

## BACHELOR OF CHEMICAL ENGINEERING (BIOPROCESS) WITH HONOURS

### PROGRAMME SPECIFICATIONS

The Bachelor of Chemical Engineering (Bioprocess) with Honours is offered on a full-time basis. The full-time programme is offered only at the UTM Main Campus in Johor Bahru. The duration of study for the full-time programme is subjected to the student's entry qualifications and lasts between four (4) years to a maximum of six (6) years.

The programme is offered on full-time basis and is based on a two semesters per academic session. Generally, students are expected to undertake courses equivalent to between twelve (12) to eighteen (18) credit hours per semester. Assessment is based on courseworks and final examinations given throughout the semester.

### General Information

1. Awarding Institution	Universiti Teknologi Malaysia			
2. Teaching Institution	Universiti Teknologi Malaysia			
3. Programme Name	Bachelor of Chemical Engineering (Bioprocess) with Honours			
4. Final Award	Bachelor of Chemical Engineering (Bioprocess) with Honours			
5. Programme Code	SETBH			
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			
9. Mode of Operation	Self-govern			
10. Study Scheme	Full Time			
11. Study Duration	Minimum : 4 years Maximum : 6 years			
Type of Semester	No. of Semesters		No of Weeks/Semester	
	Full Time	Part Time	Full Time	Part Time
Normal	8	-	14	-
Short	4	-	8	-

## Course Classification

No.	Classification	Credit Hours	Percentage
i.	University Courses (a) General (b) Language (c) Co-Curriculum	13 8 2	16.2%
ii.	School Core	65	45.8%
iii.	Programme Core	48	33.8%
iv.	Programme Electives	6	4.2%
	<b>Total</b>	<b>142</b>	<b>100%</b>
A	Engineering Courses (a) Lecture (b) Laboratory/Workshop (c) Industrial Training (d) Final Year Project	71 7 5 10	65.5%
<b>Total Credit Hours for Part A</b>		<b>93</b>	
B	Related Courses (a) Applied Science/Mathematic/ Computer (b) Management/Law/Humanities/Ethics/ Economy (c) Co-Curriculum (d) Others	26 12 2 9	34.5%
<b>Total Credit Hours for Part B</b>		<b>49</b>	
<b>Total Credit Hours for Part A and B</b>		<b>142</b>	<b>100%</b>
<b>Total Credit Hours to Graduate</b>		<b>142 credit hours</b>	

## Award Requirements

To graduate, students must:

- Attain a total of not less than 142 credit hours with a minimum CGPA of 2.0.
- Pass Industrial Training
- Complete all Professional Skills Certificate (PSC)

## CROSS-CAMPUS PROGRAMME

Students are given the opportunity to enrol in a few courses in participating universities. The grades and credits obtained during this period are transferable (up to 1/3 of the total credits of the curriculum). Currently, there are four participating universities i.e. Universiti Teknologi Malaysia, Universiti Sains Malaysia, Universiti Malaya and Universiti Malaysia Sarawak.

The programme is open to undergraduates who have undergone a minimum of two semesters of their studies with the following conditions:

- (i) The total number of credits allowed to be taken is between twelve (12) and sixteen (16) credits only.
- (ii) The student should hold a minimum CGPA of 3.00 at the time of application.
- (iii) The student is not a residence of or originated from the state where the university that he/she intends to attend is located.

The student will not be charged tuition fees by the participating university but shall pay the regular tuition fees at UTM. However, should the participating university provide accommodation, the student will need to pay accommodation fees.

## COURSE MENU

YEAR 1: SEMESTER 1			
Code	Course	Credit	Pre-requisite
SETB 1011	Industrial & Career Seminar	1	
SETB 1021	Engineering Drawing	1	
SETB 1023	Introduction to Chemical & Bioprocess Engineering	3	
SETB 1123	Statics & Biomaterial@	3	
SEEU 2003	Electrical Technology	3	
SSCE 1693	Engineering Mathematics I@	3	
UHLB 1112	English Communication Skills	2	
UHMS 1182	Appreciation of Ethics and Civilizations (for Local Students Only)	2	
UHS 1022 OR UHMS 1182	Philosophy and Current Issues (for International Students) OR Appreciation Ethics and Civilizations (for International Students)		
	<b>TOTAL CREDIT</b>	<b>18</b>	
	<b>CUMULATIVE CREDITS</b>	<b>18</b>	

<b>YEAR 1: SEMESTER 2</b>			
<b>Code</b>	<b>Course</b>	<b>Credit</b>	<b>Pre-requisite</b>
SETB 1113	Mass Balance* <sup>@</sup>	3	
SETB 2033	Thermodynamics <sup>@</sup>	3	
SSCE 1993	Engineering Mathematics II <sup>@</sup>	3	SSCE 1693
SSCK 1603	Organic Chemistry: Functional Group	3	
SSCK 1831	Organic Chemistry Practical	1	
UHS 1022	Philosophy and Current Issues (for Local Students)	2	
UHL 1012	Malay Language Communication 2 (for International Students)		
UHMT1012	Graduate Success Attributes	2	
	<b>TOTAL CREDIT</b>	<b>17</b>	
	<b>CUMULATIVE CREDITS</b>	<b>35</b>	

<b>YEAR 2: SEMESTER 1</b>			
<b>Code</b>	<b>Course</b>	<b>Credit</b>	<b>Pre-requisite</b>
SETB 1133	Microbiology for Engineers	3	
SETB 2113	Introduction to Programming	3	
SETB 2123	Energy Balance* <sup>@</sup>	3	SETB 1113#
SETB 2043	Fluid Mechanics	3	
SETB 2721	Fluid Mechanics Laboratory	1	
SSCE 1793	Differential Equations	3	SSCE 1693
UHLB 2122	Academic Communication Skills	2	UHLB 1112
	<b>TOTAL CREDIT</b>	<b>18</b>	
	<b>CUMULATIVE CREDITS</b>	<b>53</b>	

**YEAR 2: SEMESTER 2**

Code	Course	Credit	Pre-requisite
SETB 2133	Chemical Engineering Computation	3	
SETB 2213	Chemical Engineering Thermodynamics	3	SETB 2033
SETB 2313	Transport Processes*	3	SETB 2123#
SETB 2711	Thermodynamics and Material Eng. Laboratory	1	SETB 2033
SETB 1721	Bioprocess Engineering Laboratory: Upstream	1	
SSCK 1203	Analytical Chemistry for Engineering	3	
SSCK 1891	Analytical Chemistry Practical	1	
UKQF 2**2	Co-curriculum & service learning	2	
	<b>TOTAL CREDIT</b>	<b>17</b>	
	<b>CUMULATIVE CREDITS</b>	<b>70</b>	

**YEAR 3: SEMESTER 1**

Code	Course	Credit	Pre-requisite
SETB 3213	Biochemistry	3	
SETB 3741	Bioprocess Engineering Laboratory: Downstream	1	
SETB 3223	Chemical Reaction Engineering	3	
SETB 3323	Separation Processes*	3	SETB 2313#
SETB 3413	Environmental Eng. and Sustainability	3	
UHLB 3132	Professional Communication Skills	2	UHLB 2122
U*** 2**2	General Elective (Soft skill)	2	
	<b>TOTAL CREDIT</b>	<b>17</b>	
	<b>CUMULATIVE CREDITS</b>	<b>87</b>	

**YEAR 3: SEMESTER 2**

Code	Course	Credit	Pre-requisite
SETB 3113	Bioseparation Technology	3	
SETB 3143	Process Control*	3	SSCE 1793# SETB 3323
SETB 3173	Engineering Economics and Project Management	3	
SETB 3812	Undergraduate Project I**	2	
SETB 4741	Process Control Laboratory	1	
SETB 3721	Pollution Control and Reaction Laboratory	1	
SETB 3123	Molecular Biology & Genetic Engineering	3	
UHL* 1112	Foreign Language	2	
	<b>TOTAL CREDIT</b>	<b>18</b>	
	<b>CUMULATIVE CREDITS</b>	<b>105</b>	

### YEAR 3: SEMESTER 3

Code	Course	Credit	Pre-requisite
SETB 3915	Industrial Training	5	
	<b>TOTAL CREDIT</b>	<b>5</b>	
	<b>CUMULATIVE CREDITS</b>	<b>110</b>	

### YEAR 4: SEMESTER 1

Code	Course	Credit	Pre-requisite
SETB 4814	Undergraduate Project II**	4	SETB 3812#
SETB 3133	Bioreactor Design & Analysis	3	
SETB 4153	Plant Design*	3	SETB 3143
SETB 4163	Safety and Health in Chemical & BioIndustry	3	
SETB 3731	Separation Processes Laboratory	1	SETB 3323
UHIT 2302	The Thought of Science and Technology	2	
UKQT 3001	Extracurricular Experiential Learning (ExCEL)	1	

	<b>TOTAL CREDIT</b>	<b>17</b>	
	<b>CUMULATIVE CREDITS</b>	<b>127</b>	

<b>YEAR 4: SEMESTER 2</b>			
<b>Code</b>	<b>Course</b>	<b>Credit</b>	<b>Pre-requisite</b>
SETB 4824	Plant Design Project**	4	SETB 4153, SETB 4163
SETB 4133	Quality Management in BioManufacturing	3	
UBSS 1032	Introduction to Entrepreneurship	2	
SETB 4**3	Bioprocess Elective Course 1	3	
SET* 5**3	PRISMS Elective Course 1		
SETB 4**3	Bioprocess Elective Course 2	3	
SET* 5**3	PRISMS Elective Course 2		
	<b>TOTAL CREDIT</b>	<b>15</b>	
	<b>CUMULATIVE CREDITS</b>	<b>142</b>	

Note: \* - cornerstone course; \*\* - capstone course; @ - with tutorial

# - must pass (at least with grade D+) for pre-requisite course

English prerequisite is shown below:

<b>ENGLISH LANGUAGE TESTS</b>	<b>UHLB 1112</b>	<b>UHLB 2122</b>	<b>UHLB 3132</b>
a) MUET : $\geq$ Band 4	Exemption*	Compulsory	Compulsory
b) IELTS : $\geq$ Band 5.5			
c) TOEFL : $\geq$ 525			
d) TOEFL iBT : $\geq$ 60			
e) CEFR : $\geq$ B2			

\*Eligible students are required to apply for UHLB 1112 course credit exemption. The credit exemption form (UTM.E/3.8) is provided at the academic office.

## BIOPROCESS ELECTIVE COURSES

SETB 4213	Food Process Engineering
SETB 4223	Environmental Biotechnology for Engineers
SETB 4233	Bioproduct Development and Processing
SETB 4243	Biopharmaceutical Engineering
SETB 4253	Green Energy Engineering
SETB 4263	Tissue Culture and Cell Engineering

## PRISMS ELECTIVE COURSES

For students who intend to enrol in PRISMS, refer to the PRISMS Section for a list of related elective courses associated with the Postgraduate Programme.

## GRADUATION CHECKLIST

To graduate, students must pass all the stated courses in this checklist. It is the responsibility of the students to ensure that all courses are taken and passed. Students who do not complete any of the courses are not allowed to graduate.

NO.	CODE	COURSE	CREDIT EARNED (JKD)	CREDIT COUNTED (JKK)	TICK (✓) IF PASSED
<b>CHEMICAL-BIOPROCESS ENGINEERING COURSES</b>					
1	SETB 1011	Industrial Career & Seminar	1	1	
2	SETB 1021	Engineering Drawing	1	1	
3	SETB 1023	Introduction to Chemical & Bioprocess Engineering	3	3	
4	SETB 1123	Statics & Biomaterial	3	3	
5	SETB 2033	Thermodynamics	3	3	
6	SETB 1113	Mass Balance	3	3	
7	SETB 1133	Microbiology for Engineers	3	3	
8	SETB 2113	Introduction to Programming	3	3	
9	SETB 2123	Energy Balance	3	3	
10	SETB 2043	Fluid Mechanics	3	3	
11	SETB 2721	Fluid Mechanics Laboratory	1	1	

12	SETB 1721	Bioprocess Engineering Laboratory: Upstream	1	1	
13	SETB 2133	Chemical Engineering Computation	3	3	
14	SETB 2213	Chemical Engineering Thermodynamics	3	3	
15	SETB 2313	Transport Processes	3	3	
16	SETB 2711	Thermodynamics and Material Eng. Laboratory	1	1	
17	SETB 3213	Biochemistry	3	3	
18	SETB 3123	Molecular Biology & Genetic Engineering	3	3	
19	SETB 3223	Chemical Reaction Engineering	3	3	
20	SETB 3323	Separation Processes	3	3	
21	SETB 3413	Environmental Eng. and Sustainability	3	3	
22	SETB 3721	Pollution Control and Reaction Laboratory	1	1	
23	SETB 3113	Bioseparation Technology	3	3	
24	SETB 3133	Bioreactor Design & Analysis	3	3	
25	SETB 3812	Undergraduate Project I	2	2	
26	SETB 3731	Separation Processes Laboratory	1	1	
27	SETB 3143	Process Control	3	3	
28	SETB 3741	Bioprocess Engineering Laboratory: Downstream	1	1	
29	SETB 3173	Engineering Economics and Project Management	3	3	
30	SETB 3915	Industrial Training (YEAR 3/SHORT SEM.) for 12 weeks/3 months	5	HL	
31	SETB 4741	Process Control Laboratory	1	1	
32	SETB 4814	Undergraduate Project II	4	4	
33	SETB 4153	Plant Design	3	3	

34	SETB 4163	Safety and Health in Chemical & BioIndustry	3	3	
35	SETB 4824	Plant Design Project	4	4	
36	SETB 4133	Quality Management in BioManufacturing	3	3	
37	SETB ***3	Bioprocess Elective Course 1	3	3	
	SET* 5**3	PRISMS Elective Course 1			
38	SETB ***3	Bioprocess Elective Course 2	3	3	
	SET* 5**3	PRISMS Elective Course 2			
		<b>TOTAL CREDIT OF CHEMICAL-BIOPROCESS ENGINEERING COURSES (a)</b>	<b>99</b>	<b>94</b>	
<b>APPLIED SCIENCE/ MATHEMATICS COURSES (Faculty of Science)</b>					
1	SSCE 1693	Engineering Mathematics I	3	3	
2	SSCE 1993	Engineering Mathematics II	3	3	
3	SSCE 1793	Differential Equations	3	3	
4	SEEU 2003	Electrical Technology	3	3	
5	SSCK 1603	Organic Chemistry: Functional Group	3	3	
6	SSCK 1831	Organic Chemistry Practical	1	1	
7	SSCK 1203	Analytical Chemistry for Engineering	3	3	
8	SSCK 1891	Analytical Chemistry Practical	1	1	
		<b>TOTAL CREDIT OF APPLIED SCIENCE/ MATHEMATICS COURSES (b)</b>	<b>20</b>	<b>20</b>	
<b>UNIVERSITY GENERAL COURSES</b>					
<b>Cluster 1: Appreciation of Philosophy, Value and History (Faculty of Social Sciences and Humanities)</b>					

1	UHMS 1182	Appreciation of Ethics and Civilizations (for Local Students)	2	2	
	UHMS 1022 OR UHMS 1182	Philosophy and Current Issues (for International Students) OR Appreciation of Ethics and Civilizations (for International Students)			
2	UHS 1022	Philosophy and Current Issues (for Local Students)	2	2	
	UHLM 1012	Malay Language Communication 2 (for International Students)			
<b>Cluster 2: Generic Skills</b>					
1	UHMT 1012	Graduate Success Attributes	2	2	
2	U*** 2**2	General Elective (Soft skill)	2	2	
<b>Cluster 3: Knowledge Enhancement</b>					
1	UHIT 2302	The Thought of Science and Technology	2	2	
<b>Cluster 4: Co-Curriculum and Service Learning</b>					
1	UKQF 2**2	Co-Curriculum & Service Learning	2	2	
2	UKQT 3001	Extracurricular Experiential Learning (ExCEL)	1	1	
<b>Cluster 5: Language Skills</b> (Language Academy, Faculty of Social Sciences and Humanities)					
1	UHLB 1112	English Communication Skills	2	2	
2	UHLB 2122	Academic Communication Skills	2	2	
3	UHLB 3132	Professional Communication Skills	2	2	
4	UHL* 1112	Foreign Language	2	2	
<b>Cluster 6: Entrepreneurial Skills</b>					
1	UBSS 1032	Introduction to Entrepreneurship	2	2	

		<b>TOTAL CREDIT of UNIVERSITY GENERAL COURSES (c )</b>	<b>23</b>	<b>23</b>	
		<b>TOTAL CREDIT TO GRADUATE (a + b + c)</b>	<b>142</b>	<b>137</b>	
<b>OTHER COMPULSORY COURSES - PROFESSIONAL SKILLS CERTIFICATE (PSC).</b>					
<ul style="list-style-type: none"> <li>• Students are required to enrol and pass FIVE (5) PSC courses, in order to be eligible to graduate.</li> <li>• Please refer to page FE 8 in the UG Academic Handbook, for more information about PSC courses.</li> </ul>					
<b>COMPULSORY PSC COURSES (Enrol all 4 courses)</b>					
1	GSPX XXXX	Design Thinking for Entrepreneur			
2	GSPX XXXX	Talent and Competency Management			
3	GSPX XXXX	Faculty Engineering Safety Pass (FESP) <i>MODULE 1 - compulsory for SKM, SKT and SKE students</i> <i>MODULE 2 – compulsory for SKA, SC, SKBSK students</i>			
4	GSPX XXXX	English Communication Skills for Graduating Students (ECS)			
<b>ELECTIVE PSC COURSE (Choose 1 only)</b>					
1	GSPX XXXX	Data Analytics for Organization			
2	GSPX XXXX	Writing			
3	GSPX XXXX	Construction Measurement (Mechanical & Electrical Works)			
4	GSPX XXXX	Professional Ethics and Integrity			
5	GSPX XXXX	More elective courses to be added in future			

## COURSE SYNOPSIS

### CORE COURSES

#### SETB 1011 Industrial Career & 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.

### **SETB 1021 Engineering Drawing**

Computer Aided Drawing Computer Aided Command, , Geometry, Orthographic Drawing, Isometric Drawing, Sectional Drawing, Flowchart Drawing.

### **SETB 1023 Introduction to Chemical & Bioprocess 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.

### **SETB 1123 Statics & Biomaterial**

This course is designed to introduce students to the basic principles and concepts in mechanics. The content will be divided into 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 body, how to replace a force system with an 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 applications especially in medical devices etc.

### **SETB 1133 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; fundamentals of immunology; and biotechnological aspects of microbes.

### **SETB 1113 Mass Balance**

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.

### **SETB 1721 Bioprocess Engineering Laboratory: Upstream**

This laboratory course is designed to expose students to basic microbiology, biochemistry and genetic engineering techniques. The experiment will expose students to handling bacterial culture, analysis of biomolecules such as enzymes and carbohydrates.

### **SETB 2113 Introduction to Programming**

This course primarily aimed at the beginner who has no or little experience of using compiled languages. It is an introductory course to two different types of programming languages. First, is the C programming language and secondly, is the Matlab programming language. The course will cover various stages of programme development for both types of programming language. One who completed the course will have the ability to write a simple program using both C programming language and Matlab programming language.

### **SETB 2123 Energy Balance**

***Pre Requisite: SETB 1113 Mass Balance (passed)***

Energy balance on non-reactive systems, balance on reactive systems, material and energy balances on transient processes, entropy, power and refrigeration cycles.

### **SETB 2043 Fluid Mechanics**

Physics of fluid: what is fluid, some definitions, surface tension, compressible and incompressible flow, classes of flow, and physical classification. Fluid statics: pressure, differential equations of fluid statics, manometry, fluid force on submerged 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.

### **SETB 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, centrifugal pump, forced vortex flow, and calibration of bourdon tube pressure gauge.

### **SETB 2033 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.

### **SETB 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.

### **SETB 2213 Chemical Engineering Thermodynamics**

***Pre Requisite: SETB 2033 Thermodynamics (taken)***

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

### **SETB 2313 Transport Processes**

***Pre Requisite: SETB 2123 Energy Balance (passed)***

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.

### **SETB 2711 Thermodynamics and Materials Engineering Laboratory**

***Pre Requisite: SETB 2033 Thermodynamics (taken)***

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.

### **SETB 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.

### **SETB 3123 Molecular Biology & Genetic Engineering**

The course introduces students to 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).

### **SETB 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.

### **SETB 3323 Separation Processes**

***Pre Requisite: SETB 2313 Transport Processes (passed)***

Introduction to unit operations in chemical engineering: evaporation, liquid-liquid separation, liquid vapour separation, liquid-liquid extraction and leaching.

### **SETB 3413 Environmental Eng. and Sustainability**

Introduction to pollution control includes: water pollution, air pollution, noise pollution and environmental acts and techniques to reduce pollutants.

### **SETB 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

### **SETB 3113 Bioseparation Technology**

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.

### **SETB 3133 Bioreactor Design & 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.

### **SETB 3812 Undergraduate Project I**

A first stage of the Undergraduate Project which involves 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.

### **SETB 3731 Separation Processes Laboratory**

***Pre Requisite: SETB 3323 Separation Processes (taken)***

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

### **SETB 3741 Bioprocess Engineering Laboratory: Downstream**

In this laboratory, students are given the 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.

### **SETB 3143 Process Control**

***Pre Requisite: SSCE 1793 (passed), SETB 3323 Separation Processes (taken)***

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.

### **SETB 3173 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.

### **SETB 3915 Industrial Training**

A 12-week training in industry. The main rationale 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.

### **SETB 4741 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.

### **SETB 4814 Undergraduate Project II**

***Pre Requisite: SETB 3212 Undergraduate Project I (passed)***

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

### **SETB 4153 Plant Design**

***Pre Requisite: SETB 3143 Process Control (taken)***

Introduction to process plant synthesis where design of each individual unit operation is 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.

### **SETB 4163 Safety and Health in Chemical & BioIndustry**

Main danger and act, introduction to relief, occupational safety and health, danger identification, risk analysis, accident inspection.

### **SETB 4824 Plant Design Project**

***Pre Requisite: SETB 4153 Plant Design, SETB 4163 Safety and Health in Chemical & BioIndustry (taken)***

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.

### **SETB 4133 Quality Management in BioManufacturing**

This course highlights the importance of a quality management system in bioproduct manufacturing processes/industries to meet customer satisfaction. The quality system will cover both management and technical elements according to the requirements of the International Organization for Standardization (ISO) and other relevant regulations. The management requirements focus on a clear organization structure with well-defined objectives and well-organized documentation, whereas the technical requirements ensure on the competency of staffs and validity of test methods for quality assurance. The techniques and validation procedures will be included for numerous types of bioproducts such as cosmeceuticals, nutraceuticals, functional foods and pharmaceuticals. Up-to-date technologies combined with systematic validation plan will ensure bioproduct quality and its consistency.

### **BIOPROCESS ELECTIVE COURSES**

#### **SETB 4213 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.

#### **SETB 4223 Environmental Biotechnology for Engineers**

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.

#### **SETB 4233 Bioproduct Development and Processing**

This course introduces bioproduct and their processing technologies. Students are explored to various kinds of high potential bioproducts with their relevant processing technologies for formulation and development. Factors that affecting quality, safety and efficacy are highlighted in order to make them aware of the importance of these factors for bioproduct sustainability. Quality management systems in bioproduct manufacturing processes/industries are discussed and elaborated to lead students meeting customer satisfaction. The quality system will cover both management and technical elements according to the requirements of the International Organization for Standardization (ISO) and other relevant regulations. The technical requirements ensure the competency of staff and validity of test methods for quality assurance. The course will equip students with quality management skill and knowledge, especially in bioproduct selection and manufacturing.

### **SETB 4243 Biopharmaceutical Manufacturing**

This course describes the application of biotechnology procedures in the field of Pharmacy. It emphasizes on consolidating the fundamental understanding in biotechnology and phytochemical processing involved in the development and production of pharmaceutical products. The technologies covered in the course are methods to enhance the production, bioavailability and safety of biopharmaceutical products or services. Elements of businesses driven through biopharmaceutical discoveries and understanding of specific quality issues in compliance with regulatory requirements throughout the clinical development and post-approval processes are exposed to students.

### **SETB 4253 Green Energy Engineering**

The course introduces the fundamental principles and concepts in understanding bioenergy/biofuels systems. Fundamental concepts in understanding biofuels/bioenergy systems; renewable feedstocks, their production, availability and attributes for biofuel/bioenergy production; types of biomass derived fuels and energy; thermochemical conversion of biomass to heat, power and fuel; biochemical conversion of biomass to fuel; type of biofuels, environmental aspects of biofuel production; economics and life-cycle analysis of biofuel; value adding of biofuel residues; case studies on biofuel production, sustainable processes for biofuels.