensive training and industrial exposure, students will experience state-of-the-art technologies that will pave the way for professional bioprocess engineering qualifications. The graduates will be well versed in mathematical-based engineering analysis that will enable them to explain the physical, biological and chemical processes of complex biological systems and design processes that will yield products which could create wealth, promote health and promote sustainability. The sectors served by bioprocess engineers are in the area of medical, food, environment, agriculture and many more.

Career Opportunities

The demand for Bioprocess Engineers in Malaysia is enormous. To realize Vision 2020 and beyond, the government is actively pursuing the establishment of biotechnological-based industries in Malaysia through various Economic Corridors such as Iskandar Malaysia in Johor. The government of Malaysia's commitment in promoting biotechnology industries is reflected in the fund allocated in the ninth Malaysian Plan and further enhanced in the tenth Malaysian Plan. The establishment of Malaysia Biotechnology Corporation and others will nourish the expansion of existing industries while encouraging more relevant industries to participate in the new economic endeavours. Our bioprocess engineers are designed to lead biotechnology related industries and are equipped with versatile and balanced capability to accommodate other industries such as chemical, petroleum, polymers, oil and gas.

Bioprocess Engineering Laboratories

In addition to the knowledge imparted in classrooms, students will also be exposed to the practical aspects of the discipline through laboratory experiments. The Department of Bioprocess Engineering has well developed laboratories with the state-of-the-art equipment for teaching and research. Basically there are six laboratories:

a. Downstream Processing Laboratory (For Bioprocess Lab 2 and R&D)
b. Applied Biology Laboratory
c. Genetic Engineering Laboratory
d. Tissue Culture Laboratory
e. Biotransformation Laboratory (For Bioprocess Lab 1 and R&D)
f. Biomaterials and Bioseparation Laboratory

Prospective students can expect to receive hands-on training in these laboratories through laboratory courses and Bachelor Degree Research Projects.

Program Specifications for Bachelor of Engineering (Chemical-Bioprocess)

1. Programme Name		Bachelor in Engineering (Chemical-Bioprocess)	
2. Final Award		Bachelor of Engineering (Chemical-Bioprocess)	
3. Awarding Institution		Universiti Teknologi Malaysia	
4. Teaching Institution		Universiti Teknologi Malaysia	
5. Program Code		TK29 (SKB)	
6. Professional or Statutory Body of Accreditation		Board of Engineers Malaysia (BEM)	
7. Language(s) of Instruction		English and Bahasa Melayu	
8. Mode of Study (Conventional, Distance Learning, etc.)		Conventional	
9. Mode of Operation (Franchise, Self-govern, etc.)		Self-govern	
10. Study Scheme (Full Time/Part Time)		Full Time	
11. Study Duration		Minimum : 4 yrs Maximum : 6 yrs	
	Type of Semester	**No. of Semesters**	**No. of weeks**
	Regular	8	14
	Short	4	8
12. Entry Requirement	Matriculation or STPM with minimum of B- in Mathematics/ Additional Mathematics/ Further Additional Mathematics, Chemistry/ Engineering Chemistry and Physics/ Engineering Physics/ Biology with CPA 3.00 and not physically handicapped which makes him/her unable to conduct experimental/ practical work.		

13. Programme Objectives

PEO 1 Graduates perform competently in chemical and bioprocess industries and become important contributors to national development.

PEO 2 Graduates become creative, innovative and adaptable engineers as leaders or team members in their organisations and society.

PEO 3 Graduates contribute professionally towards the environmental well-being and sustainable development.

Program Specifications for Bachelor of Engineering (Chemical-Bioprocess)

14. Programme Learning Outcomes (PLO)		
Intended Learning Outcomes	**Teaching and Learning Methods**	**Assessment**
Technical Knowledge and Competencies		
PLO1 Apply general knowledge, sciences, chemical engineering principles to solve complex chemical engineering problems		
Ability to apply general knowledge, sciences, chemical – bioprocess engineering principles to solve complex chemical - bioprocess engineering problems	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, reports, problem-based exercises, group projects, and independent projects.
PLO2 Investigate, design and conduct experiments, analyze and interpret data, and apply the research skills to solve complex engineering problems		
Ability to investigate, design and conduct experiments, analyze and interpret data, and apply the research skills to solve complex engineering problems	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports and, laboratory reports and skill, presentations, individual research project and exercises.
PLO3 Design a system or process for solving complex chemical engineering problems to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations		
Ability to design a system or process for solving complex chemical - bioprocess engineering problems to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.
PLO4 Inculcate modern computational techniques and skills to solve complex chemical engineering activities.		
Ability to inculcate modern computational techniques and skills to solve complex chemical engineering activities.	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, presentations, design project, individual research project, computer project and assignment
PLO5 responsibly act as well as response to the societal health, safety, environment, legal and cultural issues that are relevant to the professional chemical engineering practice		
Ability to responsibly act as well as response to the societal health, safety, environment, legal and cultural issues that are relevant to the professional chemical - bioprocess engineering practice	Group projects, group discussion, problem-based learning, cooperative and collaborative learning, tutorials, undergraduate project, and design project.	Written assignments, laboratory reports, essays, thesis, forum and oral presentations.

Intended Learning Outcomes	Teaching and Learning Methods	Assessment
Generic Skills		
PLO6 Practice professional chemical engineering knowledge for sustainable development.		
Ability to practice professional chemical - bioprocess engineering knowledge for sustainable development.	Lectures, industrial training, undergraduate project, field development project, cooperative learning, and problem-based learning.	Group reports and presentations, learning logs/journal, peer and lecturer evaluations.
PLO7 Integrate the first principles of mathematics, natural sciences and chemical engineering for solving complex engineering problems through creative, innovative, lateral and critical thinking skills.		
Ability to integrate the first principles of mathematics, natural sciences and chemical - bioprocess engineering for solving complex engineering problems through creative, innovative, lateral and critical thinking skills.	Lectures, tutorials, seminars, laboratory works, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory skill reports, presentations, design project, individual research project and peer assessment.
PLO8 Communicate effectively through written and oral modes to all levels of society.		
Ability to communicate effectively through written and oral modes to all levels of society.	Group projects, group discussion, problem-based learning, cooperative and collaborative learning, tutorials, undergraduate project, and design project.	Written assignments, laboratory reports, essays, thesis, forum and oral presentations.
PLO9 Work independently, and as a member or a leader in a team to manage project in multi-disciplinary environment		
Ability to work independently, and as a member or a leader in a team to manage project in multi-disciplinary environment.	Industrial training, undergraduate project, design project, co-operative learning, and problem-based learning.	Group reports and presentations, learning logs/journal, peer and lecturer evaluations.
PLO 10 Work ethically according to the norms of chemical - engineering practice.		
Ability to work ethically according to the norms of chemical - bioprocess engineering practice.	Lectures, industrial training, undergraduate project, field development project, cooperative learning, and problem-based learning.	Group reports and presentations, learning logs/journal, peer and lecturer evaluations.
PLO11 Acquire knowledge and engage in life-long learning.		
Ability to acquire knowledge and engage in life-long learning.	Industrial training, industrial visit, undergraduate project, design project, and problem-based learning	Industrial training report, self-directed learning report, learning portfolios/ journal, and project report and presentation.
PLO12 Acquire entrepreneurship skills and business insights.		
Ability to acquire entrepreneurship skills and business insights.	Lectures, class projects, industrial training, undergraduate project, and design project.	Forum, presentations, assessment by industrial supervisor, test and examinations

15. Classification of Courses			
No.	**Classification**	**Credit Hours**	**Percentage**
A	University a. General b. Language c. Co-curriculum	 12 6 2	15
B	Faculty Core	71	53
C	Programme Core	37	27
D	Programme Electives	6	5
	Total	**134**	**100**
For engineering program please fill up the following classification. (Others please refer to the Statutory Body guidelines)			
A	Engineering Courses (e) Lecture (f) Laboratory/Workshop (g) Industrial Training (h) Final Year Project	 62 10 5 10	65
	Total credit hours for Part A	**87**	
B	**Related Courses** (e) Applied Science/Maths/Computer (f) Management/Law/Humanities/Ethics (g) Co-Curriculum (h) Others	 27 18 2	35
	Total credit hours for Part B	47	
iii.	**Total Credit Hours for Part A and B**	134	100
16. Total credit hours to graduate		**134 credit hours**	

17. Program structures and features, curriculum and award requirements

The course is offered in full-time mode and based on a 2 Semesters Academic Year with several courses being delivered and assessed in each Semester. Assessment is done mostly through 50% examination and 50% coursework (subjected to courses).

Award requirements:

Students should:

- Achieve a total of 134 credit hours with minimum CPA of 2.00
- Pass industrial training
- Complete the undergraduate final year project.
- Complete UTM Professional Skills courses

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL - BIOPROCESS)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 1	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKB 1011	Seminar	1	
	SKKK 1021	Engineering Drawing	1	
	SKKK 1023	Introduction to Engineering	3	
	SKKB 1123	Statics & Biomaterial	3	
	SKEU 2003	Electrical Technology	3	
	SSCE 1693	Engineering Mathematics I	3	
	ULAB 1122	Academic English Skills	2	
		Subtotal	**16**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKB 1133	Industrial Microbiology	3	
	SKKK 1113	Principle of Chemical Process I	3	
	SSCE 1993	Engineering Mathematics II	3	SSCE 1693
	SSCK 1603	Organic Chemistry: Functional Group	3	
	SSCK 1831	Organic Chemistry Practical	1	
	UICI 1012	Islam & Asian Civilization	2	
	UKQ ***2	Co-curriculum I	2	
		Subtotal	**17**	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL - BIOPROCESS)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 2	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SSCE 1793	Differential Equations	3	SSCE 1693
	SSCK 2613	Organic Chemistry: Biomolecules	3	
	SKKK 2123	Principle of Chemical Process II	3	SKKK 1113
	SKKK 2043	Fluid Mechanics	3	
	SKKK 2721	Fluid Mechanics Laboratory	1	
	ULAB 2122	Advanced Academic English Skills	2	
		Subtotal	**16**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SSCK 1203	Analytical Chemistry for Engineering	3	
	SSCK 1891	Analytical Chemistry Practical	1	
	SKKK 2133	Chemical Engineering Computation	3	
	SKKK 2213	Chemical Engineering Thermodynamics	3	SKKK 2123
	SKKK 2313	Transport Processes	3	SKKK 2123
	SKKK 2711	Thermodynamics and Material Eng. Lab	1	SKKK 1033, SKKK 2123
	ULAB 3162	English for Professional Purposes	2	
		Subtotal	**16**	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL - BIOPROCESS)
4 YEAR PROGRAMME, INTAKE 2016/2017

Y E A R 3	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKB 4113	Bioreactor Design and Analysis	3	
	SKKB 3121	Bioprocess Engineering Laboratory I	1	
	SKKK 3223	Chemical Reaction Engineering	3	SKKK 2213
	SKKK 3323	Separation Processes I	3	SKKK 1113, SKKK 2213
	SKKK 3413	Environmental Eng. and Sustainability	3	SKKK 2313
	SKKK 3721	Pollution Control and Reaction Laboratory	1	
	U*** ***2	Innovation and Creativity Cluster #	2	
		Sub total	**16**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKB 3113	Bioseparation	3	
	SKKB 3212	Undergraduate Project I	2	
	SKKB 3213	Biochemistry	3	
	SKKB 3221	Bioprocess Engineering Laboratory II	1	
	SKKK 3144	Process Control & Instrumentation	4	SSCE 1793, SKKK 3323
	SKKK 3731	Separation Processes Laboratory I	1	SKKK 3323
	SKKK 4173	Engineering Economics and Project Mngmt.	3	
		Subtotal	**17**	
	SEMESTER 3			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKB 3915	Industrial Training (Compulsory)*	5	
		Subtotal	**5**	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL - BIOPROCESS)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 4	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKK 3741	Process Control Laboratory	1	
	SKKB 4213	Molecular Biology and Genetic Engineering	3	
	SKKB 4114	Undergraduate Project II	4	SKKB 3212
	SKKK 4153	Plant Design	3	SKKK 3323
	SKKK 4163	Safety and Health in Chemical Industry	3	
	UICI 2022	Science, Technology and Mankind	2	
		Subtotal	**16**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKB 4824	Plant Design Project	4	SKKK 4153, SKKK 4163
	SKK* 4**3	Bioprocess Courses/ Electives	3	
	SKK* 4**3	Bioprocess Courses/ Electives	3	
	UHAS 3**2	Entrepreneurship Cluster #	2	
	UHAS 1172 /UHAS1162	Dinamika Malaysia / Arts, Custom and Beliefs (*International Student*)	2	
	U*** ***2 / ULAM 1112	Self, Community Dev. Cluster #/ Malay Language (*International Student*)	2	
		Subtotal	**16**	
		TOTAL CREDIT	**134**	

***SKKB3915 - Compulsory 12 weeks' industrial training to be taken during the semester break after completing Year 3**
Note: General courses (code starting with U) may change.
 # Student may choose subject from each cluster

17a. Mapping of Programme Learning Outcomes to Courses													
CORE COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Courses	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
COURSES													
SSCE 1693	Engineering Mathematics I	b	-	-	-	-	-	1	-	-	-	-	-
SSCE 1993	Engineering Mathematics II	b	-	-	-	-	-	1	-	-	-	-	-
SKEU 2003	Electrical Technology	b	-	-	-	-	-	1	-	-	-	-	-
SSCK 1603	Organic Chemistry I: Functional Group	b	-	-	-	-	1	-	-	-	-	-	-
SSCK 1831	Organic Chemistry Laboratory	-	b	-	-	-	1	-	-	-	-	-	-
SSCK 2613	Organic Chemistry II: Biomolecules	b	-	-	-	-	-	-	-	-	-	-	
SSCE 1793	Differential Equations	b	-	-	-	-	-	1	-	-	-	-	-
SSCK 1203	Analytical Chemistry for Engineering	b	-	-	-	-	-	1	-	-	-	-	-
SSCK 1891	Analytical Chemistry Practical	-	b	-	-	-	1	1	-	-	-	-	-
SKKK 1023	Introduction to Engineering	a	-	-	a	-	-	-	1	1	-	1	-
SKKK 1113	Principle of Chemical Process I	a	-	-	-	-	-	1	-	-	-	1	-
SKKK 2123	Principle of Chemical Process II	a	-	-	-	-	-	1	-	-	-	1	-
SKKK 2043	Fliud Mechanics	a	-	-	-	-	-	1	-	-	-	-	-
SKKK 2721	Fluid Mechanics Laboratory	a	a	-	-	-	1	1	1	-	1	-	-
SKKK 1021	Engineering Drawing	a	-	-	a	-	-	-	-	1	-	-	-
SKKK 2313	Transport Processes	a	-	-	-	-	-	-	-	-	-	1	-
SKKK 2213	Chemical Engineering Thermo-dynamics	a	-	-	-	-	-	-	-	-	-	1	-
SKKK 2133	Chemical Engineering Computation	a	-	-	a	-	-	-	-	-	-	1	-
SKKK 3323	Separation Processes I	a	-	a	-	-	-	-	-	-	-	1	-
SKKK 2711	Thermo-dynamics & Material Engineering Laboratory	a	a	-	-	-	1	1	1	-	1	-	-

CORE COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Courses	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
COURSES													
SKKK 3413	Environmental Engineering & Sustanability	a	-	a	-	-	1	-	-	1	1	-	-
SKKK 3223	Chemical Reaction Engineering	a	-	a	a	-	-	1	-	-	-	1	-
SKKK 3721	Pollution Control Laboratory	a	a	-	-	-	-	-	1	1	2	-	-
SKKK 3144	Process Control & Instrumentation	a	-	a	a	-	2	1	-	1	-	1	-
SKKK 3741	Process Control Laboratory	-	a	a	-	-	-	1	1	-	1	1	1
SKKK 3731	Separation Processes Laboratory I	a	a	-	-	-	-	-	1	-	-	-	-
SKKK 4153	Plant Design	a	-	a	a	1	1	-	1	-	-	-	-
SKKK 4173	Engineering Economics & Project Management	b	-	-	-	-	-	2	-	-	-	-	1
SKKK 4163	Safety in Process Plant Design	a	-	-	a	-	-	-	2	-	1	-	-
SKKB 1011	Seminar	a	-	-	-	1	-	-	-	-	-	1	-
SKKB 4113	Bioreactor Design & Analysis	a	-	-	-	-	-	-	-	-	-	1	-
SKKB 4213	Molecular Biology & Genetic Engineering	a	-	-	-	-	-	-	-	-	-	1	-
SKKB 3213	Biochemistry	a	-	-	-	-	-	-	-	-	-	1	-
SKKB 3113	Bioseparation	a	-	-	-	-	-	-	-	-	-	1	-
SKKB 3121	Bioprocess Eng. Lab I	a	a	-	-	-	-	-	1	1	2	-	-
SKKB 3221	Bioprocess Eng. Lab II	a	a	-	-	-	-	-	1	1	2	-	-
SKKB 4824	Plant Design Project	a	-	a	a	1	1	1	1	1	1	1	1
SKKB 3212	Undergraduate Project I	a	-	a	a	-	2	1	-	1	-	1	-
SKKB 4114	Undergraduate Project II	a	a	a	a	1	1	-	1	-	1	1	1
SKKB 3915	Industrial Training	a	-	-	a	-	-	-	1	1	1	-	-
SKKB 1123	Statics & Biomaterial	a	-	-	-	-	-	-	-	-	-	1	-
SKKB 1113	Industrial Microbiology	a	-	-	-	-	-	-	-	-	-	1	-

CORE COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Courses	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
COURSES													
SKKB 4813	Food Process Engineering	a	-	b	-	-	-	-	1	-	-	-	-
SKKB 4823	Biotechnology	a	-	-	-	2	2	-	1	-	-	-	-
SKKB 4833	Artificial Intelligence	a	-	b	-	-	-	-	-	-	-	-	-
SKKB4843	Environmental Biotechnology	a	b	-	-	-	1	-	-	-	-	-	-

Key:

Technical Skills :
a = major contribution to outcome
b = moderate contribution to outcome

Generic Skills :
1 = substantial (with assessment)
2 = not substantial (introduce)

UNIVERSITY COMPULSORY COURSES OFFERED		Knowledge	Research Skills	Design	Computational Techniques	Responsive to issues	Sustainable Development	Problem-solving	Communication	Leadership/ Teamwork	High Ethical Standards	Life-long learning	Entrepreneurship
Code	Courses	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010	PL011	PL012
UNIVERSITY COMPULSORY COURSES													
ULAB 1122	Academic English Skills	b	-	-	-	-		-	1	-		-	-
ULAB 2112	Advanced English for Academic Communication	b		-	-	-	-	-	1	-	-	-	-
ULAB 3**2	English Elective	b	-	-	-	-		-	1	-	-	-	-
UHAS 2**2	Civilization on Dev. Cluster	b		-	-	-	-	-	-	-	1		-
UICI 1012	Islam & Asian Civilization	b		-	-	-		-	1	-	-	-	-
UHAS 1172 @ UHAS 1162	Dinamika Malaysia @ Arts, Custom and Beliefs (International Student)	b	-	-	-	-	-	-	-	1	1	-	-
UKQ* ***1	Co-curriculum I	b	-	-	-	-	-	-	-	-	-	-	-
UKQ* ***1	Co-curriculum II	b	-	-	-	-	-	-	-	-	-	-	-
U*** ***2 @ ULAM 1112	Self, Community Dev Cluster @ (Malay Language)* For International Student	b	-	-	-	-	-	-	1	-	1	-	-
U*** ***2	Innovation & Creativity Cluster	b	-	-	-	-	-	-	1	-	1	-	-
UHAS 3**2	Entrepreneurship & Enterprise Development Cluster	b	-	-	-	-	-	-	-	-	-	-	1

Key:

Technical Skills : a = major contribution to outcome
b = moderate contribution to outcome

Generic Skills : 1 = substantial (with assessment)
2 = not substantial (introduce)

18. Career Prospects

Graduates of the programme can work as engineers in the oil and gas, petrochemical, pharmaceutical, environmental, food, polymer and chemical-related industries. Graduates may elect to get higher degrees to be researchers and academicians. They can also work as researchers in research institutes and as consultants in engineering design and environmental management firms. Other than purely technical fields, graduates have the opportunity to go into the business and management line, like banking, finance, and marketing. Their career path can also be directed towards becoming managers and directors of chemical or chemical-related industrial companies.

19. Erasmus Mundus Programme

Students are given an opportunity to enrol for one semester in participating universities in Europe countries and the grades and credits can be transferred. The programme is handled by International of Students Centre (ISC), Office of International Affairs.

20. UTM Professional Skills Certificate

All undergraduates undergoing bachelor degree programmes are required to enrol for and follow four short courses and one test during their studies in UTM to obtain the *UTM Professional Skills Certificate* as part of the requirements for graduation. Those are:-

i. How to Get Yourself Employed (HTGYE)
ii. ISO 9001:2008 Quality Management System Requirement (ISO)
iii. Occupational Safety and Health Awareness (OSHA)
iv. How to Manage Your Personal Finance (HTMYPF)
v. Test of English Communication Skills for Graduating Students (TECS)
    a. Paper I – Oral Interaction
    b. Paper II – Writing

21. Student-centered Teaching and Learning Techniques

Students in the programme are exposed to student-centred, active teaching and learning techniques in several courses, like cooperative learning and problem-based learning. These techniques facilitate deep learning, enhance generic skills and promote positive attitude, which are highly desired by industries. Through these techniques, students will develop communication, team-working and self-directed learning skills which will enable them to become effective engineers upon graduation.

22. Industrial Linkage

Industrial linkage is one of the key success areas and the pride of the chemical engineering department of UTM. Together with our centres of excellences, namely, the Institute of Bioproduct & Development (IBD) and Centre for Lipids Engineering and Research (CLEAR), we have successfully formulated smart partnership with industry through the following areas some of which are **unique** and **innovative** by nature:

i. **Industrial Advisory Board**
   Experienced key personnel from industry are currently members of an industrial advisory board appointed by the department. Members of the advisory board give talks, provide advice and feedbacks on chemical engineering programme and on process design projects.

ii. Student Industrial Training - UNIX Programme

Since the department's inception, students undergo industrial training in over 200 national and multi-national companies nationwide. The UNIX-Internship Project has generated opportunities for students to conduct their Undergraduate Research in participating industries. This can improve graduates' employability as well as enhances industrial collaboration and smart partnership.

23. Facilities Available

i. Teaching facilities include fully air-conditioned lecturer rooms / halls & theatres equipped with audio-visual support
ii. Faculty's resource centres (ExxonMobil & SCHLUMBERGER)
iii. Canteen
iv. Photocopy centre
v. Institute Bioproduct & Development (IBD)
vi. List of laboratories:
    a. Fluid Mechanics Laboratory
    b. Thermodynamic & Strength of Material Laboratory
    c. Pollution Control Laboratory
    d. Separation Process I Laboratory
    e. Separation Process II Laboratory
    f. Process Control Laboratory
    g. Chemical Reaction Engineering Laboratory
    h. Computer-Aided Design Laboratory
    i. Environmental Engineering Laboratory
    j. Heavy Duty Laboratory
    k. Computer Laboratory
    l. Organic Chemistry Laboratory
    m. Analytical Chemistry Laboratory
    n. Applied Biology Laboratory
    o. Bioprocess Engineering Downstream Laboratory
    p. Genetic Engineering Laboratory
    q. Biotransformation Laboratory

24. Support for Students and Their Learning

Personal Support

- Academic Advisor
- Counselling

Infrastructure Support

- Internet access
- e-learning
- Digital library
- Health care and Recreational

Financial Support

- Some financial support via Research Grants
- Perbadanan Tabung Pendidikan Tinggi Negara (PTPTN)

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

i. Students performance in terms of:
- KS/KB
- CPA
- Graduating students performance
- GOT
- Completion rate
- Analysis of course performance

ii. Employability
- Exit survey
- Alumni survey
- Market survey

iii. Lecturer's performance
- Teaching evaluation by students (online)

iv. Curriculum review
- Faculty academic committee
- Laboratory attachment training survey
- Postgraduate survey
- External examiner reports
- CO achievement survey by students
- Students e-Portfolio
- Generic skills evaluation (Performance Criteria Report)

v. Delivery system
- Academic Quality Assurance Committee
- AKNC audit report
- MQA standard

26. Regulation of Assessment

a. Summary of grades, marks and their interpretation

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. Assesment Tools

Measurement Tools	Learning Outcomes												Duration	Action by
	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010	PL011	PL012		
e- Portfolio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Continuous	Student
Course Outcome Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Lecturer
Course Outcome Report	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Lecturer
Research Project Survey	✓	✓		✓	✓	✓		✓	✓			✓	End of sem	Faculty
PO Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Faculty
Industry Attachment Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	End of session	Faculty
Alumni Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once/3 years	Head of Dept
Employer Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once/3 years	Head of Dept

SYNOPSIS OF BIOPROCESS ENGINEERING COURSES

First Year

SKKB 1011 Seminar
This course introduces students to the chemical/bioprocess engineering working environment through seminars from respective personnel and industrial visit to various chemical plants in Malaysia. Assignments and group-based project will be given.

SKKK 1021 Engineering Drawing
Computer Aided Drawing Computer Aided Command, , Geometry, Orthographic Drawing, Isometric Drawing, Sectional Drawing, Flowchart Drawing.

SKKK 1023 Introduction to Engineering
Overview of engineering, the profession and its requirements in the Malaysian scenario. Communication (oral and written) and teamwork skills. Mind mapping, learning styles and time management. Basic calculations and unit conversions. Create an engineering graph and solving iterative problems using computer. Ethics. Seminar. Plant visits. This course employs Cooperative Learning and grooms students with skills for Problem-based Learning.

SKKB 1123 Statics & Biomaterial
This course is designed to introduce students to the basic principles and concepts in mechanics. The content will be divided to two parts which are i) statics and ii) strength of material/biomaterial. The first part will deal with the resultant and resolution of force(s) acting on a particle, the equilibrium of a particle, the effect of force(s) on a rigid bodies, how to replace a force system with equivalent system and the equilibrium of rigid bodies. At the end of the course, students should be able to demonstrate and apply the knowledge by solving various problems in Statics. The second part will focus on the types of material/biomaterial (introduction, overview) and will follow with few elements that are important in understanding the material/biomaterial (atomic bonding, structures, strength analysis etc.). At the end of this part, should be able to relate material/biomaterial and its characteristics in order to choose the right material for different application especially in medical devices etc.

SKKB 1133 Industrial Microbiology
The course aims to provide a strong background of various types of microorganisms to the engineering students. Topics include microbe diversity; metabolism type-based classification; factors that determine the growth and their control techniques; microbial ecology, fundamental of immunology; and biotechnological aspects of microbe.

SKKK 1113 Principle of Chemical Process I
Introduction to chemical engineering and chemical processes, process and process variables, material balance strategy, degree of freedom analysis, material balance with reactions, material balance with recycle, single-phase and multiphase systems. Introduction to energy balance.

Second Year

SKKK 2123 Principle of Chemical Process II
Energy balance on non-reactive systems, balance on reactive systems, material and energy balances on transient processes, entropy, power and refrigeration cycles.

SKKK 2043 Fluid Mechanics
Physics of fluid: what is fluid, some difinitions, surface tension, compressible and incompressible flow, classes of flow, and physical classfification. Fluid statics: pressure, differential equations of fluid statics, manometry, fluid force on submerge bodies, buoyancy and stability of floating bodies, and liquid in relative equilibrium. Fluid in motion: continuity equation, energy and mass equilibrium, Euler, Bernoulli and Momentum equations. Friction in fluid flow: velocity profile in pipes, roughness, friction factor, Moody chart. Flow measurement: venturi and pitot tube, orifice, notches and weirs. Pump and pumping: principle, types, selection, and application of pumps. Dimensional analysis, similitude in fluid mechanics, parameters of incompressible and compressible flow.

SKKK 2721 Fluid Mechanics Laboratory
The course covers seven fluid mechanics-related experiments which are friction losses in pipe, stability of floating body, jet impact, flow measurement, centifugal pump, forced vortex flow, and calibration of bourdon tube pressure gauge.

SKKK 2133 Chemical Engineering Computation
This course introduces students to some numerical techniques in solving chemical engineering problems that could not be solved analytically. Students will be exposed to the numerical solution for root of equation, simultaneous algebraic equation, curve fitting, ordinary differential equations, numerical differentiation and integration problems. MATLAB programming language will be implemented with the intention of illustrating the nuance of the methods, and showing more realistically how the methods are applied for problem solving.

SKKK 2213 Chemical Engineering Thermodynamics
Volumetric properties of pure liquid, heat effects, thermodynamics properties of fluids, properties relationship for homogeneous mixture, phase equilibrium and chemical reaction equilibrium.

SKKK 2313 Transport Processes
Fundamentals of mass transfer, rate equation for molecular diffusion, mass transfer at boundary layer, mass transfer between phases, mass transfer rate at simple surface geometry, simultaneous mass transfer and chemical reaction. Also included is heat transfer theory, conduction, steady state conduction in two dimensions, steady state conduction with convection to environment, unsteady-state conduction, convection, radiation heat transfer, heat exchanger design.

SKKK 2711 Thermodynamics and Materials Engineering Laboratory
Experiments performed in this laboratory include boiler tests, diesel engine performance test, equilibrium test, energy (heat engine), tensile test, metal metalography, determination of Young modulus, air compressor, cooling system, torsion testing, stress and strain analysis.

Third Year

SKKB 4113 Bioreactor Design and Analysis
The aim of the course is to analyze the bioreactor functions so that the intended fermentation performance can be achieved. It will emphasize on mass balances on growth and product formation, kinetics of three main operation modes, oxygen transfer in aerobic cultures, heat sources and their management, power consumption, rheological effect on mixing, scaling up, the architecture and functional parts of bioreactor, and instrumentation and control.

SKKB 3121 Bioprocess Engineering Laboratory I
This laboratory course is designed to expose students to basics microbiology, biochemistry and genetic engineering techniques. The experiment will expose students to handling bacterial culture, analysis of biomolecule such as enzyme and carbohydrate.

SKKK 3223 Chemical Reaction Engineering
Topics in this course are: introduction to homogeneous reaction kinetic, batch reactor data analysis, introduction to reactor design, single reactor design, reactor design for single reaction and multiple reactor, temperature and pressure effect, nonideal flow, introduction to heterogeneous reaction system design, types of reactor test, catalytic reaction.

SKKK 3323 Separation Processes I
Introduction to unit operations in chemical engineering: evaporation, liquid-liquid separation, liquid vapour separation, liquid-liquid extraction and leaching.

SKKK 3413 Environmental Engineering and Sustainability
Introduction to pollution control includes: water pollution, air pollution, noise pollution and environmental acts and techniques to reduce pollutants.

SKKK 3721 Pollution Control and Reaction Laboratory
Experiments performed in this laboratory are: acidity and alkalinity, biological oxygen demand (BOD), coagulation and flocculation, ambient air quality monitoring, the use of direct spectrophotometer, conductivity measurement, sludge index, water sampling. To test the saponification reaction, iodine reaction, esterification reaction, continuous stirred tank reactor and biodiesel production

SKKB 3113 Bioseparation
The aim of the course is to provide an overview of the various downstream processes involved in the production of bioproducts such as food, beverages, antibiotics, antiferons, vitamins, insulins, citric acid and others. The unique natures of biomolecules make their separation processes different from conventional chemical processes. In addition, the application of mass transfer, mass balances, and thermodynamics principles are combined with life sciences so as to develop, impart and vary the biotechnology purification techniques. The various bioseparation techniques include centrifugation, microfiltration, ultrafiltration, adsorption, chromatography, electrophoresis, and many more.

SKKB 3212 Undergraduate Project I
A first stage of the Undergraduate Project which involve in preliminary studies and planning on how to carry out the study given to the student. The works include literature review, problem and scope identification, objective and method determination.

SKKB 3213 Biochemistry
This course is designed to give an overall outlook on basic chemistry of major biomolecules and their roles in biological systems. Topics include introducing the structure, properties, and functionalities of major biomolecules such as carbohydrates, proteins, lipids; roles of lipids in membrane; Michaelis-menten enzyme kinetics, major catabolism pathways such as glycolysis, and TCA cycle; electron transport system and oxidative phosphorylation; structure and functions of DNA and RNA.

SKKB 3221 Bioprocess Engineering Laboratory II
In this laboratory, students are given opportunity to gain experience in bioreactor and downstream processes (bioseparation). This laboratory work will assist the students to consolidate their fundamental understanding involved in fermentation and downstream processes of bioproducts. The experiments performed are fermentation in shake flask and 2 L bioreactor, cell immobilization, microfiltration, cell homogenization, protein precipitation and a final project.

SKKK 3144 Process Control and Instrumentation
This subject covers chemical process control, static and dynamic process behaviour, mathematical modelling, analysis of dynamic chemical process behaviour, analysis and design of feedback control systems, analysis and design of complex control systems.

SKKK 3731 Separation Processes Laboratory I
Evaporation operation, distillation operation, gas-liquid absorption operation, drying operation, liquid physical and chemical properties identification and heat transfer.

SKKK 4173 Engineering Economics and Project Management
The engineering economy study involves computing a specific economic measure of worth for estimated cash flows over a specific period of time. Project Management is the art of planning, scheduling, and controlling of project activities to achieve performance, cost, and time objectives, for a given scope of works, while using resources efficiently and effectively.

SKKB 3915 Industrial Training
A 12-week training in industry. The main rational of introducing the programme is to provide UTM students with exposure to practical aspects of industry and their work practices. During the programme, the students will have the opportunity to relate their theoretical understanding to the real application in industry and to develop skills in work ethics, management, communication and human relations.

Fourth Year

SKKK 3741 Process Control Laboratory
Experiments performed in this laboratory include: PLC, introduction to transducers and instrumentation, control of a heat exchanger, liquid level control, analysis of dynamic response, and controller tuning.

SKKB 4213 Molecular Biology and Genetic Engineering
The course introduces to students on fundamental aspects of molecular biology and gene manipulation. Discussion will emphasize on synthesis, organization, replication of DNA and RNA both eukaryote and prokaryote systems; roles of RNA in translation and transcription; regulation in gene transcription; protein synthesis and post-translational modification; recombinant technology (e.g. gene transfer and splicing techniques, genomic library development).

SKKB 4114 Undergraduate Project II
Students are required to do research project where they are required to collect data from the apparatus in laboratory and pilot plant under the supervisor of a lecturer. The use of computer is also emphasised. Students are required to submit a report at the seminar at the end of the project.

SKKK 4153 Plant Design
Introduction to process plant synthesis where design of each individual unit operation are combined with the objective of optimising the raw material and energy use for processing, cost factor and economics, environmental and also safety factor. Selection of reactor design, selection of separator design, reaction-separation system synthesis and also heat exchanger network synthesis, process safety, and waste minimisation.

SKKK 4163 Safety in Process Plant Design
Main danger and act, introduction to relief, occupational safety and health, danger identification, risk analysis, accident inspection.

SKKB 4824 Plant Design Project
Students are divided into groups. Each group will be given a design topic and will be under the supervision of a lecturer. The design project involves process selection, building the process flow diagram (PFD), material and energy balances, detailed equipment design, equipment selection and material of construction, equipment control, operational instruction, economics and costing.

SYNOPSIS OF BIOPROCESS ENGINEERING ELECTIVE COURSES

SKKB 4813 Food Process Engineering
This course introduces students to some major principles, concepts and applications in handling, processing and packaging of foods including the design of process equipment. The course will also provide practice in case studies, carrying out an industrial visit project to observe the application of knowledge in food industries and setting informative research on the business planning of selective food processing operations.

SKKB 4823 Biotechnology
This course introduces students to biotechnology field current trends in analytical tools, emerging technologies in many related biological based researches. The course will expose students to experience biotechnology through activities such as presentations, industrial trips and related seminar. At the end of the course, students should be able to appreciate biotechnological knowledge and build up awareness of ethics and responsibility in biotechnology field.

SKKB 4833 Artificial Intelligence
This introduction course of Artificial Intelligence (AI) will explain the meaning of AI and elaborate the most popular and frequently used Artificial Intelligence technologies. Application of AI technologies in chemical and bioprocess field will be explored. This course will also introduce a simple programming of AI using MATLAB. This course employs Cooperative Learning and self directed learning.

SKKB 4843 Environmental Biotechnology
This course describes the diverse problems of the environment and the approaches toward their solution or mitigation in connection to the modern or classical methods of biotechnology. It describes the significance in conservation of environmental resources and biodiversity, provision for alternate sources of energy, biological control of pests and pathogens, purification of environment, mitigation of problems of chemical fertilizers, and most important of all, improvement in the quality of life.

SYNOPSIS OF GENERAL COURSES

Science, Mathematics and Basic Engineering

SSCK 1203 Analytical Chemistry for Engineering
This course provides an introduction to quantitative chemical analysis, with emphasis on wet chemistry and instrumental methods. Topics in wet chemistry include introduction to analytical chemistry, sampling, sample preparation, data analysis, gravimetric analysis and volumetric analysis. The course also introduces the principles, instrumentation, and application of chromatographic and spectroscopic methods such as gas chromatography, HPLC, ultraviolet-visible spectroscopy, atomic absorption and atomic emission spectroscopy.

SSCK 1603 Organic Chemistry: Functional Group
This course discusses the fundamental concepts of functional groups in organic compounds. These include aliphatic and aromatic hydrocarbons, alcohols, phenols, organohologen compounds, ethers, epoxides, aldehydes, ketones and carboxylic acids. In each topic, the students will be introduced to the structures of the functional groups and the nomenclatures (common names and IUPAC names). Physical properties, preparations, reactions and visual tests will also be discussed. Inter-conversion of the related functional groups and their reaction mechanisms are also included.

SSCK 2613 Organic Chemistry: Biomolecules
This course introduces students to the classifications, synthesis and reactions of biomolecules such as carbohydrates, peptides and proteins and lipids. It will also emphasize on the three-dimensional structures and fundamental concepts on stereochemistry. Infrated spectroscopy is included as a technique in characterizing the functional groups of organic compounds.

SSCK 1891 Analyticial Chemistry Practical
This course will increase and strengthen students' understanding on the concepts in Analytical Chemistry through experiments conducted in the labboratory. The experiments will illustrate the application of classical and modern instrumental chemical techniques. Upon completion, students should be able to perform analytical chemistry experiments using common techniques and instruments to measure, analyze, manipulate and discuss accurate experimental data to present scientific reports.

SSCE 1793 Differential Equations
This is an introductory course on 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 partial differential equations (PDEs). Students will learn how to classify and solve first order ODEs, use the techniques of undetermined coefficients, variation of parameters and the Laplace transform to solve ODEs with specified initial and boundary conditions, and use the technique of separation of variables to solve linear second order PDEs.

SSCE 1693 Engineering Mathematics I
This is a first course in Engineering Mathematics. Contents include differentiation and integration which focus on hyperbolic and inverse functions, improper integrals, vectors and matrices, polar graphs, complex numbers and series. Vectors and matrices include basic operations and solving related problem in 3 dimensions. In addition, vector spaces, eigenvalues and eigenvectors are also introduced. Sketching of polar graphs is discussed. Complex numbers will include finding roots of equations. Infinite series and its convergence are treated at introductory level. Taylor and Maclaurin series are also introduced.

SSCE 1993 Engineering Mathematics II

This course is about calculus of several variables and calculus of vector-valued functions. The basic theory of partial derivatives and multiple integrals of multivariable functions with their applications are discussed. This teory is extended to vector valued functions to describe motion in space, directional derivatives, gradient, divergence and curl, line integrals, surface integrals and volume integrals. Related theorems, namely Green's Theorem, Stokes Theorem and Gauss Divergence Theorem and their application are discussed in detail.

SKEU 2003 Electrical Technology

The students will be introduced to the concept and theory of basic electrical engineering. The subject will highlight the fundamentals of electrical to enable the student to understand and apply simple electrical circuits and network in their working environment. This subject will cover on DC and Ac systems (single and three phase system) and analyze simple network using electrical basic laws; Ohm Law, Kirchoff Law, current and voltage divider, nodal and loop analysis. Students will also be exposed on the magnet and electromagnet and single phase transformer.

Co-Curriculum (Two Credits Minimum)

These courses are handled by Centre for General Courses and Co-curriculum (CGCC), Office of Deputy Vice Chancellor (Academic & International). For registration, student must follow the list of courses offered for every semester.

The objective of this activity is to fulfil the objective of the university to create a balance and all-rounded education in order to prepare students to be more matured with:

(1) Training in leaderships with greater emphasize on organization discipline and team-work among the students.
(2) Training that can provide a room for students to strengthen and develop their talents and skills for own benefit and society.
(3) Training that can promote team-work within the society and community.

9.3 BACHELOR OF ENGINEERING (CHEMICAL – GAS)

With total proven natural gas reserves of up to 75 trillion cubic feet (2007), Malaysia has been placed at the 13th spot in the list of countries with the most gas reserves. The abundant amount of gas reserves is estimated to fulfill the country's energy needs for at least 85 years. Based on the report from The Natural Gas Industry Annual Review for 2014, the upstream sector achieved considerable success in new gas discoveries contributing to an increase in the Malaysian gas reserves. In addition, PETRONAS also recorded 100 active Production Sharing Contracts (PSC) in Malaysia. These are significant achievements and underscore the fact that Malaysia's hydrocarbon potential is not yet fully exploited.

It is also testament to the relentless efforts put in by PETRONAS and the upstream partners in pushing technology limits and employing innovative means in maximizing the recovery of our domestic basins.

Thus, Malaysia urgently needs more engineers in the field of chemical and gas engineering in order to meet the increasing manpower allocation to support the numerous chemical and gas related projects especially in the processing and gas delivery to the power plant, industries, commercial, domestics as well as export market.

Gas engineering is the field of study that involves activities like processing, transmission, distribution, and gas utilization, while chemical engineering is the field of study that involves the process of converting resources into value -added products using the application of basic sciences and engineering principles to the development, design, operation and maintenance of processes. Expertise in process design, operation, project supervising, maintenance, research and management is very important in ensuring the success of these activities. The main task of chemical and gas engineers is to ensure that downstream activities are carried out optimally, economically, safely, and without the effect of pollution on the environments and ecosystem. The combination of Gas and Chemical engineering programs is offered at Universiti Teknologi Malaysia would thus produce graduates with a broad range of physical and chemical processes which enables them to easily participate in a wide variety of industrial and governmental activities.

Career Opportunities

The gas era and the country's 2020 vision have spawned the development of the gas industry, such as gas processing, transmission, distribution and utilization, and as well as petrochemical industry. These industries need manpower equipped with technical expertise in both chemical and gas engineering. Students who graduate as a chemical-gas engineer have a wide base of career choices from either in pure chemical engineering to gas engineering background. They can also easily adapt themselves in public and as well as private sectors. These include government agency, research and development centre, higher learning institution and many others.

Gas Engineering Laboratories

The Department of Gas Engineering has five laboratories:

(1) Gas System
(2) Calibration System
(3) Gas Testing and Utilization
(4) Combustion System

These laboratories have been equipped with experimental, analytical mini project and computational facilities to provide students with first-hand experience with course concepts, and with an opportunity to explore some methods used by industries. The laboratory course contents and implementation have been designed with the following objectives:

(1) To give students an opportunity to apply fundamental concepts related to chemical, gas engineering, and renewable energy knowledge,

(2) To familiarize students with measurement techniques using some scientific methods and instruments that are encountered in industry,
(3) To assist students in obtaining measurements techniques and hands on experience in assembling and testing different experiments,
(4) To give the students experience in computer data acquisition, analysis, control, and presentation
(5) To develop students' oral and written communication skills through oral presentations and technical report writing using computer application skills through the use of word processing, spreadsheets, and graphics, and
(6) To develop students' problem solving, team coordination, and critical thinking skills through open-ended laboratory works.

Gas System Laboratory

This laboratory provides facilities for experiments related to gas control system and gas transmission and distribution, which include metering methods and pressure regulating. Facilities available include pipe installation system using materials such as polyethylene (PE), carbon steel and copper pipe. Furthermore, there is an opportunity to understand concepts on gas metering, gas flow meter, coating defection and also exploring the methodology of gas pipeline jointing method. Other facilities available are corrosion kits, flow measurement kits, and porosity detection tool.

Calibration System Laboratory

This laboratory provides services and facilities for calibrations and experiments on pressure and temperature system as well as fluid flow studies, which include low to medium flow calibration facilities and metering research. Other facilities available are control and measurement, gas meter servicing and calibration, performance of gas meter through regulator and control valves functions and gas flow characteristics. The laboratory is also fully equipped with complete computer system facilities and temperature-controlled room.

Gas Testing and Utilization Laboratory

This laboratory provides services for experiments on the quality and characterization of gas and liquid fuel such as density, calorific value and flame properties. There are also facilities available to further enhance the practical understanding of the basic concept of burner control and troubleshooting. In addition, thermal energy research is actively studied for hydrogen gas production through auto thermal reaction (ATR) system in fuel cell utilization, environmental study using catalytic combustion system for high and low temperatures, energy saving and combined heat and power (CHP) and design system using the art of simulation modeling of CFD.

Combustion System Laboratory

This laboratory is equipped with a complete range of domestic and industrial equipment that are used in research and academic purposes such as fuel combustion system, flame characteristics test rig, industrial combustion simulation software, flue gas analysis system and various types of industrial burners such as recuperative and regenerative burners for combustion efficiency and exhaust emission studies.

Program Specifications for Bachelor of Engineering (Chemical-Gas)

1. Programme Name	Bachelor of Engineering (Chemical –Gas)	
2. Final Award	Bachelor of Engineering (Chemical-Gas)	
3. Awarding Institution	Universiti Teknologi Malaysia	
4. Teaching Institution	Universiti Teknologi Malaysia	
5. Programme Code		
5. Professional or Statutory Body of Accreditation	Board of Engineers Malaysia (BEM) Engineering Accreditation Council (EAC)	
6. Language(s) of Instruction	English and Bahasa Melayu	
7. Mode of Study (Conventional, distance learning, etc)	Conventional	
8. Mode of operation (Franchise, self-govern, etc)	Self-governing	
9. Study Scheme (Full Time/Part Time)	Full Time	
10. Study Duration	Minimum : 4 yrs Maximum : 6 yrs	
Type of Semester	No. of Semesters	No. of weeks per semester
Normal	8	14
Short	4	8
11. Entry Requirement	Matriculation or STPM with minimum of B- in Mathematics/ Additional Mathematics/ Further Additional Mathematics, Chemistry/ Engineering Chemistry and Physics/ Engineering Physics/ Biology with CPA 3.00 and not physically handicapped which makes him/her unable to conduct experimental/ practical work (not seriously colour blind).	

12. Programme Educational Objectives

The objectives of Chemical-Gas Engineering programme are to produce graduates who are able to:

PEO 1 Perform in global chemical or gas industries and become important contributors to national development

PEO 2 Become creative, innovative, and adaptable engineers regardless of their position as leaders or team members in their workplace and society.

PEO 3 Contribute towards environmental well-being and sustainable development.

Program Specifications for Bachelor of Engineering (Chemical-Gas)

13. Programme Learning Outcomes (PLO)		
Intended Learning Outcomes	**Teaching and Learning Methods**	**Assessment**
Technical Knowledge and Competencies		
PLO1. Apply knowledge of mathematics, science, engineering fundamentals, chemical and gas engineering principles to the solution of complex engineering problems.		
Ability to apply knowledge of mathematics, science, engineering fundamentals, chemical and gas engineering principles to the solution of complex engineering problems.	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, reports, presentations, discussions, problem-based exercises, group projects, and independent projects.
PLO2. Identify, research relevant literature, formulate and solve complex engineering problems using first principles of mathematics and engineering sciences.		
Ability to identify, research relevant literature, formulates and solves complex engineering problems using first principles of mathematics and engineering sciences.	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem based learning, cooperative & collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.
PLO3. Conduct investigations of complex problems employing appropriate research skills including design of experiments, analysis and interpretation of data and generation of valid conclusions.		
Ability to conduct investigations of complex problems employing appropriate research skills including design of experiments, analysis and interpretation of data and generation of valid conclusions	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based clearning reports, laboratory reports, presentations, design project, individual research project and exercises.
PLO4. Design solutions for complex engineering problems and as well as design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.		
Ability to design solutions for complex engineering problems and as well as design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Lecturers, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.
PLO5. Develop or utilize appropriate techniques, resources and modern engineering and computational tools to complex engineering activities, with an understanding of the limitations		
Ability to develop or utilize appropriate techniques, resources and modern engineering and computational tools to complex engineering activities, with an understanding of the limitations	Lectures, tutorials, seminars, laboratory works, directed reading, simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.

Intended Learning Outcomes	Teaching and Learning Methods	Assessment
Generic Skills		
PLO6. Communicate effectively through written and oral modes to all levels of society		
Ability to communicate effectively through written and oral modes to all levels of society.	Group projects, group discussion, problem-based learning, cooperative and collaborative learning, tutorials, undergraduate project, and design project.	Written assignments, laboratory reports, essays, thesis, and oral presentations.
PLO7. Function effectively as an individual, and as a member or leader in diverse teams or multi-disciplinary settings		
Ability to function effectively as an individual, and as a member or leader in diverse teams or multi-disciplinary settings.	Design project, tutorials, undergraduate projects, laboratory works, group assignments, problem-based learning, and cooperative learning.	Group reports and presentations, learning logs/journal, peer and lecturer evaluations.
PLO8. Apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice		
Ability to apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	Industrial training, undergraduate project, design project, co-operative learning, and problem-based learning.	Industrial training assessment by industrial supervisor, peer and lecturer evaluations, seminars, and reports.
PLO9. Explain the impact of engineering solutions in societal and environmental contexts and incorporate the principles of sustainable development in engineering process and design		
Ability to explain the impact of engineering solutions in societal and environmental contexts and incorporate the principles of sustainable development in engineering process and design.	Lectures, industrial training, undergraduate project, field development project, cooperative learning, and problem-based learning.	Reports, presentations, peer and lecturer evaluations, and industrial training assessment by industrial supervisor.
PLO10. Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice		
Ability to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice	Industrial training, industrial visit, undergraduate project, design project, and problem-based learning.	Industrial training report, self-directed learning report, learning portfolios/journal, and project report and presentation.
PLO11. Recognize the need for and readily engage in independent and life-long learning		
Ability to recognize the need for and readily engage in independent and life-long learning	Lectures, class projects, industrial training, undergraduate project, and design project.	Reports, presentations, industrial training assessment by industrial supervisor, examinations, and assignments.
PLO12. Apply knowledge of project management and entrepreneurial principles to a multidisciplinary engineering project or business plan development		
Ability to apply knowledge of project management and entrepreneurial principles to a multidisciplinary engineering project or business plan development.	Lectures, class projects, industrial training, undergraduate project, and design project.	Reports, presentations, industrial training assessment by industrial supervisor, examinations, and assignments.

14. Classification of Courses			
No.	**Classification**	**Credit Hours**	**Percentage**
i.	University d. General e. Language f. Co-Curriculum	 12 6 2	14.7 %
ii.	Faculty Core (Chemical Engineering)	67	49.3 %
iii.	Faculty Core (Science, Math & Computer)	20	14.7%
iv.	Programme Core (Gas Engineering)	26	19.1 %
v.	Programme Elective	3	2.2 %
	Total	**136**	**100 %**

Classifications based on field
(others please refer to the Statutory Body guidelines)

No.	**Classification**	**Credit Hours**	**Percentage**
A	Engineering Courses (i) Lecture (j) Laboratory/Workshop (k) Industrial Training (l) Final Year Research Project (m) Final Year Design Project	 73 8 5 6 4	70.6 %
	Total credit hours for Part A	**96**	
B	Related Courses (i) Applied Science/Maths/Computer (j) Management/Law/Humanities/Ethics (k) Co-Curriculum (l) Others	 20 18 2 -	29.4 %
	Total credit hours for Part B	**40**	
	Total Credit Hours for Part A and B	**136**	**100 %**
15. Total credit hours to graduate		**136 credit hours**	

16. Programme structures and features, curriculum and award requirements

This programme is offered on full-time mode and is based on a 2-Semester Academic Session with several courses being delivered and assessed in each semester. Assessment is based on 50% coursework and 50% final examination.

Award requirements:

To graduate, students should:

- Achieve a total of 136 credit hours with minimum CPA of 2.00
- Pass industrial training
- Complete the undergraduate final year project.
- Complete UTM Professional Skills courses

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL-GAS)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 1	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKPU 1243	Introduction to Engineering	3	
	SSCE 1693	Engineering Mathematics I	3	
	SKPG 1243	Statics	3	
	SKEU 2003	Electrical Technology	3	
	ULAB 1122	Academic English Skills	2	
	SKPG 1251	Engineering Drawing	1	
	SKPG 1611	Seminar	1	
		Subtotal	**16**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKK 1113	Principles of Chemical Processes I	3	
	SKPU 1123	Fluid Mechanics	3	
	SSCE 1993	Engineering Mathematics II	3	SSCE 1693
	SSCK 1603	Organic Chemistry: Functional Groups	3	
	UICI 1012 @	Asian and Islamic Civilization I (TITAS I)	2	
	UHAS 1172@ UHAS 1162	@ Malaysian Dynamics (Malaysian) @ Art, Custom, and Beliefs (International Student)	2	
		Subtotal	**16**	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL-GAS)
4 YEAR PROGRAMME, INTAKE 2016/2017

Y E A R 2	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKK 2123	Principles of Chemical Processes II	3	SKKK 1113
	ULAB 2122	Advanced English Academic Skills	2	
	SSCE 1793	Differential Equations	3	
	U*** 2**2# @ULAM 1112	Generic Development or Globalization (Malaysian) Malay Language for Communication(International Student)	2	
	SKPG 2113	Combustion Engineering and Gas Utilisation	3	
	SKPG 1263	Material Engineering	3	SKPG 1243
	SSCK 1831	Organic Chemistry Practical	1	SSCK1603
	SKPU 1711	Fluid Mechanics Laboratory	1	SKPU 1123
		Subtotal	**18**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKK 2213	Chemical Engineering Thermodynamics	3	SKKK 2123
	SKKK 2313	Transport Processes	3	SKKK 2123
	SKPG3123	Gas Processing and Liquefaction	3	
	SKKK3233	Physical Chemistry for Engineers	3	
	UICI 2022	Science, Technology, and Mankind	2	
	SKPG 3721	Combustion Engineering and Gas Utilisation Laboratory	1	SKPG 2113
	UKQ* ***2	Co-Curriculum	2	
		Subtotal	**17**	

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL-GAS)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 3	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKK 2133	Chemical Engineering Computation	3	SSCE1693, SSCE1993
	SSCK 1891	Analytical Chemistry Practical	1	
	SSCK 1203	Analytical Chemistry for Engineers	3	
	SKKK 3323	Separation Processes I	3	SKKK 2313
	SKKK 3223	Chemical Reaction Engineering	3	SKKK 2123
	SKKK 3413	Environmental Eng. & Sustainability	3	
	SKPU 2711	Thermodynamics and Material Engineering Laboratory	1	SKPG 1263, SKKK 2213
		Sub total	**17**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	ULAB 3162	English for Professional Purposes	2	
	SKKK 3144	Process Control & Instrumentation*	4	SSCE 1793
	SKKK 3333	Separation Process II	3	
	SKKK 4163	Safety and Health in Chemical Industry	3	
	SKPG 3213	Gas Transmission and Distribution	3	SKPU 1123
	SKKK 3721	Pollution Control Reaction Laboratory	1	SKKK3413, SKKK3223
	SKKK 3731	Separation Processes Laboratory I	1	SKKK 3323
		Subtotal	**17**	
	SEMESTER 3			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKPG 3915*	Industrial Training	**5**	
		Subtotal	**5**	

* SKPG 3915 is a compulsory 12 weeks industrial training. The evaluation is only pass or fail.

CURICULLUM FOR BACHELOR OF ENGINEERING (CHEMICAL-GAS)
4 YEAR PROGRAMME, INTAKE 2016/2017

Y E A R 4	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKKK 4173	Engineering Economics and Project Management	3	
	SKPG 4812	Undergraduate Project I	2	
	SKKK 4153	Plant Design	3	SKKK 3323
	SKPG 4223	Storage and Reticulation System	3	SKPG 3213
	SKKK 3761	Separation Processes Laboratory II	1	SKKK 3323
	SKPG 4711	Gas Flow System Laboratory	1	SKPG 3213
	SKKK 3741	Process Control Laboratory	1	SKKK 3144
		Subtotal	**14**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	U*** 3**2	General Elective	2	
	SKPG 4**3	Gas Engineering Elective	3	
	UHAS 3012	Entrepreneurship and Enterprise Development	2	
	SKKK 4824	Plant Design Project	4	SKKK 4153, SKKK 4163
	SKPG 4824	Undergraduate Project II	4	SKPG 4812
	SKPG 4611	Gas Engineering Seminar	1	
		Subtotal	**16**	
		TOTAL CREDIT	**136**	

Course Mapping for Curriculum of Bachelor of Engineering (Chemical-Gas)

17a. Mapping of Programme Learning Outcomes to Courses of Bachelor of Engineering (Chemical-Gas)													
CORE COURSES OFFERED		Knowledge	Problem-solving	Research Skillls	Design	Engineering/ Computational Skills	Communication	Independent/ Teamwork	Responsibility towards Issues	Sustainable Development	Ethics	Life-long learning	Project Management/ Entrepreneurship
Code	Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
SKPU 1243	Introduction to Engineering	b	b				1	1				2	
SKPG 1243	Statics	a						1					
SKPG 1251	Engineering Drawing	b				a							
SKPG 1611	Seminar	b	b				1	2					
SKPG 1263	Material Engineering	a						1			2	2	
SKPG 2113	Combustion Engineering and Gas Utilisation	a	a					1					
SKPU 1123	Fluid Mechanics	a	b				1	2	2		2		
SKPU 1711	Fluid Mechanics Laboratory	a	b	a			1	2	1		2	2	
SKPU 2711	Thermodynamics and Material Engineering Laboratory	a	a	a	b		1	2	2	2	2	2	
SKPG 3721	Combustion Engineering and Gas Utilisation Laboratory	a	a				1	1	2		1		
SKPG 3123	Gas Processing and Liquefaction	a	a					1					
SKPG 3213	Gas Transmission and Distribution	a	a		a		1	2					
SKPG 3915	Industrial Training	a	a	a	a	b	1	1	1	1	1	1	1
SKPG 4812	Undergraduate Project I	a	a	a			1		2	2	1	1	
SKPG 4223	Storage and Reticulation System	a	a				2	1					

CORE COURSES OFFERED		Knowledge	Problem-solving	Research Skillls	Design	Engineering/ Computational Skills	Communication	Independent/ Teamwork	Responsibility towards Issues	Sustainable Development	Ethics	Life-long learning	Project Management/ Entrepreneurship
Code	Subject	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
SKPG 4711	Gas Flow System Laboratory	a	a	a	b	a	1	1			1		
SKPG 4824	Undergraduate Project II	a	a	a	a	a	1		2	2	1	1	
SKPG 4611	Gas Engineering Seminar	b					1	2	2	2	2	2	
SSCE 1693	Engineering Mathematics I	a	a				2	1					
SKEU 2003	Electrical Technology	b	b				1	2					
SKKK 1113	Principles of Chemical Processes I	a	a									1	
SSCE 1993	Engineering Mathematics II	a	a				2	1					
SSCK 1603	Organic Chemistry: Functional Groups	b	b				2	1					
SKKK 2123	Principles of Chemical Processes II	a	a			a	2	1				2	
SSCE 1793	Differential Equations	a	a				2	1					
SSCK 1831	Organic Chemistry Practical	b	b	a			1	2	2		2	2	
SKKK 2213	Chemical Engineering Thermodynamics	a	a									1	
SKKK 2313	Transport Processes	a	a				2	2				1	
SKKK 3323	Separations Processes I	a	a				2	1					
SKKK 3223	Chemical Reaction Engineering	a	a				2	1				2	

CORE COURSES OFFERED		Knowledge	Problem-solving	Research Skillls	Design	Engineering/ Computational Skills	Communication	Independent/ Teamwork	Responsibility towards Issues	Sustainable Development	Ethics	Life-long learning	Project Management/
Code	Course	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010	PL011	PL012
SSCK 1203	Analytical Chemistry for Engineering	b	b				2	1					
SKKK 2133	Chemical Eng. Computation	a	a			a	2	2	1		2	2	
SKKK 3233	Physical Chemistry for Engineers	a	a				2	1	2		2		
SSCK 1891	Analytical Chemistry Practical	b	b	a			1	2	2		2	2	
SKKK 3144	Process Control & Instrumentation	a			a		2	1					
SKKK 3413	Environmental Eng & Sustainability	a	a				1		2		2		
SKKK 3731	Separation Process Laboratory I	a	a	a			1	2	2		2	2	
SKKK 4173	Engineering Economics and Project Management	b	a				1	2	2		2		2
SKKK 3761	Separation Process Laboratory II	a	a	a			1	1	2		2	2	
SKKK 4163	Safety and Health in Chemical Industry	a	a					1					
SKKK 4153	Plant Design	a		a	a		1			2	2	2	2
SKKK 3741	Process Control Laboratory	a	a	a		a	1	1				1	
SKKK 4824	Plant Design Project	a	a		a	a	1	1	1	1	1	1	1
SKKK 3721	Pollution Control & Chemical Reaction Engineering Laboratory	a	a	a			1	2	2		2		
SKKK 3333	Separation Process II	a	a				1	2					
SKPG 4253	Economic and Management of Natural Gas	a					1	1	1				1
SKPG 4233	Fire and Explosion Safety	a	a		a	a	2	2					

UNVERSITY COMPULSORY COURSES OFFERED		Knowledge	Problem-solving	Research Skillls	Design	Engineering/ Computational Skills	Communication	Independent/ Teamwork	Responsibility towards Issues	Sustainable Development	Ethics	Life-long learning	Project Management/ Entrepreneurship
Code	**Course**	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010	PL011	PL012
ULAB 1122	Academic English Skills						1	2					
UICI 1012	Asian and Islamic Civilization I (TITAS I)	b	b				2	1					
UHAS 1172 @ UHAS 1162	Malaysian Dynamics @ Arts, Custom and Beliefs (International)	b	b				2	1					
ULAB 2122	Advanced Academic English Skills						1	2					
U*** 2**2 @ ULAM 1112	Generic Development or Globalization @ Malay Language for Communication (International)						2	1					
UICI 2022	Science, Technology & Mankind						2	1					
UKQ* ***2	Co-curriculum	b	b				2	1					
ULAB 3162	English for Professional Purposes						2	1					
U*** 3**2	General Elective	b	b				2	1					
UHAS 3012	Entrepreneurship and Enterprise	b	b				2	1					

Technical Skills : a = major contribution to outcome

b = moderate contribution to outcome

Generic Skills : 1 = substantial (with assessment)

2 = not substantial (introduce)

17b. Mapping of Programme Learning Outcomes to MQA Requirements

PROGRAMME OUTCOMES (CHEMICAL-GAS)		MQA PROGRAMME OUTCOMES							
		Knowledge	Practical Skills	Critical Thinking and Problem-solving Skills	Communication, leadership and team	Social Skill and Responsibilities	Ethics, Professionalisme, and	Life-long Learning and Information	Entrepreneurship and Management Skill
		D01	D02	D03	D04	D05	D06	D07	D08
PLO1	Apply knowledge of mathematics, science, engineering fundamentals, chemical and gas engineering principles to the solution of complex engineering problems.	✓							
PLO2	Identify, research relevant literature, formulate and solve complex engineering problems using first principles of mathematics and engineering sciences.			✓					
PLO3	Conduct investigations of complex problems employing appropriate research skills including design of experiments, analysis and interpretation of data and generation of valid conclusions.		✓						
PLO4	Design solutions for complex engineering problems and as well as design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	✓		✓		✓	✓		
PLO5	Develop or utilize appropriate techniques, resources and modern engineering and computational tools to complex engineering activities, with an understanding of the limitations		✓	✓					
PLO6	Communicate effectively through written and oral modes to all levels of society				✓				
PLO7	Function effectively as an individual, and as a member or leader in diverse teams or multi-disciplinary settings.				✓	✓			
PLO8	Apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.					✓	✓		
PLO9	Explain the impact of engineering solutions in societal and environmental contexts and incorporate the principles of sustainable development in engineering process and design.					✓			
PLO10	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.						✓		
PLO11	Recognize the need for and readily engage in independent and life-long learning.							✓	
PLO12	Apply knowledge of project management and entrepreneurial principles to a multidisciplinary engineering project or business plan development.								✓

SYNOPSES OF GAS ENGINEERING COURSES

SKPG 1611 Seminar
Pre-requisites: None

This course introduces students to the chemical engineering working environment through seminars from respective personnel and industrial visit to various chemical plants in Malaysia. Assignments and group-based project will be given.

SKPG 2113 Combustion Engineering and Gas Utilisation
Pre-requisites: None

This course enables students to understand the basic concept of combustion and related calculations as well as to expose them to the concept of flame, explosion, and detonation and its related safety aspects. In addition, it permits students to explain the use of gaseous fuels and its related energy generating technologies and equipment. The important concept and methods of fuel inter-changeability will be highlighted.

SKPG 3721 Combustion Engineering and Gas Utilisation Laboratory
Pre-requisites: None

The laboratory is the practical introduction to the method of determining fuel characteristics such as specific gravity and calorific value. Then, it offers the practical understanding of the basic concepts of flame, meter clocking and boiler. It is also enables students to obtain understanding of a few phenomena during combustion with some related factors. Besides, students will be exposed to membrane technology and its application in industry.

SKPG 3123 Gas Processing and Liquefaction
Pre-requisites: None

This course is designed to expose students' techniques and technologies of processing and liquefying hydrocarbon and non-hydrocarbon gases. The course enables students to relate and apply the knowledge of some core chemical engineering courses such as Mass and Energy Balance, Separation Process I & II, etc. In gas processing and liquefaction processes. At the end of the course students should be able to identify and explain the gas properties in a single &mixture phases of gas-liquid separation system. Hence students would explain & develop techniques of gas processing, i.e. gas cleaning, drying, sweetening, separation and gas liquefaction and perform analysis of these techniques in relation to the existing available technologies. Through some cases study of group assignments, students may exposure of current technology & technique of gas-liquid production & separation processes. Overall view of gas utilization scope of gas processed hydrocarbon is also presented.

SKPG 3213 Gas Transmission and Distribution
Pre-requisites: SKPU1123

This course is design to expose student to hydrocarbon gas pipeline system used locally and oversea. The course contents include an introduction to gas industry, the type of gas transmission and distribution system, the codes and standards in gas pipeline system, the gas pipeline network analysis and the construction materials and procedures. The students are also required to prepare a group technical report and present their project at the end of the course. A visit to the related industries that requires student to prepare a brief report will be arranged for them gain some industrial experience.

SKPG 3915 Industrial Training
Pre-requisites: None

Students shall attend industrial training prior to their final year at UTM and they will have to apply for the company of their choice whose activities related to the area of their study. The placement is subjected to the approval by the UTM after considering the suitability of the company. The industrial training provides an opportunity for students to experience the actual working environment and to be able to put into practice the theories that they learned in class. A lecturer from the faculty will pay a visit during their training to monitor their progress at the company. The students will return to UTM to complete their studies whereby they could share their experiences with their fellow students and lecturers.

SKPG 4812 Undergraduate Project 1
Pre-requisites: None

This course is designed to train students on some important aspects of research management. In the first part of the undergraduate research project course, the students are only required to carry out preliminary

studies on the assigned chemical and gas engineering related topics but also to do research planning that will be implemented in the following semester. At the end of this course, students should be able to prepare a complete research proposal and subsequently present their proposal. In addition, students will have opportunity to gain important generic skills such as communication, team working, problem-solving and creative and critical thinking.

SKPG 4223 Storage and Reticulation System
Pre-requisites: SKPG3213
This course enables students to acquire and practice the fundamental knowledge of liquefied petroleum gases (LPG), natural gases (NG) and liquefied natural gases (LNG) storage and as well as of gas reticulation system. The course also emphasizes on the important aspects of corrosion system, methods of corrosion control and corrosion protection system as well as pressure testing. The students are also required to prepare a group technical report and present their project at the end of the course. A visit to the related industries will also be arranged for them to gain some industrial experience.

SKPG 4711 Gas Flow System Laboratory
Pre-requisites: SKPG 3213
This course is designed to allow students to undergo some laboratory works related to gas engineering courses, which is divided through recipe and project base types. It will consist of 12 hours and 18 hours for recipe and project base respectively. At the end of this course, students should be able to practically apply the different methods of gas pipeline jointing technique, welding work, gas meter verification, gas flow measurement, and LPG storage and reticulation system. The students are also required to prepare and install a pipe reticulation system by group. The student shall prepare an individual and group laboratory reports. A short quiz will be given at the beginning of each laboratory session. In addition, students will have opportunity to gain important generic skills such as communication, team working, and problem solving and creative and critical thinking.

SKPG 4824 Undergraduate Project II
Pre-requisites: SKPG4812
This course is continuation of the Undergraduate Project I. The second part of Undergraduate Project requires students to implement the research proposal that has been prepared in the previous semester. This might involve practical activities such as laboratory works, data collection from industry and computer programming/simulation. At the end of the course, students should be able to prepare a full report compiling the first and second part of the Undergraduate Research Project and subsequently present their research findings. Finally, students must submit a bound thesis according to the UTM thesis-writing format. In addition, students will have opportunity to gain important generic skills such as communication, team working, problem-solving and creative and critical thinking.

SKPG 4611 Gas Engineering Seminar
Pre-requisites: None
This course is designed for final year student which consist of talk by the industrialists and experienced engineers and visit to chemical-gas related industries. By having this course students can understand the past, current and future trend of gas industry and the applications as well as health, safety and environment. The day-to day technology need continuously supply of information. The knowledge gained from this course should be able to supplement the understanding about the chemical-gas engineering discipline. At the end of this course, students should be able to view the actual working environment and strengthen their knowledge prior to graduate or become as a chemical engineer or gas engineer. A speaker and industry to visit may from or to Petronas Gas Bhd., Petronas Carigali Sdn. Bhd., Gas Malaysia Sdn. Bhd., Gas Contractors, etc. In addition, students will have opportunity to gain important generic skills such as communication. It is hoped that this course will be able to broaden students' knowledge in the real chemical-gas related industry and will be able to draw out in professional, ethical, societal and global contexts.

SKKK 1113 Principles of Chemical Processes I
Pre-requisites: None
This course introduces students to the chemical engineering profession and the fundamental operations of chemical process equipment. It also provides students with the basic principles of chemical engineering material balances as well as calculation techniques to solve material balance problems for chemical process systems and equipment. It also provides students with the basic principles of the First Law of thermodynamics and its applications.

SKKK 2123 Principles of Chemical Processes II
Pre-requisites: SKKK1113
This course introduces students to the chemical engineering profession and the fundamental operations of chemical process equipment. It also provides students with the basic principles of chemical engineering energy balances as well as calculation techniques to solve the material and energy balance problems for chemical process systems and equipment.

SKKK 2213 Chemical Engineering Thermodynamics
Pre-requisites: SKKK2123
This course introduces students to the chemical engineering thermodynamic theory and applications in the areas of volumetric properties of fluids, heat effects, thermodynamic properties of fluids, thermodynamics of solutions, and physical and chemical equilibria. In addition, thermodynamics of solutions, and physical and chemical equilibria. In addition, student will also be given computer assignments to expose them to solving problems using software packages.

2313 Transport Processes
Pre-requisites: SKKK2123
This course introduces students to the basic principles and application of heat and mass transfer engineering. The understanding from this courses will be useful for the better understanding in distillation, absorption, liquid-liquid extraction, membrane separation, leaching, evaporation and others chemical Processes.

SKKK 2133 Chemical Eng. Computation
Pre-requisites: SSC31693, SSCE1993
This course introduces students to some numerical techniques in solving chemical engineering problems that could not be solved analytically. Students will be exposed to the numerical solution for root of equation, simultaneous algebraic equation, curve fitting, ordinary differential equations, numerical differentiation and integration problems. MATLAB programming language will be implemented with the intention of illustrating the nuance of the methods, and showing more realistically how the methods are applied for problem solving.

SKKK 3233 Physical Chemistry for Engineers
Pre-requisites: None
Physical chemistry is an important basic engineering subject where introduce fundamental physical principles that govern the properties and behavior of chemical systems from either a microscopic or a macroscopic viewpoint. In this subject, three important areas i.e. thermodynamics, electrochemical systems and kinetics are introduced. Thermodynamics embrace an interrelationship of various equilibrium properties of the system and its changes in processes. Electrochemical systems discuss on the electric potential that lead to the determination of thermodynamic properties in the electrochemical cells. Kinetics includes the rate processes of chemical reactions, diffusion, adsorption and molecular collisions.

SKKK 3323 Separations Processes I
Pre-requisites: SKKK2313
This course introduces different types of unit operations involved in the chemical and other physical processing industries such as humidification absorption, distillation, liquid-liquid extraction and solid-liquid extraction (leaching). It also deals with design of separation operations using mass transfer principles.

SKKK 3223 Chemical Reaction Engineering
Pre-requisites: SKKK2123
This course introduces students to chemical reactor design and theories in the area of chemical reaction engineering with emphasis on homogeneous and heterogeneous reactions. It deal with some problems related to multiple reactions and non-isothermal operations. Students will orally present their findings on identification of three industrial reactors. Students will also work cooperatively on a computer assignment to expose them to solving problems using software packages such as Polymath.

SKKK 3144 Process Control & Instrumentation
Pre-requisites: SSCE1793, SKKK3323
This course covers the fundamentals of dynamic process modeling, dynamic process behaviors and process control. Although more concentration is given to lumped parameter systems modeling, distributed

parameter systems will also be introduced. Feedback control system design, analysis and tuning are dealt with in detail. Also included are model estimation techniques for FOPDT systems. Other commonly found control structures, such as feed forward, ratio and cascade control, and plant-wide control systems design are taught qualitatively. This course employs Cooperative Problem-based Learning.

SKKK 3413 Environmental Engineering & Sustainability
Pre-requisites: None
This course introduces the cause, effect and method to control pollution from industries. The course covers the three major categories of industrial pollution; water pollution, air pollution and industrial waste management. In the first part, the course includes the source and types of water pollutants, regulations pertaining to waste water discharge, and techniques to treat waste water before discharging to the environment. The second part of the course covers the source and effect of air pollution, regulations requirement for air pollution control, and technology to control air pollution emissions from industries. The third part covers the management of industrial waste that includes definition of scheduled waste, scheduled waste regulations, and techniques to manage the waste.

SKKK 3731 Separation Process Laboratory I
Pre-requisites: SKKK3323
This subject introduces students to the equipment in the separation processes discussed in Separation I. This will give a 'hands on' experience to the students how to handle the equipments and to interpret the data taken from the experiments. There are also various types of packing and plate in the column (absorption and distillation) that are being used in the laboratory. Comparison can be made on the efficiency of each packing/plate after all the packing/plate types have been used. This subject also demonstrates the basic principles of different types of equipments involved in the chemical/bio-process industries such as liquid-liquid extraction, leaching and heat exchanger. Students will be assessed by their performance in the report submitted and by a test that will be conducted at the end of the course after the students have all completed the experiments.

SKKK 3333 Separation Process II
Pre-requisites: None
This subject introduces different types of unit operations and separation processes involved in the chemical industries such as particle technology, crystallization, solid-liquid separation, filtration, membrane separation processes, drying and evaporation. All of the topic is illustrated by detail examples and is accompanied by homework exercises.

SKKK 4173 Engineering Economics and Project Management
Pre-requisites: None
This is a two-in-one course covering both Engineering Economy and Project Management topics. Engineering economy is the application of economic factors and criteria to evaluate alternatives, considering the time value of money. The engineering economy study involves computing a specific economic measure of worth for estimated cash flows over a specific period of time. Project Management is the art of planning, scheduling, and controlling of project activities to achieve performance, cost, and time objectives, for a given scope of works, while using resources efficiently and effectively.

SKKK 3761 Separation Process Laboratory II
Pre-requisites: SKKK3323
This course introduces students to the equipment in the separation processes taught in Separation 1 and 2. This will give a 'hands-on' experience to the students on how to handle the equipments, obtain, analyze and interpret the experimental data. This laboratory covers particulate solid separation process, drying, and evaporation experiments. It will expose the students to the variety of the equipment that can be applied in the chemical/bio-process industries. Assessments will be based on report writing and presentation to the selected experiment that will be conducted at the end of the course after the students have completed their experiments.

SKKK 4163 Safety and Health in Chemical Industry
Pre-requisites: None
This course presents the principles and methodology for occupational and process safety and health in chemical industry. In particular, it emphasizes on the safety law and regulations, occupational safety and health management systems and also methods in safety and loss prevention. The course features extensive work group exercises as well as individual project and assignments.

SKKK 4153 Plant Design
Pre-requisites: SKKK3323

This course presents the principles and methodology for product and process design. In particular, it emphasizes on the key elements of process design which include process creation/synthesis, process analysis, process evaluation and process optimization in generating inherently safe, economic and environmentally friendly processes. The course features extensive use of process simulation tools through group as well as individual project works.

SKKK 3741 Process Control Laboratory
Pre-requisites: SKKK3144

This course exposes students to areas of process control systems in the chemical industry. It also teaches the students how to control the specific control variables through the use of simple PID control. Students will experience how to perform open loop and closed loop tuning method for specific process. Students will also gain hands-on experience in process control through experiments employing pilot-scale chemical processes.

SKKK 4824 Plant Design Project
Pre-requisites: SKKK4153, SKKK4163

This course is designed to provide an opportunities to final year student to apply and integrate fundamental knowledge that they have learned from other courses to conceptually design an inherently safe, economic and environmentally friendly processes. In this course, the student will explore various aspects in designing a process plant, which include project background, evaluate alternative design and operation options, selection of process route, market survey, site study, gathering data for raw materials and products (e.g. physical properties, cost), constructing process flow sheet, mass and energy balance, heat integration, equipment sizing and costing, waste treatment, safety, HAZOP and assessment of project profitability. Commercial process simulator also will be used extensively e.g. ASPEN PLUS, HYSYS, DESIGN II to perform detailed (rigorous) plant design calculations and produce process flow diagrams (PFD). The project is carried out by a team not more than five students. At the end of the course, students should be able to prepare a comprehensive report and subsequently present their research findings. By completing this project, students will develop important generic skills such as, team working, problem-solving, life-long learning, creative and critical thinking as well as written and oral communication skills.

SKKK 3721 Pollution Control Reaction Laboratory
Pre-requisites: SKKK3413, SKKK3223, SKKK3323

This laboratory course contains experiments that are covered basis concept in chemical reaction engineering and pollution control such as kinetic analysis of reaction, water and analysis. All experiments require students to apply fundamental laboratory techniques and skills as well as communication skill. Students, who are assigned as a group will demonstrate a mastery of laboratory techniques and clearly describe the qualitative and quantitative aspects of the experiments performed.

Gas Engineering Electives Courses

SKPG 4233 Fire and Explosion Safety
Pre-requisites: None

This course enables students to understand the basic concept of fire science and combustion and related calculations as well as to expose them to the concept of explosion and detonation. In addition, the principles of fire and explosion protection and mitigation will be discussed within the context of understanding the fire and explosion development mechanism. At the end of the course, students should be able to explain and relate the fundamental knowledge of combustion, flame and explosion and its important safety aspects involving gaseous fuel utilization. Students should able to apply general combustion and engineering principles to fires and explosion and should know the parameters involved on the initiation of both fire and explosion. The students should be also able to use CFD fire modeling (CFast) to analyze the fire development on the case studies given.

SKPG 4253 Economic and Management of Natural Gas
Pre-requisites: None

This course introduces general concept of natural gas economic and management of its industry. Various issues will be is cussed including the Act and regulation, economic of supplying natural gas, energy

demand, energy policies and international trade. This will enable students to have a basic knowledge of natural gas economics and managements that ready to be further explored.

SKPG 4133 Membrane Technology for Gas Separation
Pre-requisites: None
Provide knowledge to students to enable them to describe the fundamentals of gas separation membrane and membrane processes. The students will also be learning to manufacture their own simple geometry membrane during the schedule laboratory class. This subject will also enable the students to select the right membrane materials, membrane morphology and membrane module according to the properties of the involved compounds for specific application. In addition, the students will be able to evaluate the productivity and purity of the products under fixed operating conditions from transport equation or supplier information. This subject is also briefly provide the students with the knowledge of potential application of membrane gas separation technology in various industries including petrochemicals, food, energy, environment and some emerging application in the future like Fuel Cells.

18. Career Prospects

A gas engineer is primarily concerned with two main activities: (1) the transformation of raw (hydrocarbon and non-hydrocarbon) gases into more usable and marketable products through chemical and physical processes, and (2) storage, transportation, distribution and utilization of processed gases. Among related projects are gas processing, gas transmission and distribution, and gas power plant. A combination of gas and chemical engineering courses makes it a uniquely distinct engineering discipline. Hence, graduates can also be a chemical engineer and easily participate in a wide variety of petrochemical & oleo chemical industries and governmental activities such as Petronas, Shell, Talisman, Murphy Oil, Newfield, Hess, ExxonMobil, Felda, Energy Commission of Malaysia (EC), SIRIM, DOSH, NIOSH and consulting firms. Gas-chemical graduates can also involve in the field of academics through teaching and research activities in university.

19. Facilities available

(a) Teaching facilities include fully air-conditioned lecturer rooms/halls & theatres equipped with audio-visual support and Internet facilities
(b) Faculty Resource Centre
(c) WiFi zones
(d) List of laboratories:
    (i) Fluid Mechanics Laboratory
    (ii) Thermodynamic & Strength of Material Laboratory
    (iii) Pollution Control Laboratory
    (iv) Separation Process I Laboratory
    (v) Separation Process II Laboratory
    (vi) Process Control Laboratory
    (vii) Chemical Reaction Engineering Laboratory
    (viii) Combustion & System Laboratory
    (ix) Gas Laboratory
    (x) Heavy Duty Laboratory
    (xi) Computer Laboratory
    (xii) Calibration System Laboratory
    (xiii) Gas Testing and Utilization Laboratory
    (xiv) Membrane Research Laboratory

20. UTM-MPRC Institute for Oil and Gas

UTM-MPRC Institute for Oil and Gas formerly known as Gas Technology Centre (GASTEG) is one of the centres of excellence under the Faculty of Petroleum and Renewable Energy Engineering. It is a centre where the experts and specialists in gas technology from public and private sectors dedicate and deliver their vast experience through a systematic training program. It covers a wide range of training, research and services for the gas industry. The core activities are as follows:

(1) Accredited training and examination center for Gas Engineers, Gas Engineering Supervisors and Gas Fitters competence course accredited by Gas Department, Energy Commission.
(2) Research and development in gas engineering related field especially in gas piping, metering and regulating and natural gas vehicle. It also covers an academic research for both the undergraduate and postgraduate.

(3) Providing consultation services in any gas technology related field to public and private sectors.
(4) Event organizer to gas engineering professional courses and gas safety seminars to contractors, engineers, and fitters throughout regional area.

21. Advanced Membrane Technology Research Centre (AMTEC)

Advanced Membrane Technology Research Centre (AMTEC), formerly known as Membrane Research Unit (MRU), Universiti Teknologi Malaysia (UTM) is a research center for advanced membrane technology and new membrane applications. The mission and vision of AMTEC is to be a leader in membrane technology and applications especially in the Asia Pacific region and globally through innovation and creative technologies. The center produces postgraduate students in addition to training engineers, scientists, and technicians from Malaysia and abroad in membrane technology to enhance the nation human capital and productivity. AMTEC incorporates a business venture laboratory that is involved in the design, fabrication and commercialization of customized membrane module and membrane system for local and overseas applications. AMTEC is a platform for multidisciplinary research and development in the areas of science, engineering, industrial design, and commercialization in UTM and the Asian region.

The research program in Advanced Membrane Technology Research Centre (AMTEC) involves fundamental and application study of various membrane-based separation processes including gas separation, reverse osmosis, ultrafiltration, Nano filtration and ion exchange membranes for fuel cell. In particular, we study the effects of fabrication conditions of flat sheet and hollow fiber membranes on the structural properties and separation performance by adopting a combine effect of phase inversion and rheological induced molecular orientation approach. The idea of enhance molecular orientation during membrane manufacturing enhances membrane performance has been successfully proven in membrane processes, such as gas separation, reverse osmosis, nanofiltration, and ultrafiltration. This has led to the widespread interest in developing high performance membranes for gas-gas and liquid-liquid phase separation.

The research programs have been expended to include development of Polyacrylonitrile (PAN)-based carbon fiber as precursor for composite materials, development carbon membranes for gas separation and synthesis and production of carbon nanotubes for hydrogen storage for fuel cell application. These important areas that fall under nanomaterial and nanotechnology have generated widespread interest into developing an advanced material both for membrane and composite technologies. The research program in AMTEC, UTM is highly interdisciplinary and involves a number of international collaborations. Recently, the British Council approved a project under Prime Minister Initiative 2 Connect (PMI2) – Research Co-operation Award, which is in collaboration with Imperial College, London.

8.4 BACHELOR OF ENGINEERING (PETROLEUM)

Petroleum engineering involves a wide range of activities related to field exploration, development, production and abandonment of oil and gas resources. Petroleum engineering Programme covers formation evaluation, reservoir engineering, drilling engineering, well completion, well treatment and diagnosis, and production engineering. Beside that, the Programme requires a good knowledge of other related disciplines, namely geophysics, petroleum geology, petroleum project economics and management, engineering safety, etc.

UTM's undergraduate Petroleum Engineering Programme was the first Petroleum Engineering Programme offered in this country by the Department of Petroleum Engineering, UTM way back in 1975. The goal of the Programme is to provide undergraduate students with a world-class petroleum engineering education that will equip them with the technical and generic skills as required by the global oil and gas industry. Our undergraduate Programme is fully accredited by the Engineering Accreditation Council (EAC) and Washington Accord. In addition, the Programme has also been benchmarked against ABET Programme criteria for petroleum and similarly named engineering Programmes, Society of Petroleum Engineering competency matrix for Petroleum Engineers, and six ABET-accredited institutions of higher learning in the United States of America (USA).

Petroleum engineering graduates are involved in the wide spectrum of the exploration and production business; from making discoveries and developing reservoirs to optimizing production and making commercial evaluations, determining the drilling methods to be used, and monitoring the drilling and production activities. They also work on designing tools and operational procedures in order to gain efficiency in the recovery of oil and gas. Simulation Programmes are used extensively by petroleum engineers to determine the best possible method of recovery of petroleum from different reservoirs. Models and designs of drilling and other equipment are also simulated on computers. The aim is to maximize hydrocarbon recovery at minimum cost while maintaining a strong emphasis on reducing environmental impact.

Over the years, we have been assisted by experienced advisory panels from oil and gas industry and renowned universities in improving our academic curriculum so that it is of high quality and relevant to the needs of oil and gas industry. Industry practitioners are invited every semester to give professional talks to all petroleum students on latest technology and contemporary oil and gas related issues. There are numerous opportunities for our students to participate in student organizations. The Society of Petroleum Engineers' Student Chapter (SPE-UTM) has been among the most active in the Asia-Pacific region over the past few years. The presence of international

students from Kazakhstan, Yemen, Somalia, Singapore, Nigeria, China, Sudan, Indonesia, Iran, Uganda, Indonesia, etc. at the Department of Petroleum Engineering has further complemented our effort in producing well-rounded petroleum graduates who are ready to face the challenges in global oil and gas industry.

Career Opportunities

Our petroleum graduates are hired by global oil and gas companies over the years. They can be assigned in various companies; working for major, fully-integrated international oil companies, smaller independent operators, specialized companies that provide services for the producing companies, or consulting firms in oil and gas or the environmental arena. Among the oil and gas companies are Petronas, Exxonmobil, Shell, Talisman, Murphy Oil, Newfield, Petrofac, Hess Oil, Nippon Oil, and Newfield, while the oil-related service providers are Schlumberger, Haliburton, Baker Hughes, UMW Drilling, Geowell, Dimension Bid, Dialog, and Scomi. As a petroleum engineer, you can expect to earn the highest starting salary among all of the engineers. Salaries for petroleum engineers are, and will continue to be, among the highest paid of all professionals. We genuinely care about our students and their future. Over the last few decades, our graduates have been serving the society in key positions and have made tremendous impact to the development of Malaysia.

Several worldwide trends, namely exploring deep-water fields, development of marginal fields, implementation of Enhanced Oil Recovery (EOR) Programmes, etc., ensure that the strong demand for petroleum engineers will continue. The ever-increasing population of the Earth, when combined with the growing thirst for energy in the developing countries, is putting significant upward pressure on the demand for oil and gas production. This increasing demand for energy, and the simple fact that oil and gas resources are limited, places the petroleum engineer in a strong position now and for many years to come.

Petroleum Engineering Laboratories

The following laboratory facilities are available in the Department of Petroleum Engineering to support the petroleum engineering curriculum, research and development, and related services.

(1) Geology Laboratory
(2) Reservoir Engineering Laboratory
(3) Drilling Engineering Laboratory
(4) Heavy Duty Laboratory
(5) Petroleum Testing/Analysis Laboratory
(6) Workshop and Modeling Laboratory
(7) Petroleum Engineering Modeling and Simulation Laboratory

Geology Laboratory

This laboratory provides facilities related to mineralogy and crystallography, petrography, petrology, sedimentology, geophysics, petroleum geology, and engineering geology. This laboratory is equipped with rocks and mineral specimens, polarization and binocular microscopes, image analyzer, rock cutting and lapping machines, thin-section preparing machine, crushing and grinding machines, sieving, planimeter, seismograph, etc.

Reservoir Engineering Laboratory

The Reservoir Engineering Laboratory consists of basic core analysis laboratory, fluid physical properties laboratory, and laboratory segment. The experiments include the measurement of rock and fluid properties, fluid displacement experiment, and enhanced oil recovery flood experiment. Among the equipment available include helium porosimeter, gas and liquid permeameter, spinning drop tensiometer, resistivity meter, and Brookfield viscometer.

Drilling Engineering Laboratory

This laboratory provides students hands-on experience in dealing with the basic techniques of formulating, testing and analyzing the changing behaviors of drilling fluids. The experiments consist of measuring the physical properties of drilling fluid, such as mud weight, rheology, sand content, mud cake and filtration characteristics, and the laboratory work of studying the effects of common contaminants on drilling fluid characteristics and their relevant treatment techniques.

Heavy Duty Laboratory

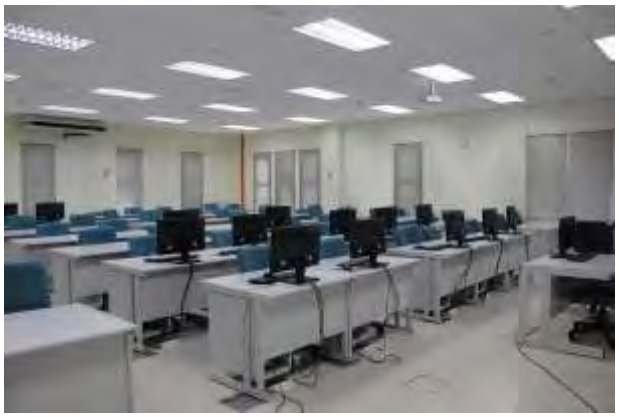
This laboratory is dedicated for all undergraduate and postgraduate projects that require big spaces for pilot scale study or mimic the oilfield conditions. The experimental rigs currently available are the rigs for drilling fluid, reservoir flow assurance, and multiphase flow studies.

Petroleum Testing/Analysis Laboratory

This is a servicing laboratory which provides the testing for petroleum and petroleum products and other liquids. The laboratory operates according to, and fulfill to the management and technical requirements of MS/ISO 17025 standards.

Petroleum Engineering Modeling and Simulation Laboratory

This lab have more than 20 state-of-the-art computer which been install with industry recon modeling and simulation software. This software are Schlumberger E&P software called Petrel RE, and newly develop simulation software called tNavigator by Rock Flow Dynamic. The establishment of this lab is to provide a training and exposure to student on the industry recon modeling and simulation software, research activity, and group work such as Field Development Project.



Programme Specifications for Bachelor of Engineering (Petroleum)

1. Awarding Institution			Universiti Teknologi Malaysia	
2. Teaching Institution			Universiti Teknologi Malaysia	
3. Programme Name			Bachelor of Engineering (Petroleum)	
4. Final Award			Bachelor of Engineering (Petroleum)	
5. Programme Code			TK31 (SKP)	
6. Professional or Statutory Body of Accreditation			Board of Engineers Malaysia (BEM) Engineering Accreditation Council (EAC)	
7. Language(s) of Instruction			English and Malay	
8. Mode of Study (Conventional, Distance Learning, etc.)			Conventional	
9. Mode of Operation (Franchise, Self-govern, etc.)			Self-govern	
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	
	Full time	Part time	Full time	Part time
Regular	8	-	14	-
Short	4	-	8	-
12. Entry Requirements			Matriculation or STPM with minimum of B in Mathematics, Chemistry and Physics/Biology and CPA 3.00, and not seriously color blind.	

13. Programme Educational Objectives (PEO)

The objectives of Petroleum Engineering Programme are to produce graduates who are able to:

PEO1 Perform in global oil and gas industries and become important contributors to national development.

PEO2 Become creative, innovative, and adaptable engineers regardless of their position as leaders or team members in their workplace and society.

PEO3 Contribute towards environmental well-being and sustainable development.

14. Programme Outcomes (PO)		
(a) Technical Knowledge and Competencies		
PLO1. Acquire and apply knowledge of mathematics, science, engineering fundamentals, and petroleum engineering principles to solve complex petroleum engineering problems.		
Intended Learning Outcomes	**Teaching and Learning Methods**	**Assessment**
Able to acquire, practice and apply knowledge of mathematics, science, engineering fundamentals, and petroleum engineering principles to solve complex petroleum engineering problems.	Lectures, tutorials, seminars, laboratory works, directed reading, independent research, and problem-based learning, cooperative and collaborative learning.	Examinations, laboratory reports, presentations, discussion, problem-based exercises, group projects, and independent projects.
PLO2. Identify, formulate, research relevant literature and analyse complex petroleum engineering problems.		
Able to identify, formulate, research relevant literature and analyse complex petroleum engineering problems through effective thinking skills such as creative, innovative, lateral and critical thinking.	Lecturers, tutorials, seminars, laboratory works, directed reading, undergraduate project, field development project, problem-based learning, cooperative and collaborative learning.	Examinations, reports, presentations, discussions, problem-based exercises, group projects, and individual research project.
PLO3. Design solutions for complex petroleum engineering problems that fulfil public health and safety, cultural, societal and environmental considerations.		
Able to provide design solutions for complex petroleum engineering problems that fulfil public health and safety, cultural, societal and environmental considerations.	Lecturers, seminars, laboratory works, directed reading, simulation exercises, computer-based, exercises, undergraduate project, field development project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, field development project, individual research project and assignments.
PLO4. Investigate complex petroleum engineering problems using research-related knowledge and methods to provide conclusive results.		
Able investigate complex petroleum engineering problems using research-related knowledge and methods to provide conclusive results.	Industrial training, industrial visit, geological field work, laboratory works, undergraduate project, workshop, and field development project.	Industrial training reports, external industrial training evaluations, laboratory reports, presentations, problem-based learning reports, individual undergradute project reports, field development project reports, and assignments.
PLO5. Develop or utilize appropriate techniques, resources and modern engineering and computational tools to complex petroleum engineering activities, with an understanding of the limitations.		
Able to develop or utilize appropriate techniques, resources and modern engineering and computational tools to complex petroleum engineering activities, with an understanding of the limitations.	Lectures, seminars, workshop, mentor-mentee guidance, industrial visit, and problem-based learning.	Field development plan and management reports, reservoir model simulation reports, well testing analysis, and presentation.

(b) Generic Skills		
PLO6. Apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.		
Intended Learning Outcomes	**Teaching and Learning Methods**	**Assessment**
Able to apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	Group projects, group discussion, problem-based learning, workshop, cooperative and collaborative learning, undergraduate project, seminar, and field development project.	Written assignments, laboratory reports, essays, thesis, and oral presentations.
PLO7. Identify the impact of petroleum engineering solutions in societal and environmental contexts and demonstrate the needs for sustainable development.		
Able to identify the impact of petroleum engineering solutions in societal and environmental contexts and demonstrate the needs for sustainable development.	Industrial training, undergraduate project, field development project, co-operative learning, and problem based learning.	Industrial training assessment by industrial supervisor, peer and lecturer evaluations seminars, and reports.
PLO8. Practice professional ethics with full responsibility and integrity.		
Able to demonstrate high ethical standards in professional practice, including concern over environmental and social issues.	File development project, tutorial, undergraduate projects, laboratory works, group assignments, geology field trip, problem-based learning, cooperative learning.	Groups reports and presentations, learning logs/ journal, peer and lecturer evaluations.
PLO9. Communicate effectively on complex petroleum engineering activities through written and oral modes to all level of society.		
Able to communicate effectively and confidently on complex petroleum engineering activities through written and oral modes to all levels of society.	Industrial training, industrial visit, undergraduate project, field development project, and problem based learning.	Industrial training report, self-directed learning report, learning portfolios/ journal, and project report and presentation.
PLO10. Function effectively as an individual, as a member or leader in a team that may involve diverse multi-disciplinary settings.		
Able to work independently and function with confidence as an individual, and in both single and multi-disciplinary teams.	Lectures, industrial training, undergraduate project, field development project, cooperative learning, and problem-based learning.	Reports, presentations, peer and lecturer evaluations, and industrial training assessment by industrial supervisor.
PLO11. Acquire knowledge and engage in life-long learning in the broadest context of technological change.		
Able to perpetually seek, acquire, and present contemporary knowledge.	Lectures, class projects, industrial training, undergraduate project, and field development project.	Reports, presentations, industrial training assessment by industrial supervisor, examinations, assignments, and projects.
PO12. Demonstrate and apply knowledge on finance and management principles and aquire entrepreneurship skills.		
Able to demonstrate and apply knowledge on finance and management principles and aquire entrepreneurship skills.	Lectures, class projects, industrial training, undergraduate project, and field development project.	Reports, presentations, industrial training assessment by industrial supervisor, examinations, assignments, and projects.

15. Classification of Courses			
No.	**Classification**	**Credit hours**	**Percentage**
1	University (a) General (b) Language (c) Co-Curriculum	 8 6 2	11.9
2	Faculty Core	31	23.1
3	Programme Core	74	55.3
4	Programme Electives	9	6.7
5	Free Electives	4	3.0
	Total	**134**	**100**
For engineering Programme, please fill up the following classification. (Others please refer to the Statutory Body guidelines)			
A	Engineering Courses (a) Lecture (b) Laboratory/Workshop (c) Industrial Training (d) Final Year Project	 69 13 5 6	69.4
	Total credit hours for Part A	**93**	
B	Related Courses (a) Applied Science/Maths/Computer (b) Management/Law/Humanities/Ethics (c) Co-Curriculum (d) Others	 23 16 2 -	30.6
	Total credit hours for Part B	41	
16	**Total credit hours to graduate**	**134**	**100**

17. Programme Structures and Features, Curriculum, and Award Requirements

The course is offered in full-time mode and based on a 2-semester Academic Year with several subjects being delivered and assessed in each semester. Assessment is done through 50% examination and 50% coursework.

Award requirements:

Students should:

(1) Achieve a total of 134 credit hours with minimum CPA of 2.00.
(2) Complete the undergraduate final year project.
(3) Pass industrial training.
(4) Complete UTM Professional Skill courses.

CURICULLUM FOR BACHELOR OF ENGINEERING (PETROLEUM)
4–YEAR PROGRAMME, INTAKE 2016/2017

	Code	Courses	Credits	Co-Requisites	Pre-Requisites
		Semester 1			
	SKEU 2003	Electrical Technology	3		
	ULAB 1122	English Academic Skills	2		
	SSCE 1693	Engineering Mathematics 1	3		
	SKPU 1243	Introduction to Engineering	3		
	SKPP 1313	Fundamentals of Petroleum Engineering	3		
	SKPP 1113	Engineering Mechanics	3		
		Subtotal	**17**		
	Semester 2				
	UICI 1012	Asian and Islamic Civilization 1	2		
	SSCE 1993	Engineering Mathematics 2	3		
	SKPU 1123	Fluid Mechanics	3		
	SKPP 1133	Engineering Drawing	3		
	SSCK 1203	Analytical Chemistry for Engineering	3		
	UKQ* ***1	Co-Curriculum 1	1		
		Subtotal	**15**		

YEAR 1

CURICULLUM FOR BACHELOR OF ENGINEERING (PETROLEUM)
4–YEAR PROGRAMME, INTAKE 2016/2017

	Code	Courses	Credits	Co-Requisites	Pre-Requisites
YEAR 2	**Semester 1**				
	ULAB 2112	Advanced English for Academic Com.	2		
	SSCE 1793	Differential Equations	3		
	SKPP 2113	Thermodynamics	3		
	SKPP 2213	Basic Geosciences	3		
	SKPP 2721	Geosciences Lab	1	SKPP 2213	
	SKPU 1711	Fluid Mechanics Lab	1	SKPU 1123	
	UHAS 1172#	Malaysian Dynamics			
	UHAS 1162##	Arts, Customs, and Beliefs	2		
	U*** 2**2#@ ULAM 1112##	General Elective @ Malay Language for Communication	2		
		Subtotal	**17**		
	Semester 2				
	SSCE 2193	Engineering Statistics	3		
	SCSJ 2053	Fortran Programming	3		
	SKPP 2123	Mechanics of Materials	3		SKPP1113
	SKPP 2313	Reservoir Rock and Fluids Properties	3		
	SKPP 2731	Reservoir Engineering Lab	1	SKPP2313	
	UICI 2022	Science, Technology, and Mankind	2		
	UKQ* ***1	Co-curriculum	1		
		Subtotal	**16**		

Local student

@ Student may take this course from university general courses (cluster C))

International student

CURICULLUM FOR BACHELOR OF ENGINEERING (PETROLEUM)
4–YEAR PROGRAMME, INTAKE 2016/2017

	Code	Courses	Credits	Co-Requisites	Pre-Requisites
YEAR 3	**Semester 1**				
	SSCE 2393	Numerical Methods	3		
	SKPP 3413	Drilling Engineering	3		
	SKPP 3741	Drilling Engineering Lab	1	SKPP3413	
	SKPP 3213	Formation Evaluation	3		
	SKPP 3313	Reservoir Engineering	3	SKPP2313	
	SKPP 3921#	Geology Field Work	1		SKPP2213
	ULAB 3162	English for Professional Purposes	2		
	SKPU 2711	Thermodynamics & Mechanics of Material Lab	1	SKPP2123, SKPP2113	
		Subtotal	**17**		
	Semester 2				
	SKPP 3423	Well Completion	3		
	SKPP 3223	Petroleum Geology	3		SKPP2213
	SKPP 3113	Evaluation & Management of Petroleum Projects	3		
	SKPP 3513	Petroleum Production Engineering	3		
	SKPP 3123	Safety in Petroleum Engineering	3		
	U*** ***2##	General Elective	2		
	SKPP 3915###	Industrial Training	5		
		Subtotal	**22**		

CURICULLUM FOR BACHELOR OF ENGINEERING (PETROLEUM)
4–YEAR PROGRAMME, INTAKE 2016/2017

	Code	Courses	Credits	Co-Requisites	Pre-Requisites
	Semester 1				
	SKPP 4812	Undergraduate Project 1	2		
	SKPP 4834	Field Development Project	4	SKPP 3413, 3313, 3513, 3223	
Y	SKPP 4313	Reservoir Simulation	3	SKPP 3313	SSCE 2393
E	SKPP 4523	Gas Engineering	3		
A	SKPP 4**3	Petroleum Eng. Elective	3		
R		**Subtotal**	**15**		
	Semester 2				
4	SKPP 4824	Undergraduate Project II	4		SKPP4812
	SKPP 4323	Well Testing	3		SKPP3313
	UHAS 3012	Entrepreneurship and Enterprise Development	2		
	SKPP 4**3	Petroleum Eng. Elective	3		
	SKPP 4**3	Petroleum Eng. Elective	3		
		Subtotal	**15**		
		Total Credits	**134**		

SKPP 3921 is carried out during the semester holiday after the 4th semester.

Student may take this course from university general courses (cluster B), i.e.UHAS 2122 (Critical and Creative Thinking) or UPPP 3012 (Research Methodology).

SKPP 3915 is a compulsory industrial training (12 weeks) and should be carried out during semester break, after 6th semester. Assessment criterion is pass or fail.

COURSE MAPPING FOR CURRICULUM OF BACHELOR OF ENGINEERING (PETROLEUM)

Courses	PLO1	POL2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
SKPU 1243 Introduction to Engineering	a	b							1	1		
SKPP 1313 Fundamentals of Petroleum Engineering	b	b							1			
SKPP 1113 Engineering Mechanics	a									1		
SKPU 1123 Fluid Mechanics	a									1		
SKPU 1711 Fluid Mechanics Lab	a			b					1	1		
SKPP 1133 Engineering Drawing	a				b						1	
SKPP 2113 Thermodynamics	a								1			
SKPP 2213 Basic Geosciences	a	b							1			
SKPP 2721 Geosciences Lab	a			b					1	1		
SKPP 2123 Mechanics of Materials	a									1		
SKPU 2711 Thermodynamics & Mechanics Material Lab	a			b					1	1		
SKPP 2313 Reservoir Rock and Fluids Properties	a	a							1			
SKPP 2731 Reservoir Engineering Lab	a			b					1	1		
SKPP 3413 Drilling Engineering	a	a							1			
SKPP 3741 Drilling Engineering Lab	a			b					1	1		
SKPP 3213 Formation Evaluation	a	a							1			
SKPP 3313 Reservoir Engineering	a	a							1			
SKPP 3921 Geology Field Work	a	a					1		1	1		

SKPP 3423 Well Completion	a		a							1		
SKPP 3223 Petroleum Geology	a	a							1			
SKPP 3113 Evaluation & Management of Petroleum Projects	a		a		b				2		1	
SKPP 3513 Petroleum Production Engineering	a			a	b	1			1		1	1
SKPP 3123 Safety in Petroleum Engineering	a	a							1			
SKPP 3915 Industrial Training*	a	a	b	a	a	1	1	1	1	1		
SKPP 4812 Undergraduate Project 1	a	a						1	1		1	1
SKPP 4834 Field Development Project	a	a	a	a	a	1	1	1	1	1	1	1
SKPP 4313 Reservoir Simulation	a	a			a				1	1		
SKPP 4523 Gas Engineering	a	a							1			
SKPP 4824 Undergraduate Project II	a	a	a	a	a	1	1	1	1		1	1
SKPP 4323 Well Testing	a	a			a				1			
SKPP 4153 Petroleum Refining Technology##	a		a						1			
SKPP 4513 Well Diagnosis & Treatments##	a	a							1			
SKPP 4333 Enhanced Oil Recovery##	a	a									1	
SKPP 4253 Geophysics##	a	a									1	
SKPP 4343 Waterflooding##	a	a									1	
SKPP 4413 Advanced Drilling Engineering##	a	a									1	
SKPP 4423 Advanced Well Completion##	a	a									1	

Courses	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
SKPP 4163 Renewable Energy##	a										1	
SKPP 4413 Advanced Drilling Engineering##	a	a									1	
SKPP 4423 Advanced Well Completion##	a	a									1	
SKPP 4163 Renewable Energy##	a										1	
SSCE 1793 Differential Equations	a									1		
SSCE 1993 Engineering Mathematics 2	a										1	
SSCE 2393 Numerical Methods	a									1		
SSCE 2193 Engineering Statistics	a									1		
SSCK 1203 Analytical Chemistry for Engineering	a										1	
SCSJ 2013 Fortran Programmeming	a	b								1		
UHAS 1172 @ UHAS 1162 Malaysian Dynamics @ Art, Customs, and Beliefs		b								1		
UICI 1012 Asian & Civilisation		b				1	1	1				
U*** 2**2# @ ULAM 1112 Generic Development or Globalization @ Malay Language for Com.		b				1	1	1				
UICI 2022 Science, Technology, and Mankind		b				1	1	1				
UKQ* ***1 Co-curriculum 1										1		

Courses	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
UKQ* ***1 Co-curriculum 2										1		
ULAB 1112 English for Academic Communications									1			
ULAB 2112 Advanced English for Academic Com.									1			
U*** 2**2 General Elective										1	1	
ULAB 3**2 English Elective									1			
UHAS 3012 Entrepreneurship and Enterprise Development							1		1			1

Petroleum elective courses

Key:

Technical skills: a = major contribution to outcome;

b = moderate contribution to outcome;

c = minor contribution to outcome

Generic skills: 1 = substantial (with assessment);

2 = not substantial (enhance)

17b. Mapping of Programme Learning Outcomes to MQA Requirements									
FACULTY'S PROGRAMME OUTCOMES		MQA PROGRAMME OUTCOMES							
		Knowledge	Practical Skills	Critical Thinking and Problem-solving Skills	Communication, leadership and team skills	Social Skill and Responsibilities	Ethics, Professionalisme, and Humanities	Life-long Learning and Information Management	Entrepreneurship and Management Skill
		D01	D02	D03	D04	D05	D06	D07	D08
PLO 1	Apply knowledge of mathematics, science, engineering fundamentals, chemical and gas engineering principles to the solution of complex engineering problems.	✓							
PLO 2	Identify, research relevant literature, formulate and solve complex engineering problems using first principles of mathematics and engineering sciences.		✓						
PLO 3	Conduct investigations of complex problems employing appropriate research skills including design of experiments, analysis and interpretation of data and generation of valid conclusions.			✓					
PLO 4	Design solutions for complex engineering problems and as well as design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.						✓		
PLO 5	Develop or utilize appropriate techniques, resources and modern engineering and computational tools to complex engineering activities, with an understanding of the limitations		✓						
PLO 6	Communicate effectively through written and oral modes to all levels of society				✓				
PLO 7	Function effectively as an individual, and as a member or leader in diverse teams or multi-disciplinary settings				✓				
PLO 8	Apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice				✓				
PLO 9	Explain the impact of engineering solutions in societal and environmental contexts. and incorporate the principles of sustainable development in engineering process and design.					✓			

17b. Mapping of Programme Learning Outcomes to MQA Requirements

FACULTY'S PROGRAMME OUTCOMES		MQA PROGRAMME OUTCOMES							
		Knowledge	Practical Skills	Critical Thinking and Problem-solving Skills	Communication, leadership and team skills	Social Skill and Responsibilities	Ethics, Professionalisme, and Humanities	Life-long Learning and Information Management	Entrepreneurship and Management Skill
		D01	D02	D03	D04	D05	D06	D07	D08
PLO 10	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice					✓			
PLO 11	Recognize the need for and readily engage in independent and life-long learning							✓	
PLO 12	Apply knowledge of project management and entrepreneurial principles to a multidisciplinary engineering project or business plan development								✓

18. Assesment Tools

Measurement Tools	Learning Outcomes												Duration	Action by
	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010	PL011	PL012		
Exam, quizzes, peer teaching	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Continuous	Lecturer, student
e- Portfolio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Continuous	Student
Course Outcome Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Lecturer
Course Outcome Report	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Lecturer
Research Project Survey	✓	✓		✓	✓	✓		✓	✓			✓	End of sem	Faculty
PO Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	End of sem	Faculty
Industry Attachment Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	End of session	Faculty
Alumni Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once/3 years	Head of Dept
Employer Survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Once/3 years	Head of Dept

SYNOPSES OF PETROLEUM ENGINEERING COURSES

SKPP 1313 Fundamental of Petroleum Engineering
Pre-requisites: None

This course covers six main areas. Introduction: what is petroleum, history of oil in Malaysia. Geology and exploration: rock characteristics, rock types, oil and gas origin, oil and gas migration and accumulation, traps and exploration methods. Reservoir characteristics: petroleum physical properties, bulk volume, porosity, permeability, saturation and recovery factor concept. Drilling: rig types, drilling methods, drilling fluid, circulation system, rotary system, power system, hoisting system, vertical and directional drilling and drilling problems. Formation evaluation and well completion: coring, logging, drill stem test, casing and cementing, completion types and perforation. Production and transportation: natural flow and artificial flow, surface facilities, stimulation and transportation.

SKPP 2213 Basic Geoscience
Pre-requisites: None

This course comprises six main areas. Earth physical & chemical characteristics: main parts of the earth & main earth characteristics. Minerals: natural elements & compounds, physical properties of minerals and classification of minerals. Rocks: group of rocks, igneous rock, sedimentary rocks and metamorphic rocks. Geological time: concept & geological time scale, fossil and fossil application. Surface processes: weathering, surface water & underground water and sediment transportation & deposition. Geological structure: mechanical deformation, stress and strain, fault, fold and joint.

SKPP 2313 Reservoir Rock and Fluids Properties
Pre-requisites: None

This course exposes students to the concepts and calculations of reservoir rock, gas, and liquid properties. Porosity: theory, measurement and rock compaction. Permeability: theory, absolute/effective permeability, permeability ratio and measurement. Fluid saturation. Electrical conductivity: resistivity relationship and measurement. Surface energy and Capillary pressure: basic, measurement and water saturation from capillary pressure. Basic concept of phase behaviour one, two and several components. Gas properties: ideal gas, real gas and gas viscosity. Liquid properties: volume behaviour, density, surface tension, liquid viscosity and vapour pressure. Two phase properties system: equilibrium relationship, equilibrium calculation and separation calculation. Reservoir fluid properties: gas formation volume factor, gas solubility, oil formation volume factor, and two phase formation volume factor.

SKPP 2721 Geoscience Laboratory
Pre-requisites: None

This course enables students to understand better the theories they learned from the Basic Geoscience course. Mineral Properties: physical and chemical properties. Rocks identification: igneous, sedimentary and metamorphic rocks. Geological mapping: Brunton compass and map construction. Sand sieve analysis.

SKPP 2731 Reservoir Engineering Laboratory
Pre-requisites: None

The content of this laboratory works can assist students to understand better the theories they learned from the Reservoir Rock and Fluid Properties course. Measurement of absolute permeability: gas permeameter and liquid permeameter. Measurement of viscosity: glass capillary, Brookfield apparatus and Kern balance. Measurement of porosity: helium porosimeter and Ruska pump apparatus. Measurement of relative permeability: core lab retorted. Measurement of density: gas density, hydrometer. Measurement of capillary pressure.

SKPP 3113 Evaluation and Management of Petroleum Projects
Pre-requisites: None

This course comprises Introduction: definition, effective money measurement, decision making process and several objectives & subjective in result analysis. Economic environment and cost concepts: supplies & demand law, cost concepts and selectivity in current economy. Time-money and interest relationship: cash flow monitoring, sign & cash flow diagram, inflation and conservation & capital cost. Project evaluation: methods, value measurement, alternatives that have different age, values reducing & evaluation, effect of income tax and replacement studies. Risk, uncertainty, sensitivity, and approximation: meeting, sensitivity analysis and decision making. Capital: financial state terminology, capital requirement

& Oil Company project handling, equipment purchasing & renting and Malaysian government & petroleum activities relationship.

SKPP 3123 Safety in Petroleum Engineering
Pre-requisites: None
The course presents fundamental principle of safety and risk assessment in petroleum engineering. In particular, it emphasizes on safety legislations, inherent safety design concept, methods of hazard identification, chemical health risk assessment and various methods of risk assessments. The course also covers health and environmental issues related to petroleum engineering. At the end of this course, it is expected that the students will be able to appreciate the theoretical and practical aspects of occupational safety and health in petroleum engineering. Students should also be able to use the techniques of hazard identification and risk assessment in the design and operation of petroleum engineering projects.

SKPP 3213 Formation Evaluation
Pre-requisites: None
This course exposes students to electric logging: basic concept of reservoir resistivity, spontaneous potential and resistivity log. Radioactive log: basic concept of radioactivity, Gamma-ray log and neutron log & formation density log. Acoustic log: basic concept of elastic wave and acoustic log. Uses and evaluation: Archie's equation, lithology determination, assessing the true formation resistivity and evaluating the hydrocarbon reserves. Miscellaneous logging Programme: Tixter approximation quick look interpretation technique, miscellaneous logs and computer aided log interpretation. Productivity test: overview and repeat formation tester.

SKPP 3223 Petroleum Geology
Pre-requisites: SKPP2213
This course exposes the students to the relationship between the complex chemical mixture of organic compounds of hydrocarbon to the organic and inorganic theories of petroleum formation. Explanation will be given on the source rocks, the existence of kerogen, the concept of maturity of organic matter and the process of generation of petroleum. These aspects will be viewed in relation to the philosophy used in exploration activities. The topics on sedimentology and stratigraphy will also be included, to give the knowledge of reservoir rock characteristics and identifying areas of petroleum accumulation The processes of migration, entrapment of petroleum and types of sedimentary basins will also be discussed to give an idea of the locations and distribution of oil/gas fields around the world as well as the geophysical techniques of exploration such as the seismic, gravity, magnetic survey techniques.

SKPP 3313 Reservoir Engineering
Pre-requisites: None
This course covers Gas reservoir: gas in place calculation & volumetric recovery, material balance equation for gas reservoir. Condensate gas reservoir: phase diagrams & reservoir types, initial oil & gas calculation and reservoir performance. Non-saturated oil reservoir: reservoir volume, reservoir volumetric recovery. Oil reservoir under simultaneous drive solution gas drive, gas cap drive and water drive: gas cap & water drive reservoir, general material balance equation, application & limitation, steady state water drive estimation. Water influx: calculation model, calculation using material balance equation. Fluid flow: Darcy flow equation, fluid types & reservoir flow system, effect of different permeabilities, flow through cracks, fluid radial flow and PI, PR, damage zone & well stimulation.

SKPP 3413 Drilling Engineering
Pre-requisites: None
The drilling engineering courses comprises Basic drilling equipment: rig components and drilling string. Drilling fluids: functions, properties, testing equipment's & techniques, classification, mixing & treatment, calculation and problems associated with drilling fluids. Drilling hydraulic: rheological model, pressure losses and nozzle bit selection. Deviated well drilling: vertical well drilling, deviated well drilling deviated well planning and directional survey. Well control: pressure relationship, abnormal pressure, fracture gradient prediction, kick and blow-out prevention equipment. Well abandonment: application and techniques.

SKPP 3423 Well Completion
Pre-requisites: None

This course consists of casing: function, types, casing string design and liner. Cementing: function, cement material & additive, testing of slurry and cementing techniques. Well completion practices: factors affecting well completion, types, tubing size selection, completion interval & well head installation. Tubing string, types & connections, design and tubing inspection, handling & installation. Production packer and tubing sealing assemblies: function, types, selection, effect of temperature & pressure and tubing sealing assemblies. Subsurface equipment: tubing auxiliaries equipment, production control equipment, communication equipment and subsurface safety valves. Perforating: types, evaluation of performance, factors affecting perforating and perforating proactive. Completion and work over fluid: selection criteria, types, perforating fluid and packer.

SKPP 3741 Drilling Engineering Laboratory
Pre-requisites: None
The content of this laboratory works exposes students to the determination of clay properties, weighting material, mud thinner material and filtration control agent in mud. Pollution in drilling mud. The study is emulsion mud and oil based mud. Effects of high temperature and high pressure on mud properties.

SKPP 3513 Petroleum Production Engineering
Pre-requisites: None
This course covers three main areas, normally surface facilities, gas lift design, and well performance evaluation. Well performance: inflow performance relationship, vertical lift performance and choke performance. Gas lift: types, mechanical valve, installation types, design and evaluation. Surface facilities: flow control devices, dehydration, storage tanks, separator and flowing string & manifold.

SKPP 3921 Geology Field Work
Pre-requisites: SKPP2213
This course exposes students to the practical aspect of field geology, and introduce geology of Malaysia. Students will be trained how to make geological observations including simple geological mapping using the compass-step method.

SKPP 4313 Reservoir Simulation
Pre-requisites: SKPP3313, SSCE2393
This course covers the fundamental of numerical reservoir simulation which include the development of simple governing equation, partial differential flow model, finite difference approximation, study the error & stability analysis, Programming to reservoir simulator and the use of commercial simulator. The course is conducted by normal lectures and student individual/group project based on development of simple reservoir simulator.

SKPP 4323 Well Testing
Pre-requisites: SKPP3313
This course covers introduction and principles of well testing, conventional and modern well test interpretation methods, effect of reservoir boundaries, reservoir aspects, well aspects, fluid aspects, interferences and pulse test, and well test design.

SKPP 4523 Gas Engineering
Pre-requisites: None
The course covers the relationship between upstream and downstream activities and the processes involve in the transporting, treating and measuring the gas.

SKPP 4812 Undergraduate Project 1
Pre-requisites: None
This course is designed to train students on some important aspects of research management. In the first part of the undergraduate research project course, the students are not only required to carry out preliminary studies on the assigned petroleum engineering related topics but are also required to plan the research methodology that will be implemented in the following semester and maintain a log book. At the end of this course, students are required to prepare a complete research proposal, and subsequently present it. In addition, students will have the opportunity to gain important generic skills such as communication, team working, problem-solving and creative and critical thinking.

SKPP 4824 Undergraduate Project II
Pre-requisites: SKPP4812

This course is a continuation of the Undergraduate Project I. The second part of Undergraduate Project requires students to implement the research proposal that has been prepared in the previous semester. This might involve practical activities such as laboratory works, data collection from industry and computer programming/simulation. At the end of the course, students should be able to prepare a full report compiling the first and second part of the Undergraduate Research Project and subsequently present their research findings. Finally, students must submit a bound thesis according to the UTM thesis-writing format. In addition, at the end of the course, students will have the opportunity to gain important generic skills such as communication, team working, problem-solving and creative and critical thinking.

SKPP 4834 Field Development Project
Pre-requisites: SKPP3223, SKPP3313, SKPP3413, SKPP3513
The objective of this course is to provide training, assignment and understanding of a particular development plan and profitability analysis on a particular gas or oil fields or both which are found either onshore or offshore. This project emphasizes on information preparation for management side so that hydrocarbon (oil or gas) can be produced commercially. Scope: The student will be provided with data from wild cat and several evaluation wells. The data which will be given are seismic data, well log, production testing and drill stem test. Technique and economy analysis will help to explain the followings: 1. Cumulative reserve and recoverable reserve. 2. Development plan, a. platform and facilities design determination, b. well design and drilling schedule and c. well completion design. 3. Reservoir drainage and management. 4. Production estimation and production profile. 5. Cash flow and profitability analysis. In the planning as well, every drilling and production design, high technology, safety, flexibility and economy must be taken into consideration. A comprehensive FDP must consist of: 1. Geological aspects: top structure, cross sectional area, reservoir extension, porosity, permeability, lithology, and reserve estimation. 2. Formation evaluation: logging data, log interpretation technique and reservoir parameter summary. 3. Reservoir engineering: PVT analysis report, well testing result and its analysis, permeability thickness, well parameter potential and recoverable reserve. 4. Drilling engineering: casing design, drilling Programme, well control and directional drilling Programme. 5. Production engineering: drainage policy, platform design and facilities, well completion design, and production estimation. 6. Economy evaluation: cost estimation, cash estimation, profitability analysis and sensitivity analysis. All finding must be included in the appendix.

Petroleum Engineering Elective Courses (SKP 4**3)

SKPP 4153 Petroleum Refining Technology
Pre-requisites: None
This course introduces the characteristics of crude oil and that each of the hydrocarbon compounds has its own boiling temperature. The principles of distillation are introduced leading to the separation into fractions according to cut points. Maximisations of cuts or fractions are achieved through processes like catalytic cracking, alkylation, catalytic reforming and hydro cracking. Gasoline blending is introduced to increase octane number for better performance and to provide designed vapour pressure in gasoline to cope with seasonal altitudinal needs.

SKPP 4163 Renewable Energy
Pre-requisites: None
The course covers the global energy supply-demand trend including Malaysia, oil and gas recovery from conventional and unconventional reserves, the origin of renewable energy flows, and the individual renewable energy sources.

SKPP 4253 Geophysics
Pre-requisites: SKPP2213
This course introduces students with the introduction and application of applied geophysics in resource exploration and development, and pollution control. The course emphasis on the methods of geophysical techniques, especially seismic methods, including some of the modern interpretation techniques. It also discusses the general approach, equipment and field operations of the methods used. The course provides practice in carrying out a small-scale fieldwork project to investigate shallow geological features which are presumed to exist in the subsurface.

SKPP 4333 Enhanced Oil Recovery

Pre-requisites: SKPP2313, SKPP3313
In this course, students are introduced to the important concepts, theories, and methods of enhanced oil recovery (EOR). This course covers the general classification of EOR processes, microscopic displacement of multiphase fluids in porous media, and the concept of mobilization and trapping of oil, mobility ratio and capillary number. Also included are the important concepts and operational procedures of various types of EOR methods such as polymer flooding, chemical flooding, miscible and immiscible gas flooding and thermal recovery processes.

SKPP 4343 Waterflooding
Pre-requisites: SKPP2313, SKPP3313
This course covers the waterflood technique to increase the oil recovery after natural depletion. The displacement and the entrapment of oil by water are also discussed, followed by prediction of the waterflood performance using various published methods.

SKPP 4413 Advanced Drilling Engineering
Pre-requisites: SKPP3413
This course covers the special operations such as coring and fishing, identification of kick or blow out and methods of well control, advance drilling operations used in the industry, drilling optimization and procedures and legislation of well abandonment.

SKPP 4423 Advanced Well Completion
Pre-requisites: SKPP3423
Upon completion of this course, students should be able to prepare well space-out for single and dual completions. This course also exposes students to a safe slick line and completion operations, and preparation of a completion report after the respective well has been released to production and slick line report upon completion of its operation. The content delivered also covers deep sea completion and slick line operations, and completion in unconventional hydrocarbon energy sources.

SKPP 4513 Well Diagnosis & Treatment
The course covers problem wells, diagnosis of problem wells, through tubing production tubing, formation damage, work over planning, sand control, and stimulation. Pre-requisites: SKPP3413.

19. Minor in Petroleum Engineering

For students from different approved Programmes who wish to have a ***Minor*** in the Petroleum Engineering Programme, they must complete **18** credit hours of selected courses.

Core Courses for minor in Petroleum Engineering:

No.	Code	Courses	Credit
1	SKPP 1313	Fundamentals of Petroleum Engineering	3
2	SKPP 2213	Basic Geosciences	3
3	SKPP 2313	Reservoir Rock and Fluids Properties	3
4	SKPP 3313	Reservoir Engineering	3
5	SKPP 3413	Drilling Engineering	3
6	SKPP 3513	Petroleum Production Engineering	3
		Total credits for minor	**18**

20. Career Prospects

Graduates of the Programme can work as a petroleum engineer, reservoir engineer, drilling engineer, completion engineer, production engineer, mud engineer, and petro physicist. Potential employers are oil companies like Petronas, ExxonMobil, Shell, Murphy Oil, Talisman, Petrofac, Newfield, Hess, Nippon Oil, and oil service companies like Schlumberger, Halliburton, Baker Hughes, M-I Swaco, UMW Drilling, ScomiOiltools, Dimension Bid, Geowell, Eastern Energy, etc.

21. Cross Campus Programme

Students are given an opportunity to enroll a few courses in participating universities and the grades and credits (up to 1/3 of the total credits of the curriculum) can be transferred. At the moment, there are four participating universities, i.e., Universiti Teknologi Malaysia, Universiti Sains Malaysia, Universiti Malaya, and Universiti Malaysia Sarawak.

22. UTM Professional Skills Certificate

In order to improve students' generic skills and enhance their knowledge 'outside the box', they are required to complete the following five modules during their study in UTM: (a) How to Get Yourself Employed, (b) ISO 9000:2008 Quality Management System Requirement, (c) Occupational Safety and Health Awareness, (d) How to Manage Your Personal Finance, and (e) Test of English Communication Skills for Graduating Students. The UTM Professional Skills Certificate will be awarded to students who have successfully completed all the five modules.

23. Harvard Business School Programme

This Programme which provides management-related case studies is offered in every semester. Eight modules have been prepared according to the courses offered in curriculum. The case studies are selected based on the respective course outcomes. At the end of the session, students should be able to explain, analyse, and communicate effectively based on the issues addressed.

24. Study Abroad Programme

Selected 3rd and 4th Year students with CGPA $\geq$ 3.5 and MUET $\geq$ 4 are allowed to participate in the study abroad Programme for one semester at a renowned overseas university. Student may entitle for credits transfer.

25. International Service Learning

This Programme combines academic study with community service, so that experiences in and out of the classroom are constantly reinforcing each other. Students have the opportunity to use their classroom learning in a real-life situation. The Programme can enhance students' academic understanding, cultural awareness, generic skills, and real-life skills.

26. Global Outreach Programme

Students spend one or two weeks in a foreign country to gain new academic, cultural, and international experiences. The Programme aims to improve language skills, interpersonal and cross-cultural communication, and also to develop self-confidence, independence, and social skills.

27. Facilities Available

(a) Teaching facilities include fully air-conditioned lecturer rooms/hall & theatres.
(b) Faculty Library.
(c) WiFi.
(d) List of laboratories:
    (i) Fluid Mechanics Laboratory
    (ii) Thermodynamic & Strength of Material Laboratory
    (iii) Geology Laboratory

(iv) Core Analysis Laboratory
(v) Reservoir Fluid Analysis Laboratory
(vi) Drilling Engineering Laboratory
(vii) Workshop
(viii) Heavy Duty Laboratory
(ix) Computer Laboratory

SYNOPSES OF GENERAL COURSES

Basic Engineering

SCSJ 2013 Fortran Programming

Pre-requisites: None

Fortran is a computer language that is used throughout the world to write programs for solving problems in science and engineering. It is a very powerful and yet easy-to-use language. This course covers six major titles: (1) Introduction to Computing. (2) Problem Solving, Algorithm Design and Flowchart, (3) Data Types, Constants and Variables, (4) Arithmetic Operators, (5) Unformatted & Formatted Input/output, (6) Control & Loop Statements, (7) Arrays, and (8) Subprogram. This is a hands-on based course focused on nurturing students' skills on programming and problem solving techniques.

SCS* 2**3 Programming for Engineers

Pre-requisites: None

This course formally introduces the concept of computers, algorithms, programming languages, pseudocode, and problem solving. The two programming languages introduced in this course are FORTRAN and MATLAB. Topics covered in this course include the data types, constants, variable, arithmetic operations, assignment statement, looping, formatted I/O, functions, subroutines, arrays, matrix operations, data structures, plotting, and model building. At the end of the course, students should be able to code any mathematical expressions and logical flow of information into pseudocode computer programming language.

SKEU 1**3 Electric Circuits and Signals

Pre-requisites: None

This course introduces the students to the different types of signals and networks present in Electrical Engineering systems. Emphasis mainly will be on continuous and discrete signals. Signal representation in both time (Fourier Series) and frequency domain (Fourier and Laplace Transform) will be discussed. The concept of transfer function is introduced and other applications of the Laplace transform such as for obtaining the solution of differential equations and circuit analysis are presented. Finally, the use of Bode plot in filter design will be covered.

SKEU 2**3 Electronic Circuits

Pre-requisites: None

This course introduces students the relevant concepts in dc and ac circuits. Firstly, students are exposed to the steady-state electrical circuit. Afterwards, the relevant concepts in transient circuit analysis for first and second order circuit are taught to the students. The course is also equipped the students with necessary knowledge related to the ac power calculation, three phase circuits and the analysis of Two-port networks. At the end of the course, the student should be able to apply the theorems and concepts in order to solve and analyze completely with confidence any given linear electric circuit.

SKEU 2003 Electrical Technology

Pre-requisites: None

The students will be introduced to the concept and theory of basic electrical engineering. This subject will highlight the fundamentals of electrical engineering to enable the student to understand and apply simple electrical circuits and network in their working environment. This subject will cover on DC and Ac systems (single and three phase system) and analyze simple network using electrical basic laws; Ohm Law, Kirchoff Law, current and voltage divider, nodal and loop analysis. Students will also be exposed on the magnet and electromagnet and single phase transformer.

SKEU 3741 Electrical and Electronic Laboratory

Pre-requisites: SKEU13, SKEU2**3**

The course exposes the students to some common electrical components and measurement instruments that can be used in experiments on the electrical and electronic engineering. On theother hand, this teaching laboratory will provide the skill of using electronic devices and measurement instruments to the students. The lab consists of Digital Laboratory and Electrotechnique Laboratory. List of experiments covers on several topics of basic courses of digital electronic and electrical engineering such as combinational logic circuits, MSI circuits, adder circuits, decoder circuit, comparator, counter designing, network theorems and resonant circuits.

SKEU 3751 Control and Instrumentation Laboratory
Pre-requisites: None
The purpose of this course is to provide students with practical experience in the use of equipment, experimental data analysis, and to develop basic skill in laboratory report writing. There will be at least 10 experiments from participating third year laboratories such as Control, Basic Communications, Instrumentation, Microprocessor and Industrial Electronics. The students will also be exposed to the common electrical engineering equipment and measurement techniques.

SKPG 1243 Statics
Pre-requisites: None
Composition and resolution of vector – in particular a force acting on a particle: difference between a vector and scalar, resultant of two vectors, resolutions of a vector, and resultant of several forces. Equilibrium of a particle: two forces, three forces, and more than three forces. Friction: laws of friction, friction angle, particle equilibrium on rough horizontal and inclined plane. Statics of a rigid body, parallel forces and center of gravity, parallel lamina rectangle and triangle, moment and coupled forces. Plane forces directory. Equilibrium of a rigid body: three forces, more than three forces including friction. Conditions for rolling and slipping.

SKPG 1251 Engineering Drawing
This course comprises computer aided drawing, computer aided command, geometry, orthograph drawing, isometric drawing, sectional drawing, and flowchart drawing.

SKPG 1263 Materials Engineering
Pre-requisites: SKPG1243
The first part of this course deals with classification of engineering material, structure property relationship, crystal structure, crystal defects, phase diagram, heat treatment and mechanical properties, with emphasis on metals. The second part is about mechanics of deformable solids. Course work is based on the assumption that structure are in static equilibrium. Analysis is limited to materials stress in elastic rang. Covers stress and strain relationship in deformable solids, analysis of axial members, shafts, and beams. Covers combined stresses, indeterminate members, and properties of structural materials

SKPP 1113 Engineering Mechanics
Pre-requisites: None
This course has been designed to introduce students to the basic principles and concepts in statics and dynamics. The course is divided into two parts: the first part deals with the analysis of particle and rigid body in static, which covers the resultant and resolution of force(s) acting on a particle and rigid body, the equilibrium of a particle and rigid body, how to replace a force system with an equivalent system, and analysis of friction. The second part deals with the analysis of particles in motion. It includes the kinematics and kinetics of particles and kinematics of rigid bodies. It will cover the rectilinear and curvilinear motion of particles, Newton's Second Law of particles and work and energy for particles.

SKPP 1133 Engineering Drawing
Pre-requisites: None
This course provides a fundamental background in engineering drawing to the students, which will enable them to work more effectively in the various fields of engineering. It will emphasize on the introduction to engineering drawing, fundamentals of engineering drawing, geometry, orthographic and isometric drawing. This course also introduces the sectional and flowchart drawing and computer aided engineering drawing to the students.

SKPP 2113 Thermodynamics
Pre-requisites: None
Definition of system, fundamental quantities, pressure, temperature. State of system: phase and phase diagram, PVT surfaces, equation of state - perfect gas law, real gas, and Van der Waal equation. Heat and work: definition, work done by a close system, work in flow process, definition of heat, specific, and Van der Wall heat equation. First law of thermodynamics: potential, kinetic, and internal energy, reversible and irreversible processes, enthalpy, application to closed and open systems. Second law of thermodynamics: statement of second law, heat engine, absolute temperature scale, and entropy. Devices for the transfer of heat and work: thermodynamics of flow process, compressor, and expander, refrigeration and gas liquefaction, and steam power plant.

SKPP 2133 Dynamics
Pre-requisites: None
This course is designed to introduce students to the second part of mechanics which deals with the analysis of particles and bodies in motion. It will include the kinematics and kinetics of particles and kinematics of rigid bodies. It will cover the rectilinear and curvilinear motion of particles, Newton second law of particles, work and energy for particles and kinematics of rigid bodies. At the end of the course, students should be able to demonstrate and apply the knowledge by solving various problems involving kinematics and kinetics of particles and kinematics of rigid bodies, which forms the basis of further engineering courses.

SKPU 1123 Fluid Mechanics
Pre-requisites: None
Physics of fluid: what is fluid, some definitions, surface tension, compressible andIncompressible flow, classes of flow, and physical classification. Fluid statics: pressure, differential equations of fluid statics, manometry, fluid force on submerge bodies, buoyancy and stability of floating bodies, and liquid in relative equilibrium. Fluid in motion: continuity equation, energy and mass equilibrium, Euler, Bernoulli and Momentum equations. Friction in fluid flow: velocity profile in pipes, roughness, friction factor, Moody chart. Flow measurement: venturi and pitot tube, orifice, notches and weirs. Pump and pumping: principle, types, selection, and application of pumps. Dimensional analysis, similitude in fluid mechanics, parameters of incompressible and compressible flow.

SKPU 1243 Introduction to Engineering
Pre-requisites: None
Overview engineering, the profession and its requirements in the Malaysian scenario. Communication (oral and written) and teamwork skills. Mind mapping, learning styles and time management. Basic calculations and unit conversions. Create an engineering graph and solving iterative problems using computer. This course employs Cooperative Learning (CL) and grooms students with skills for Cooperative Problem-based Learning (CPBL).

SKPU 1711 Fluid Mechanics Laboratory
Pre-requisites: SKPU1123
The course covers seven fluid mechanics-related experiments which are friction losses in pipe, stability of floating body, jet impact, flow measurement, centrifugal pump, forced vortex flow, and calibration of bourdon tube pressure gauge.

SKPU 2711 Thermodynamics and Mechanics of Material Laboratory
Pre-requisites: SKPP2113
This laboratory course contains seven experiments that are covered basic concepts in Thermodynamics and Strength of Material. Laboratory experiments are designed for hand-on experience to understand the engineering principles. The experiments application includes First Law of Thermodynamics, Second Law of Thermodynamics, Properties of Pure Substance and Properties & Strength of Materials. This course also emphasizes the technical writing aspect where all students' observation and arguments of each experiment must be reported in proper format.

Islamic Studies and Social Sciences
UHAS 1172 Malaysian Dynamics
Pre-requisites: None
This course is designed for Malaysia students. It introduces a range of social science disciplines, which includes knowledge of sociology, political science, history and international relations. This course will add value to the UTM students to develop self-esteem, promote unity among students, and produce students with a dynamic and global thinking.

UHAS 1162 Arts, Customs and Beliefs of Malaysian
Pre-requisites: None
This course is designed for First Year foreign undergraduates. Students will be exposed to various aspects of the Malaysian culture such as the belief system, religious festivals, customs and etiquette of different racial groups in Malaysia. They will also be introduced to Malaysian traditional music, arts and crafts.

UHAS 3102 Entrepreneurship & Enterprise Development
Pre-requisites: None

This course introduces the concepts and principles of entrepreneur ship and the process of starting a business venture. A three-stage approach is used to achieve the course learning outcome: (a) understanding the individual characteristics of an entrepreneur, (b) analysis business opportunities and forming an entrepreneurial venture, and (c) developing a business plan for the venture. During the first stage, students will be exposed to the concepts and principles of entrepreneurship and individual characteristics and the required skills to successfully manage business ventures. After that, they will be introduced to techniques and tools to analyse and assess business ideas and the procedures to set up business ventures in Malaysia. Finally, they will be guided through every stage of the business plan development using their business ideas as case study. In addition to guided T&L, students will also be exposed to real life entrepreneurial activities through entrepreneurship carnivals containing talks by successful entrepreneurs, entrepreneurial workshops, and entrepreneurial activities.

UICI 1012 Islamic and Asian Civilizations (TITAS 1)
Pre-requisites: None

This course discusses Civilization: the concept of civilization and its main characteristics, the interaction between civilizations, the similarities and differences between civilizations; Civilization, issues and challenges of contemporary Islamic Civilization, Western domination and globalization; Malay civilization, Islamic civilization influence on the Malay community, Malaysia and challenges of civilization: colonialism, secularism, Malay civilization as the foundation civilization of Malaysia, the Islamic revival and its application in Malaysia: Chinese civilization: The universal views and the values of the Chinese civilization, the role of Islamic Civilisation in China, and the effect of interaction between Chinese civilization and foreign civilization; Indian Civilization: Universal views and values of the Indian civilization, the role of Islamic civilization in India and the effects of interaction with foreign civilization.

UICI 2022 Science, Technology and Mankind
Pre-requisites: None

This course discusses the philosophy of knowledge in terms of definitions, concepts, theories, historical development, cultural knowledge, and knowledge transfer. Also discussed are science and Islam in terms of concepts, historical development, the Islamic view of learning science, methodology of Islamic science, and comparison between Islamic science and Western science. The next discussion is about technology in terms of concepts, historical development, the solutions to current issues, and the relationship between technology and divinity. Also included within the scope of this discussion are the things associated with mankind in terms of concepts, theories, the creation of mankind, the status and human responsibility, and the factors of human dignity and purpose of its creation. This course also discusses the accomplishments of Islamic scholars in science and technology.

Extra-Curriculum Activities and General Courses
UKQ* ***1 Co-Curriculum I & II (Two Credits Minimum)
Pre-requisites: None

This course is handled by Co-curriculum and General Courses Unit of UTM. For registration, student must follow the list of courses offered for every semester. The objective of this course is to fulfill the objective of the university to create a balance and all-rounded education in order to prepare students to be more matured with:

(1) Training in leaderships with greater emphasize on organization discipline and team-work among the students.
(2) Training that can provide a room for students to strengthen and develop their talents and skills for own benefit and society.
(3) Training that can promote team – work within the society and community.
Below are some of the courses offer by Co-curriculum and General Courses Unit of UTM:

UKQS 1061 Badminton
Pre-requisites: None

This course introduces students to the technique of playing badminton, basic skills of playing badminton and conducting games as well as managing a badminton tournament.

UKQT 1371 Lovely Soul (Budi Penyayang)
Pre-requisites: None
This course introduces students onto the community program and wellfare together with team working spirit. Students involve into community works such as works for disable people, orphan, etc.

ULAB 1122 English for Academic Communication
Pre-requisites: None
This course prepares students for skills needed to perform academic tasks, such as taking notes from written and oral texts, producing academic assignments and giving oral presentations. Through these tasks, students will practice various skills such as looking for information from various sources (print, Internet, etc.), extracting information from different text types, making notes of information obtained, expanding notes into coherent extended text, and presenting information as well giving viewpoints in an oral presentation.

ULAB 2122 Advanced English for Academic Communication
Pre-requisites: None
This course prepares students for advanced academic communication in English with emphasis on oral communication skills. Students will be assigned projects that require them to look for and extract relevant information from various sources. In the process of completing the projects assigned, students will put into practice various skills developed in the earlier subject as well as skills in collecting data through interviews and questionnaire survey, integrating and presenting information (in oral and written modes), time management and group interaction. The various oral activities such as presenting a proposal of the project, giving a briefing on the progress of the report and presenting the completed report are designed to build students' oral communication skills and confidence in expressing themselves, i.e. skills that are much needed in their studies and career.

ULAB 3**2 English Elective
Pre-requisites: None
This elective course has been designed to improve students reading, and communication skills. Students are required to choose only one course from the followings: ULAB 3112 English for Workplace Communication, ULAB 3132 Reading for Specific Purposes, ULAB 3142 Writing for Specific Purposes, and ULAB 3152 Effective Oral Communication Skills.

Effective Oral Communication Skills
Pre-requisites: None
The course focuses on the techniques of producing good spoken discourse which include public communication such as impromptu and public speeches, group discussion and negotiation. Aspects of sound and speech production will be introduced to improve intelligibility and communicability. Basic principles of oral communication and the importance of non-verbal communication will be introduced for effective communication. Students will have substantial practice in oral communication through in-class tasks and activities. These tasks and activities will enhance students' confidence in using English for academic and professional purposes.

U*** 2**2 Generic Development or Globalisation
Pre-requisites: None
Malaysian students are allowed to choose a course from either the Generic Development or Globalization cluster, which are offered by various faculties via the Centre of General Courses and Co-Curriculum, i.e. Ethnic Relations, Islamic Institutions, Islam and Current Issues, Energy Security, etc. International students are made compulsory to take ULAM 1112 (Malay Language for Communication).

UHAS 1152 Ethnic Relations
Pre-requisites: None
This course discusses about the community, sosio and basic concepts of sosiology in ethnic relations. The course also highligh the growth and formed of Malaysian ethnic. Focus given onto the issues and challenge by multi ethnics in Malaysia to united.

UICI 2042 Islamic Institutions
Pre-requisites: None

Family and society institution, marriage, parent skill, duties and responsibilities of family, Ummah concept social guarantee and control. Education: society, role, manners, and responsibilities in education. Economic institution: philosophy and objective of justice in economy. Institution of Law and judgment system: principle, sources, quality of Islamic laws and differences between modern laws. Institutions of Qada, hisbah, Tahkim, and Mazalim. Islamic judgment system that practice in Malaysia: principles and types of government and administration.

UICI 3032 Islam and Current Issues
Pre-requisites: None

Symptoms of moral decadency, economic issues, development and environment, Ethics issues in science and technology, globalisation issue and conflict of Western and Eastern civilization. Challenges that faced by Malaysian today.Government and administration: Parliament system, Republic, Democracy, and Autocracy. Trend of opinion post modernism, the questions of religious extremism and fundamentalism.Ethnic relation issue and chauvinism, and related issues with Islamic credibility.

UKPU 2112 Energy Security
Pre-requisites: None

The course examines the relationship between security and supplies and demands of energy resources. The course will highlight policy challenges to integrate diverse economic, geopolitical and environmental objectives by examining selected energy security policy issues and approaches. The course will examine how the demands of the growing energy consumption will present significant impact and challenges to the Malaysian and international community. The course is set to provide students with a basis for better understanding the emergence of energy issues, energy security and energy policy and its effect on environment and economy as critical components in international relations study. Emphasize will be given to new technologies and innovations to shift petroleum based economies to a new renewable energy. The course takes energy security as its launching point, exploring not only how countries shape their grand strategies to meet their energy needs, but also how such actions have implications for other countries and the international system. Case studies will be included in the course.

ULAM 1112 Malay Language for Communication
Pre-requisites: None

This course is a university requirement for international Bachelor degree students from the non-Malay regions. The course focuses on oral communication to enable students to interact and socialize with the local community. At the end of the course students should be able to communicate in basic Malay language in different contexts.

U*** 2**2 General Elective
Pre-requisites: None

Students are allowed to choose a course from the Innovation and Creativity cluster which are offered by various faculties via the Centre of General Courses and Co-Curriculum: Research Methodology, Creative and Critical Thinking, Creative and Innovactive Design for Competition, Innovation and Creativity, and Innovative Design Practice for Wealth Creation.

Science and Mathematics
SSCE 1693 Engineering Mathematics 1
Pre-requisites: None

This is a first course in Engineering Mathematics. It covers topics including differentiation and integration which focus on hyperbolic and inverse functions. Improper integrals are also studied. Vectors and matrices including basic operations, solving related problems in three dimensions are discussed. In addition, vector spaces, eigenvalues and eigenvectors are introduced. Sketching of polar graphs is discussed. This course also covers complex numbers, function of complex variable, series and power series.

SSCE 1793 Differential Equations
Pre-requisites: None

This is an introductory course on differential equations. Topics include first order ordinary differential equations (ODEs), linear second order ODEs with constant coefficients up to fourth order, the Laplace transform and its inverse, Fourier series, and partial differential equations (PDEs). Students will learn how

to classify and solve first order ODEs, use the technique of undermined coefficients, variation of parameters and the Laplace transform to solve ODEs with specified initial and boundary conditions, and use the technique of separation of variables to solve linear second order PDEs and the method of d'Alembert to solve wave equation.

SSCE 1993 Engineering Mathematics 2
Pre-requisites: None
This course is about multivariable calculus of real and vector-valued functions. The basic theory of partial derivatives and multiple integrals of real functions with their applications are discussed. This theory is extended to vector valued functions to describe motion in space, directional derivates, gradient, divergence and curl, line integrals, surface integrals and volume integral. Related theorems, namely Green's Theorem, Stokes' Theorem and Gauss Divergence Theorem and their applications are discussed.

SSCE 2193 Engineering Statistics
Pre-requisites: None
This course begins with basic statistics, elementary probability theory and properties of probability distributions. Introduction to sampling distribution, point and interval estimation of parameters and hypothesis testing are also covered. Simple linear regression and one-way analysis of variance are also taught in this course. Students are taught on how to use and incorporate statistical tools and software for solving engineering statistics problem through a group assignment.

SSCE 2393 Numerical Methods
Pre-requisites: None
This course discusses problem solving using numerical methods the involve non-linear equations, systems of linear equation, interpolation and curve fitting, numerical differentiation and numerical integration, eigenvalue problems, ordinary differential equations, and partial differential equations.

SSCK 1293 Analytical Chemistry for Engineering
Pre-requisites: None
This course provides an introduction to quantitative chemical analysis, with emphasis on wet chemistry and instrumental methods. Topics in wet chemistry include introduction to analytical chemistry, sampling, sample preparation, data analysis, gravimetric analysis and volumetric analysis. The course also introduces the principles, instrumentation, and application of chromatographic and spectroscopic methods such as gas chromatography, HPLC, ultraviolet-visible spectroscopy, atomic absorption and atomic emission spectroscopy.

SSCK 1603 Organic Chemistry: Functional Groups
Pre-requisites: None
This course discusses the fundamental concepts of functional groups in organic compounds. These include aliphatic and aromatic hydrocarbons, alcohols, phenols, organohalogen compounds, ethers, epoxides, aldehydes, ketones and carboxylic acids. In each topic, the students will be introduced to the structures of the functional groups and the nomenclatures (common names and IUPAC names). Physical properties, preparations, reactions and visual test will also be discussed. Interconversion of the related functional groups and their reaction mechanisms are also included.

SSCK 1831 Organic Chemistry Practical
Pre-requisites: SSCK1603
This course introduces the classifications, synthesis and reaction of biomolecules such as carbohydrates, peptides, proteins and lipids. It will also emphasiz on the three-dimensioal structures and fundamental concepts of stereochemistry. Infrared spectroscopy is included as a technique in charaterising the functional groups of compounds.

SSCK 1891 Analytical Chemistry Practical
Pre-requisites: None
This course strengthens student understanding of the concepts in Analytical Chemistry through experiments conducted in the laboratory. Experiments consist of application of classical methods such as volumetry and gravimetry and modern instrumental chemical techniques such as chromatography and spectroscopy. Upon completion, students should b able to perform analytical chemistry experiments using general analytical techniques and us instruments to measure data, analyze, manipulate, discuss and report data.

9.5 BACHELOR OF ENGINEERING (NUCLEAR)

Depletion of the country's petroleum and gas reserves has prompted the country to look for alternative sources of energy. Nuclear energy is one of the best alternative sources of energy. Rapid developments in the application of nuclear engineering in other sectors such as defence, medical and agriculture are demanding for more nuclear engineers. It has been shown that one of the critical conditions for the successful introduction of a nuclear power programme and other nuclear related industries is the availability of trained manpower that meets the desired quality and quantity. These reasons have called for the establishment of education/training infrastructures as well as national education and training capabilities in the field of engineering and science in order to develop qualified personnel for the nuclear power programme.

Nuclear engineering deals with the practical applications of nuclear processes. The main objective of this programme is to train and prepare students to become nuclear engineers with the capability in designing, producing and constructing in the aspects of research and development (R&D), maintenance, sales, consultancy, education, and training. Nuclear engineering is based upon the extensive use of mathematics and physical principles. These principles are applied to radioactivity, nuclear interactions and the interaction of radiation with materials. Further applications require the knowledge of energy removal and conversion, materials science, instrumentation and control, and chemistry. The programme is designed such that the graduates are be able to perform tasks and functions for nuclear power related fields which primarily require nuclear-related qualifications in both design and construction in the operation of a nuclear power plant and in other nuclear related industries.

Apart from the technical competencies, this program is also designed to improve students' generic skills. These include critical thinking, communication, leadership, team working, life-long learning, ethics, and entrepreneurship.

Nuclear Engineering Laboratories

For nuclear courses, a few laboratories are in the process of setting-up. In the mean time, existing laboratory facilities at the Faculty of Science are available to the students to carry out nuclear related experiments. Arrangements have also been made for the students to use laboratory facilities at the Malaysian Nuclear Agency.

All laboratories are equipped with modern experimental equipment and facilities that could provide students with first-hand experience with course concepts, and with an opportunity to explore some methods used by industries. The laboratory course contents and implementation have been designed with the following objectives:

(1) To apply fundamental concepts related to nuclear engineering knowledge;
(2) To familiarize students with measurement techniques using some scientific methods and instruments that are ocmmonly used in nuclear industry;

(3) To assist students in obtaining measurements techniques and hands-on experience in assembling and testing different experiments;
(4) To expose students to computer data acquisition, analysis, control, and presentation
(5) To develop students' problem solving, team coordination, and critical thinking skills through open-ended laboratory works.

Program Specifications for Bachelor of Engineering (Nuclear)

1. Programme Name		Bachelor of Engineering (Nuclear)	
2. Final Award		Bachelor of Engineering (Nuclear)	
3. Awarding Institution		Universiti Teknologi Malaysia	
4. Teaching Institution		Universiti Teknologi Malaysia	
5. Programme Code		TK21 (SKN)	
6. Professional or Statutory Body of Accreditation		Board of Engineers Malaysia (BEM) Engineering Accreditation Council (EAC)	
7. Language(s) of Instruction		English and Bahasa Melayu	
8. Mode of Study (Conventional, distance learning, etc)		Conventional	
9. Mode of operation (Franchise, self-govern, etc)		Self-governing	
10. Study Scheme (Full Time/Part Time)		Full Time	
11. Study Duration		Minimum : 4 yrs Maximum : 6 yrs	
Type of Semester		No. of Semesters	No. of weeks per semester
Normal		8	14
Short		4	8
12. Entry Requirement	Matriculation or STPM with minimum of B in Mathematics, Chemistry and Physics/Biology and CPA 3.00, and not seriously colour blind.		

13. Programme Educational Objectives

PEO 1 Perform in nuclear industries and become important contributors to national development.

PEO 2 Become creative, innovative, and adaptable engineers regardless of their position as leaders or team members in their workplace and society.

PEO 3 Contribute towards environmental well-being and sustainable development.

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Program Specifications for Bachelor of Engineering (Nuclear)

14. Programme Learning Outcomes (PLO)		
Intended Learning Outcomes	**Teaching and Learning Methods**	**Assessment**
Technical Knowledge and Competencies		
PL01. Apply general fundamental scientific nuclear engineering knowledge		
Apply knowledge of mathematics, science, engineering fundamentals, nuclear engineering principles to the solution of complex engineering problems.	Lectures, tutorial, seminars, laboratory works, directed reading simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, reports, presentations, discussions, problem-based exercises, group projects, and independent projects.
PL02. Identify, formulate, and solve engineering problems critically and creatively		
Identify, research relevant literature, formulate and solve complex engineering problems using first principles of mathematics and engineering sciences.	Lectures, tutorial, seminars, laboratory works, directed reading simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.
PL03. Plan, design, and conduct experiments, analyze and interpret data, and apply the skills to nuclear engineering practices.		
Conduct investigations of complex problems employing appropriate research skills including design of experiments, analysis and interpretation of data and generation of valid conclusions.	Lectures, tutorial, seminars, laboratory works, directed reading simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.
PL04. Design a system or process to meet the desired engineering, economic, health, safety, and environmental requirements towards sustainable development and environmental considerations.		
Design solutions for complex engineering problems and as well as design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Lectures, tutorial, seminars, laboratory works, directed reading simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.
PL05. Utilize computational techniques and skills using appropriate tools to solve nuclear engineering practices		
Develop or utilize appropriate techniques, resources and modern engineering and computational tools to complex engineering activities, with an understanding of the limitations.	Lectures, tutorial, seminars, laboratory works, directed reading simulation exercises, computer-based exercises, undergraduate project, design project, problem-based learning, cooperative and collaborative learning.	Examinations, problem-based learning reports, laboratory reports, presentations, design project, individual research project and exercises.

Intended Learning Outcomes	Teaching and Learning Methods	Assessment
Generic Skills		
PL06. Communicate effectively in both written and oral forms		
Communicate effectively through written and oral modes to all levels of society.	Group projects, group discussion, problem-based learning, cooperative and collaborative learning, tutorials undergraduate project, and design project.	Written assignments, laboratory reports, essays, thesis, and oral presentations.
PL07. Function effectively as an individual or in a group		
Function effectively as an individual, and as a member or leader in diverse teams or multi-disciplinary settings.	Design project, tutorials, undergraduate projects, laboratory works, group assignments, problem-based learning, and cooperative learning.	Group reports and presentations, learning logs/ journal, peer, and lecturer evaluations.
PL08. Practice, social, health, safety, legal and cultural responsibility		
Apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	Industrial training, undergraduate project, design project, co-operative learning, and problem-based learning.	Industrial training assessment by industrial supervisor, peer and lecturer evaluations, seminars, and reports.
PL09. Social and environmental responsibility and sustainability		
Explain the impact of engineering solutions in societal and environmental contexts and incorporate the principles of sustainable development in engineering process and design	Lectures, industrial training, undergraduate project, field development project, cooperative learning, and problem-based learning.	Industrial training report, self-directed learning project, learning portfolios/ journal, and project report and presentation.
PL010. Practice and professional ethics integrity		
Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice	Industrial training, industrial visit, undergraduate project, design project, and problem-based learning.	Industrial training report, self-directed learning report, learning portfolios/journal, and project report and presentation.
PL011. Display life-long learning skills		
Recognize the need for and readily engage in independent and life-long learning.	Lectures, class projects, industrial training, undergraduate project, and design project.	Reports, presentation, peer and lecturer, and industrial training assessment by industrial supervisors.
PL012. Apply entrepreneurship knowledge in decision making		
Apply knowledge of project management and entrepreneurial principles to a multidisciplinary engineering project or business plan development	Lectures, class projects, undergraduate project, and design project.	Reports, presentation, peer and lecturer, written assignments, and examinations.

15. Classification of Courses			
No.	**Classification**	**Credit Hours**	**Percentage**
i.	University a. General b. Language c. Co-Curriculum	 10 8 2	14.8 %
ii.	Faculty Core	28	20.7 %
iii.	Faculty Core (Science, Math & Computer)	27	20.0 %
	Programme Core (Nuclear Engineering)	51	37.8 %
iv.	Programme Electives	9	6.7 %
	Total	**135**	**100 %**

Classifications based on field
(others please refer to the Statutory Body guidelines)

No.	**Classification**	**Credit Hours**	**Percentage**
A	Engineering Courses a. Lecture b. Laboratory/Workshop c. Industrial Training d. Final Year Research Project	 71 6 5 6	71.9 %
	Total credit hours for Part A	88	
B	Related Courses a. Applied Science/Maths/Computer b. Management/Law/Humanities/Ethics c. Co-Curriculum d. Others	 27 18 2 -	28.1 %
	Total credit hours for Part B	47	
	Total Credit Hours for Part A and B	**135**	**100 %**
16. Total credit hours to graduate		**135 credit hours**	

17. Programme structures and features, curriculum and award requirements

The programme is offered in a full-time mode and based on a 2-semester academic session with several courses being delivered and assessed in each semester. Assessment is based on 50% coursework and 50% final examination.

Award requirements:

Students should:
(1) Achieve a total of 135 credit hours with minimum CPA of 2.0.
(2) Pass industrial training.
(3) Complete the undergraduate final year project.
(4) Complete UTM Professional Skills courses.

This programme is offered on full-time mode and is based on a 2-Semester Academic Session with several courses being delivered and assessed in each semester. Assessment is based on coursework, final examination and final year project.

Award requirements:

To graduate, students should:

- Achieve a total of 136 credit hours with minimum CPA of 2.00

Core Courses for Minor in Chemical Engineering

For students from different approved programmes who wish to have a Minor in the Chemical Engineering Programme, they must complete 21 credit hours of selected courses.

CURICULLUM FOR BACHELOR OF ENGINEERING (NUCLEAR)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 1	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKPN 1243	Introduction to Nuclear Engineering	3	
	SSCE 1693	Engineering Mathematics I	3	
	ULB 1122	Academic English Skills	2	
	UHAS 1172	Malaysian Dynamics	2	
	SKPG 1243	Statics	3	
	SKPN 1113	Modern Physics	3	
		Subtotal	**16**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SSCE 1993	Engineering Mathematics II	3	SSCE 1693
	SKPG 1263	Material Engineering	3	
	SKEU 1**3	Electric Circuits and Signals	3	
	UICI 1012	Asian and Islamic Civilization I (TITAS I)	2	
	SKPU 1123	Fluid Mechanics	3	
	UKQ* ***2	General Elective	2	
		Subtotal	**16**	

CURICULLUM FOR BACHELOR OF ENGINEERING (NUCLEAR)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 2	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SSCE 1793	Differential Equations	3	
	SCS* 2**3	Programming for Engineers	3	
	SKPP 2133	Dynamics	3	
	SKPP 2113	Thermodynamics	3	
	SKPU 1711	Fluid Mechanics Lab	1	SKPU 1123
	ULAB 2122	Advanced Academic English Skills	2	
	UICI 2022	Science, Technology and Mankind	2	
		Subtotal	**17**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SSCE 2193	Engineering Statistics	3	
	SKPN 2213	Nuclear Physics	3	SKPN 1113
	SKPP 1133	Engineering Drawing	3	
	SKPN 3173	Engineering Economics & Project Management	3	
	SKEU 2**3	Electronic Circuits	3	
	UKQ* ***2	Co-Curriculum	2	
		Subtotal	**17**	

Student may take this course from university general courses (cluster C).

CURICULLUM FOR BACHELOR OF ENGINEERING (NUCLEAR)
4 YEAR PROGRAMME, INTAKE 2016/2017

YEAR 3	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SSCE 2393	Numerical Methods	3	
	SKEU 2003	Electrical Technology	3	
	SKPN 3113	Nuclear Radiation Protection	3	
	SKPN 3711	Nuclear Physics Lab	1	SKPN 2213
	SKPN 3213	Nuclear Reactor Theory	3	SKKK 2123
	ULAB 3162	English for Professional Purposes	2	
	SKPU 2711	Thermodynamics & Mechanics of Material Lab	1	SKPG 1263, SKPP 2113
		Sub total	**16**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKPN 3223	Control and Instrumentation Engineering	3	
	UHAS 3012	Entrepreneurship and Enterprise Development	2	
	SKPN 3253	Nuclear Safety, Regulation and Security	3	
	SKPN 3133	Transport Process	3	
	SKPN 3721	Nuclear Reactor Lab	1	SKPN 3213
	SKEU 3741	Electrical and Electronic Laboratory	1	SKEU 1**3, SKEU 2**3
	SKPN 3233	Radiation Detection and Measurement	3	
		Subtotal	**16**	
	SEMESTER 3			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKPG 3915*	Industrial Training (Compulsory)	**5**	
		Subtotal	**5**	

* SKPG 3915 is a compulsory 12 weeks industrial training. The evaluation is only pass or fail.

CURICULLUM FOR BACHELOR OF ENGINEERING (NUCLEAR)
4 YEAR PROGRAMME, INTAKE 2016/2017

Y E A R 4	**SEMESTER 1**			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	U*** ***2	General Elective	2	
	SKPN 4812	Undergraduate Project I	2	
	SKPN 4113	Nuclear Fuel Cycle and Waste Management	3	
	SKPN 4123	Nuclear Reactor Materials	3	SKPG 1263
	SKPN 4133	Analytical Radiochemistry	3	
	SKPN 4833	Nuclear Engineering System and Design I	3	
	SKEU 3751	Control and Instrumentation Laboratory	1	SKPN 3223
		Subtotal	**17**	
	SEMESTER 2			
	CODES	**COURSES**	**CREDIT**	**PRE-REQUISITES**
	SKPN 4824	Undergraduate Project II	4	SKPN 4812
	SKPN 4834	Nuclear Engineering System and Design II	4	
	SKPN 4**3	Elective Nuclear II	3	
	SKPN 4**3	Elective Nuclear III	3	
	SKPN 4611	Nuclear Engineering Professional Practice	1	
		Subtotal	**15**	
		TOTAL CREDIT	**135**	

SKPN 3915 is a compulsory industrial training (12 weeks). Assessment criterion is pass or fail.
Student may take this course from university general courses (cluster C), i.e. UHAS 2122 (Critical and Creative Thinking) or UPPP 3012 (Research Methodology).

Mapping of Courses to Programme Learning Outcomes

Code	Courses	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
SKPN 1243	Intro. To Nuclear Engineering	a	a				2	1	2		2	2	
SSCE 1693	Engineering Mathematics I	a	a				2	1					
SKPG 1243	Statics	b	b				1	2	2		2		
SKPN 1113	Modern Physics	a	a	a			1						
SSCE 1993	Engineering Mathematics II	a	a				2	1					
SKPG 1263	Materials Engineering	a	a					1	2		2	2	
SKEU 1**3	Electric circuits and signals	a		b			1						
SKPU 1123	Fluid Mechanics	a	b				1	2	2		2		
SKPU 1711	Fluid Mechanics Lab	a	a	a			1	2	2		2	2	
SSCE 1793	Differential Equations	a	a				2	1					
SCS* 2**3	Programming for Engineers	a	a			a	2	2	1		1	2	
SKPP 2133	Dynamics	a	a	b							1		
SKPP 2113	Thermodynamics	a	a				2	1				2	
SSCE 2193	Engineering Statistics	a	a				2	1					
SKPN 2213	Nuclear Physics	a	a				1						
SKPP 1133	Engineering Drawing	a		a				1			2		
SKPU 2711	Thermodynamics & Mechanics of Material Lab	a	a	a			1	2	2	2	2	2	
SKEU 2**3	Electronic Circuits	a		b			1						

SSCE 2393	Numerical Methods	a	a					1					
SKEU 2003	Electrical Technology	a		b			1	2		2			
SKPN 3173	Engineering Economics and Project Management	a					1	1					2
SKPN 3113	Radiation Protection	a	a	b						1	2		
SKPN 3711	Nuclear Physics Lab	a			a		1			2	2		
SKPN 3721	Nuclear Reactor Lab	a	a		a		1	2		2			
SKEU 3741	Electrical and Electronic Laboratory	a			b		1	2		2			
SKPN 3223	Control and Instrumentation Engineering	a	a				2	1	2		2	2	
SKPN 3253	Nuclear Safety and Regulation	a	a								1		
SKPN 3213	Nuclear Reactor Theory	a	a	a			1			2			
SKEU 3751	Control and Instrumentation Laboratory	a			b		1	2		2	2		
SKPN 3133	Transport Process	a	a				2	2				1	
SKPN 3915*	Industrial Training	a	a	a	a	a	1	1	1	1	1	1	1
SKPN 4812	Undergraduate Project I	a	a	a	a	a	1	1	1	2	1	1	
SKPN 4113	Nuclear Fuel Cycle and Waste Management	a	a	a						1		1	
SKPN 4123	Nuclear Reactor Material	a	a	a			1			2	2		
SKPN 4133	Analytical Radiochemistry	a	a	a			1				2		
SKPN 3233	Radiation Detection and Measurement	a	a	a	a		1				2		

SKPN 4824	Undergraduate Project II	a	a	a	a	a	1	1	1	1	1	1	1
SKPN 4833	Nuclear Engineering System and Design I	a	a	a	a	a	1	1	1	1	1	1	1
SKPN 4834	Nuclear Engineering System and Design II	a	a	a	a	a	1	1	1	1	1	1	1
SKPN 4**3	Elective Nuclear	a	a				1				1		
SKPN 4611	Nuclear Engineering Professional Practice	a			a							1	
SKEU 4453	Power Engineering	a	a				1				1		
ULAB 1112	English for Academic Communications	b	b				2	1				2	
UHAS 1172	Malaysian Dynamics (Malaysian)	b	b				2	1			2	2	
UHAS 1162	Art, Custom and Beliefs (International student)	b	b				2	1			2	2	
UICI 1012	TITAS	b	b				2	1			2	2	
ULAB 2112	Advanced English for Academic Communication	b	b				2	1				2	
UICI 2022	Science, Technology and Mankind	b	b				2	1			2	2	
U*** 2**3	Generic Development or Globalizations (Malaysian)	b	b				2	1			2	2	
ULAM 1112	Malay Language for Communication (International Student)	b	b				2	1				2	
U*** 2**2	General Elective	b	b				1	2			2	2	
ULAB 3**2	English Elective	b	b				2	1				2	

UHAS 3012	Entrepreneurship and Enterprise Development	b	b				2	1			2	2	
UKQ ***1	Co-curriculum I	c	c				2	1					
UKQ ***1	Co-curriculum II	c	c				2	1					

Key:

Technical skills: a = major contribution to outcome

b = moderate contribution to outcome

Generic skills: 1 = substantial (with assessment)

2 = not substantial (enhance)

Synopses of Nuclear Engineering Courses

SKPN 1243 Introduction to Nuclear Engineering
Pre-requisites: None

This course gives students a basic introduction to nuclear engineering. The course provides a broad overview of the fundamental aspects of nuclear engineering and an introductory comparative analysis of nuclear power and other energy sources. Other topics covered include atomic and nuclear physics, interactions of radiation with matter, nuclear reactors and nuclear power, neutron diffusion and moderation, nuclear reactor theory, the time-dependent reactor, heat removal from nuclear reactors, nuclear reactor materials, radiation protection, radiation shielding and reactor sources with respect to economics and environmental impacts.

SKPN 1113 Modern Physics
Pre-requisites: None

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.

SKPN 2213 Nuclear Physics
Pre-requisites: SKPN1113

The course introduces to some 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. The next topic of the course is introducing the radiation sources and the types of ionizing radiations. Nuclear decay process and the properties of ionizing radiations will be discussed in this topic. The interactions of nuclear radiations with mater and mechanism of nuclear reaction are also covered in this subject. The next topic is providing the students knowledge with some basic concept on radioactivity including radioactive decay law, radioactive decay series and radioactive equilibriums. Some nuclear models such as liquid drop model, shell model and optical model of the nucleus will be introduced at the end of the subject. In general, the course provides a basic concept of interaction processes of nuclear radiation in order to widening the appreciation of nuclear physics to the students.

SKPN 3173 Engineering Economics and Project Management
Pre-requisites: None

This is a two-in-one course covering both Engineering Economy and Project Management topics. Engineering economy is the application of economic factors and criteria to evaluate alternatives, considering the time value of money. The engineering economy study involves computing a specific economic measure of worth for estimated cash flows over a specific period of time. Project Management is the art of planning, scheduling, and controlling of project activities to achieve performance, cost, and time objectives, for a given scope of works, while using resources efficiently and effectively.

SKPN 3113 Nuclear Radiation Protection
Pre-requisites: None

Designed to ground students in the principles of radiation protection, that is, on justification, optimization and dose limits. It will emphasize on the theories, the techniques and the procedures for external dose control that is the use of distance, shielding and time; and internal dose control, including introduction to the physics of aerosol, use of unsealed sources, primary and secondary containments, radioactive laboratories and leak tests. The course will also discuss 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.

SKPN 3711 Nuclear Physics Lab
Pre-requisites: SKPN2213

Experiments of health physics and radiation safety are performed and laboratory reports are written by students. Topics of experiment include 1. Geiger Muller Tube detector, 2. Counting Statistics, 3. Linear Absorbtion Coefficient and Inverse Square Law, 4. Attenuation of betas in aluminium, 5. Gamma Spectroscopy, 6. Portable Instrumentation and Calibration, 7. Protective Clothing and Equipment for

Respiratory Protection, 8. Protective Equipment, personnel monitoring devices, decontamination, 9. Area and effluent monitoring, 10. Waste management. Experiments are performed at UTM and MNA.

SKPN 3721 Nuclear Reactor Lab
Pre-requisites: SKPN3213
Experiments on nuclear reactor engineering are perfomed and laboratory reports are prepared by the students. Topics of experiment include 1. Flux distribution in a subcriticality pile, 2. RTP reactor startup and shutdown, 3. Control rod calibration by the period method, 4. Control rod calibration by the drop method, 5. Approach to critical with a control rod, 6. Reactor power calibration, 7. Neutron startup source, 8. Reactor kinetic and delayed neutron effects, 9. TRIGA pulsing experiment, 10. Measurement of thermal diffusion length in graphite, 11. Reactor flux measurement. Experiments are performed at MNA.

SKPN 3223 Control and Instrumentation Engineering
Pre-requisites: None
This course introduces students some of the metrological terminologies used in experimental methods, concept of metrology and its application. The course will also provide understanding the concept of standardization as the management system of standards and quality. The measurement technique for electrical quantity and analysis of the result according to ISO Guide will be introduced as well. It will examine transducers in order to gain an awareness of what they can do. Transducer operations, characteristic and functions will be discussed.

SKPN 3253 Nuclear Safety, Regulation and Security
Pre-requisites: None
The first part of this course will familiarize students with the principles and methods used in the safety evaluation of nuclear power plants. In the second part of the course, the students will be informed regarding the safety philosophies, design criteria and regulations. Then, the deterministic and probabilistic models, reliability analysis, nuclear and thermal-hydraulic transients, radiological consequences, and risk assessment will be described in details. Throughout the course, strong emphasis is placed on design-basis and severe accident analysis, role of engineered safety systems, siting, and licensing of the nuclear power plant.

SKPN 3213 Nuclear Reactor Theory
Pre-requisites: None
The course starts with brief discussion on neutron physics related to production, absorption and scattering of neutron, neutron cross sections and nuclear fission. The next topics will emphasize on the principle of neutron moderation and neutron multiplication leading to steady state fission reactor core design based on diffusion theory. The principle of fusion reaction and energy production from controlled thermonuclear fusion is also briefly highlighted. In general, the course provides on the general concepts of neutron physics and it application in nuclear reactor for energy generation.

SKPN 3133 Transport Process
Pre-requisites: None
The course starts with a brief discussion on processes of energy generation and transport from the core of a nuclear fission reactor to the thermal design of such a core. The topics emphasize of energy (heat) generation in nuclear processes, the transport of that energy by the reactor coolant to the power cycle, and the limitations imposed by the transport mechanism on the designer of nuclear reactor cores.

SKPN 3915 Industrial Training
Pre-requisites: None
Industrial Training is to provide exposure for the students on practical engineering in the workplace. The students will have the opportunity to better understand the engineering practice in general and to experience the frequent and possible problems. This training is part of the learning process. So, the exposure that uplifts the knowledge and experience of a student is to be properly documented in the form of a logbook and a technical report. Through this documents, the experience gain can be delivered to their peers when they return to the faculty to complete their study. A properly prepared report can facilitate the presentation of the practical experience in an orderly, precise and interesting manner.

SKPN 4812 Undergraduate Project I
Pre-requisites: None
This course is designed to train students on some important aspects of research management. In the first part of the undergraduate research project course, the students are only required to carry out preliminary studies on the assigned chemical and gas engineering related topics but also to do research planning that will be implemented in the following semester. At the end of this course, students should be able to prepare a complete research proposal and subsequently present their proposal. In addition, students will have opportunity to gain important generic skills such as communication, team working, problem-solving and creative and critical thinking.

SKPN 4113 Nuclear Fuel Cycle and Waste Management
Pre-requisites: None
The first part of the course introduces nuclear fuel cycle as the progressions of steps in utilizations of fissile materials, from the initial mining of uranium through the final disposition of the material removed from the reactor. Characteristics of nuclear of nuclear fuel cycle, front end of fuel cycle, fuel utilization, back end of fuel cycle and uranium resources will be studied. The second part of the course is nuclear waste management. Categories of nuclear waste and hazard measure of waste are discussed. Next storage and disposal of nuclear waste, waste disposal plans, and policy issues in nuclear waste disposal are discussed. Students are expected to gain adequate knowledge and understanding of nuclear fuel cycle and nuclear waste management for future undertaking.

SKPN 4123 Nuclear Reactor Material
Pre-requisites: SKPN3213
This course will provide a valuable insight on some of the key issues facing the nuclear power generation industry. Many of these are related to the materials involved, their response to, and their reliability under, extreme conditions. The basic aspects of the nuclear fuel cycle, current and future nuclear reactor designs, and the materials problems associated with nuclear energy production. The key issues in materials failure and the requirements for efficient and safe operation of current reactor designs as well as design of novel materials for future reactors will be described. At the end of this course, the students will be familiar to the basic issues concerned with the selection of materials for various components in nuclear reactors. The effects of radiation and environment on various properties of materials in nuclear applications will be dealt with to get an appreciation of the materials' limitations on the operation of reactors. The course is designed for those from a range of backgrounds in engineering, materials and physics.

SKPN 4133 Analytical Radiochemistry
Pre-requisites: None
The subject focused on the fundamentals of nuclear structure and physico-chemical properties in radioactivity and the mass-energy relationship presented in this course include binding energy, nuclear reactions – energetic of nuclear reactions, cross-section and types of reactions. Radioactivity phenomena as explained in rates of nuclear decay, determination of half lives and growth of radioactive products are covered. Quantitative aspect of this course will be discussed under units of radioactivity, detection of radiation and instrumentation in radiochemistry. The study of the interaction of radiation with matter. Basic principles of nuclear reactors are also presented along with applications of radionuclides in chemistry and other related areas. Some aspects of nuclear energy generation, nuclear fuel reprocessing and nuclear waste disposal will also be discussed.

SKPN 3233 Nuclear Radiation Detection and Measurement
Pre-requisites: None
The important detection techniques for ionizing radiations are introduced in this course. 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 next topic will emphasize on the principles of operation and basic characteristics of various detection systems. Various nuclear detectors such as gas filled detector, scintillation detector and semiconductor detector are main concerned of the subject. 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.

SKPN 4824 Undergraduate Project II
Pre-requisites: SKPN4812
This course is continuation of the Undergraduate Research Project I (SKN 4812). The second part of Undergraduate Research Project requires students to implement the research proposal that has been prepared in the previous semester. This might involve practical activities such as laboratory works, data collection from industry and computer programming / simulation. At the end of the course, students should be able to prepare a full report compiling the first and second part of the Undergraduate Research Project and subsequently present their research findings. Finally, students must submit a bound thesis according to the UTM thesis-writing format. In addition, students will have opportunity to gain important generic skills such as communication, team working, problem-solving and creative and critical thinking.

SKPN 4834 Nuclear Engineering System and Design
Pre-requisites: None
To acquaint the student with the engineering problems related to a nuclear power plant. Reactor systems and their components. Nuclear fuel materials: change of properties during operation. Cladding materials, neutron moderators, coolants, construction materials for core components and neutron absorbing materials. Pressure vessel, role, materials, influence of radiation, diagnostics during operation, testing of properties, phenomena in reactor pressure vessel. Heat generation source distribution and dynamics. Heat transfer and removal. One-channel analysis. Temperature distribution in the reactor. Hot channel and hot spot in multichannel analysis. One and two-phase cooling. Boiling crisis. Stationary core cooling. Non-stationary phenomena. Types of nuclear reactors. Classification of nuclear reactors. Components of a nuclear power plant. Primary circuit, instrumentation. Heat exchangers, pressurizes, secondary circuits, turbines and capacitors. Auxiliary components. Power and temperature coefficients of reactivity. Power reactor operation. Limits and conditions for safe operation. Commissioning. Startup.

SKPN 4611 Nuclear Engineering Professional Practice
Pre-requisites: None
This course introduces students to nuclear engineering ethics and an engineer's responsibilities towards safety, health and welfare of the public. It places emphasis on the engineer as a professional man, engineers & society, code of ethics and professional conduct, standards, laws and regulations pertaining to professional engineering practice. At the end of the course, students will have an understanding of professional and ethical responsibility and be able to demonstrate and apply engineering professional ethics in their career as an engineer.

Nuclear Engineering Elective Courses

SKPN 1313 Fundamentals of Energy Engineering
Pre-requisites: None
This course introduces the basic concept of primary energy sources and the technologies used to utilize them. This course also describes basic engineering calculations on material and energy balances during energy transformations in energy systems. In addition, the course will present an introduction to alternative technologies of energy converters such as fuel cell and battery.

SKPN 2113 Energy Security
Pre-requisites: None
The course examines the relationship between security and supplies and demands of energy resources. The course will highlight policy challenges to integrate diverse economic, geopolitical and environmental objectives by examining selected energy security policy issues and approaches. The course will examine how the demands of the growing energy consumption will present significant impact and challenges to the Malaysian and international community. The course is set to provide students with a basis for better understanding the emergence of energy issues, energy security and energy policy and its effect on environment and economy as critical components in international relations study. The course takes energy security as its launching point, exploring not only how countries shape their grand strategies to meet their energy needs, but also how such actions have implications for other countries and the international system.

SKPN 3123 Sustainable Energy
Pre-requisites: None

This course enables students to a professional career development of long-term solutions to meet the world's rapidly growing energy needs using sustainable energy production from existing sources. In addition to in-depth knowledge of sustainable energy technologies and systems, this course will facilitate an understanding of designing state-of-the-art technologies that underpin energy systems within the context of the sustainability of energy supply and demand. The course is engineering-based but also covers a wider range of topics including sustainability and environmental studies. At the end of the course, students will gain a thorough insight into the possibilities and limitations of sustainable energy systems, specifically in relation to sustainable development.

SKPN 3153 Nanomaterials Engineering
Pre-requisites: None
The aim of this course is to expose undergraduate student with advance knowledge that have been discovered in the process of research and development. This course discusses a number of topics that focus on synthesis processes, types of nanomaterials and their applications in various fields. This course is set to show how the knowledge in application of nanomaterial evolves rapidly.

SKPN 4423 Nuclear Radiation Physics
Pre-requisites: None
This course is a follow-up of nuclear physics and is designed to expose students 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 is 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.

SKPN 4473 Advanced Nuclear Physics
Pre-requisites: SKPN2213
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- well of the nucleus. Different aspects of nuclear forces are dealt with great length. The classical shell model of the nucleus is discussed in detail together with some other realistic nuclear models. The three important nuclear emission; alpha emission, beta decay, gamma radiation will also be dealt. In addition the types of nuclear reactions, types and processes are included. The course ended with the introduction of nuclear energy production and nuclear astrophysics.

18. Career Prospects

Graduates of this program can find work opportunities in industries/sectors such as in the Electric power generation, transmission and distribution; in various regulatory bodies of the Federal government; in management, scientific, and technical consulting services; in architectural, engineering and related services; in scientific research and development services, food and agriculture and medical. Nuclear engineers typically do the followings:

i.	Design or develop nuclear equipment, such as reactor cores, radiation shielding, or associated instrumentation
ii.	Monitor nuclear facility operations to identify any design, construction, or operation practices that violate safety regulations and laws
iii.	Examine nuclear accidents and gather data that can be used to design preventive measures
iv.	Write operational instructions to be used in nuclear plant operation or in handling and disposing of nuclear waste
v.	Direct operating or maintenance activities of operational nuclear power plants to ensure that they meet safety standards
vi.	Perform experiments to test whether methods of using nuclear material, reclaiming nuclear fuel, or disposing of nuclear waste are acceptable
vii.	Take corrective actions or order plant shutdowns in emergencies
viii.	Facilitate new levels of research and development (R&D) to optimize nuclear power generation prepare and review R&D projects according to required initiatives.

ix.	Perform scientific and engineering work to generate and utilize nuclear energy for nuclear fission process, nuclear system and related materials and ensure safe environment.

Nuclear engineers are also on the forefront of developing uses of nuclear material for medical imaging devices, such as positron emission tomography (PET) scanners. They also may develop or design cyclotrons, which produce a high-energy beam that the healthcare industry uses to treat cancerous tumors.

19. Facilities Available

i. Teaching facilities include fully air-conditioned lecturer rooms/hall & theatres.

ii. Faculty Library.

iii. WiFi.

iv. Nuclear Engineer laboratories

SYNOPSIS OF GENERAL COURSES

Science, Mathematics and Basic Engineering

SSCK 1203 Analytical Chemistry for Engineering
This course provides an introduction to quantitative chemical analysis, with emphasis on wet chemistry and instrumental methods. Topics in wet chemistry include introduction to analytical chemistry, sampling, sample preparation, data analysis, gravimetric analysis and volumetric analysis. The course also introduces the principles, instrumentation, and application of chromatographic and spectroscopic methods such as gas chromatography, HPLC, ultraviolet-visible spectroscopy, atomic absorption and atomic emission spectroscopy.

SSCK 1603 Organic Chemistry: Functional Group
This course discusses the fundamental concepts of functional groups in organic compounds. These include aliphatic and aromatic hydrocarbons, alcohols, phenols, organohologen compounds, ethers, epoxides, aldehydes, ketones and carboxylic acids. In each topic, the students will be introduced to the structures of the functional groups and the nomenclatures (common names and IUPAC names). Physical properties, preparations, reactions and visual tests will also be discussed. Inter-conversion of the related functional groups and their reaction mechanisms are also included.

SSCK 2613 Organic Chemistry: Biomolecules
This course introduces students to the classifications, synthesis and reactions of biomolecules such as carbohydrates, peptides and proteins and lipids. It will also emphasize on the three-dimensional structures and fundamental concepts on stereochemistry. Infrated spectroscopy is included as a technique in characterizing the functional groups of organic compounds.

SSCK 1891 Analyticial Chemistry Practical
This course will increase and strengthen students' understanding on the concepts in Analytical Chemistry through experiments conducted in the labboratory. The experiments will illustrate the application of classical and modern instrumental chemical techniques. Upon completion, students should be able to perform analytical chemistry experiments using common techniques and instruments to measure, analyze, manipulate and discuss accurate experimental data to present scientific reports.

SSCE 1793 Differential Equations
This is an introductory course on 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 partial differential equations (PDEs). Students will learn how to classify and solve first order ODEs, use the techniques of undetermined coefficients, variation of parameters and the Laplace transform to solve ODEs with specified initial and boundary conditions, and use the technique of separation of variables to solve linear second order PDEs.

SSCE 1693 Engineering Mathematics I
This is a first course in Engineering Mathematics. Contents include differentiation and integration which focus on hyperbolic and inverse functions, improper integrals, vectors and matrices, polar graphs, complex numbers and series. Vectors and matrices include basic operations and solving related problem in 3 dimensions. In addition, vector spaces, eigenvalues and eigenvectors are also introduced. Sketching of polar graphs is discussed. Complex numbers will include finding roots of equations. Infinite series and its convergence are treated at introductory level. Taylor and Maclaurin series are also introduced.

SSCE 1993 Engineering Mathematics II
This course is about calculus of several variables and calculus of vector-valued functions. The basic theory of partial derivatives and multiple integrals of multivariable functions with their applications are discussed. This teory is extended to vector valued functions to describe motion in space, directional derivatives, gradient, divergence and curl, line integrals, surface integrals and volume integrals. Related theorems, namely Green's Theorem, Stokes Theorem and Gauss Divergence Theorem and their application are discussed in detail.

SKEU 2003 Electrical Technology

The students will be introduced to the concept and theory of basic electrical engineering. The subject will highlight the fundamentals of electrical to enable the student to understand and apply simple electrical circuits and network in their working environment. This subject will cover on DC and Ac systems (single and three phase system) and analyze simple network using electrical basic laws; Ohm Law, Kirchoff Law, current and voltage divider, nodal and loop analysis. Students will also be exposed on the magnet and electromagnet and single phase transformer.

Co-Curriculum (Two Credits Minimum)

These courses are handled by Centre for General Courses and Co-curriculum (CGCC), Office of Deputy Vice Chancellor (Academic & International). For registration, student must follow the list of courses offered for every semester.

The objective of this activity is to fulfil the objective of the university to create a balance and all-rounded education in order to prepare students to be more matured with:

(1) Training in leaderships with greater emphasize on organization discipline and team-work among the students.
(2) Training that can provide a room for students to strengthen and develop their talents and skills for own benefit and society.
(3) Training that can promote team-work within the society and community.

GRADES AND GRADING SYSTEM

Student performance in a particular course is represented by the earned grade. The relationship between marks, grades, and grade points is given in the following table:

Marks	Grades	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 – 45	D+	1.33
35 – 39	D	1.00
30 – 34	D–	0.67
00 – 29	E	0.00

The following letter grades also may be used:

TS (*Tidak Selesai*) Incomplete grade. An incomplete is given only when the student has been in attendance and has done satisfactory work but cannot complete the course work of a particular course or sit for the final examination due to illness or other circumstances beyond the student's control.

HS (*Hadir Sahaja*) Grade for courses taken on a satisfactory attendance basis.

HL (*Hadir Lulus*) Satisfactory grade for courses taken on a **HW** (*Hadir Wajib*) basis.

HG (*Hadir Gagal*) Failure grade for courses taken on a **HW** (*Hadir Wajib*) basis.

Academic standing of each student is based on the Grade Point Average (GPA) and the Cumulative Point Average (CPA) computed in every semester.

To calculate your Grade Point Average (commonly referred to as a GPA) for a semester:

(1) Compute the grade points earned in each course, using the table above to find the point equivalent for each grade and multiplying that grade by the number of credits for that course, then adding all resulting numbers. This is your grade point total for the semester.

(2) Add all the credits attempted, whether you earned a passing or failing grade – but do NOT include credits in a course for which you earned a TS, HG, HL or HS.

(3) Divide your grade point total by the total number of credits attempted (again, ignore credits for HL or HS courses). This is your Grade Point Average for the semester.

FOR EXAMPLE: If you took the following courses and secured the given grades:

Courses	Credits	Grade
English	2	A
Engineering Mathematics	2	B
Material Balance	3	B-
Material Engineering	3	C
TITAS I	2	B+

In **step 1**, find the point equivalents for your grades in the chart above and multiply them by the credits attempted in the courses:

Courses	Grade points	Credits	Grade
English	4.00	X 2 =	8.00
Engineering Mathematics	3.00	X 2 =	6.00
Material Balance	2.67	X 3 =	8.01
Material Engineering	2.00	X 3 =	6.00
TITAS I	3.33	X 2 =	6.66

Then, add the total points for each course

8.00 + 6.00 + 8.01 + 6.00 + 6.66 = **34.67** total points earned

In **Step 2**, add the total credits attempted in those graded courses: 2 (for English) + 2 (for Engineering Math) + 3 (for Material Balance) + 3 (for Material Engineering) + 2(for TITAS I) = **12** credits attempted

In **Step 3**, divide the total grade points earned by the total graded credits (and round up the results if needed): 34.67/12 = 2.89. This means that the score of 2.89 would be your Grade Point Average for the semester.

To calculate your Cumulative Point Average (CPA):

(1) Add your quality point totals for ALL semesters you have been at the University (see Step 1 above).

(2) Calculate the total number of credits attempted in ALL semesters (see Step 2 above).

(3) Divide your quality point total for all semesters by the total credits attempted in all semesters.

Student academic standing for each semester is based on the GPA acquired while the overall standing is based on the CPA which will determine the status according to the following:

Academic Standing	CPA
Kedudukan Baik (KB) *Good Standing*	CPA $\geq$ 2.00
Kedudukan Bersyarat (KS) *Probation*	1.70 $\leq$ CPA < 2.0
Kedudukan Gagal (KG) *Failure*	CPA < 1.70

1. Student who acquired a KS status is not allowed to take more than 13 credits in the following semester.

2. Those who earned KS for three semesters consecutively will automatically be given an academic standing of KG and will be dismissed from the programme.

3. Those who earned a GPA < 1.0, even with a CPA ≥ 1.70 can:
   - continue his/her study,
   - be asked to take the following semester off, or
   - be dismissed from the programme

Summary of UTM Academic Regulation

1. Student can withdraw the subject between before week 9.
2. The maximum credit transfer is 33% (must be grade C and above).
3. Maximum semester is 12 semester for student with transfer credit less than 20.
4. Student is required to attend 80% of the Class meeting.
5. Student is allowed to improve his/her grade if he/she get B- and below.
6. Student who fail to register without deferment may be terminated.

Please refer to UTM Academic Regulation for a complete listing of the academic regulation.

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