Bachelor of Engineering (Bio-Medical)

BACHELOR OF ENGINEERING (BIO-MEDICAL)
PROGRAMME SPECIFICATIONS

The Bachelor of Engineering (Bio-Medical) is offered on a full-time basis. The full-time programme is offered only at the UTM Johor Bahru campus. Student enrolment for full-time programme is subjected to the student's entry qualifications and the duration of study is between four (4) to six (6) years.

The curriculum is planned based on a 2-semester per academic session. Generally, students are expected to undertake courses between twelve (12) to eighteen (18) credit hours per semester or equivalent for credit exemption. Assessment is based on coursework 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 Engineering (Bio-Medical)
4. Final Award	Bachelor of Engineering (Bio-Medical)
5. Programme Code	SMBE-03
6. Professional or Statutory Body of Accreditation	Malaysian Qualification Agency Engineering Accreditation Council
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 years Maximum: 6 years

Course Classification

No.	Classification	Credit Hours	Percentage
i.	University Courses a. General b. Language c. Co-Curriculum	 12 8 3	16.7%
ii.	Faculty & Programme Core	106	76.8%
iii.	Programme Electives	9	6.5%
	Total	**138**	**100%**
A	Engineering Courses (a) Lecture/Project/Laboratory (b) Industrial Training (c) Final Year Project	 97 5 6	**78.3%**
Total Credit Hours for Part A		**108**	
B	Related Courses (a) Applied Science/Mathematic/Computer (b) Management/Law/Humanities/Ethics/Economy (c) Language (d) Co-Curriculum	 15 4 8 3	**21.7%**
Total Credit Hours for Part B		**30**	
Total Credit Hours for Part A and B		**138**	**100%**
Total Credit Hours to Graduate		**138 credit hours**	

Programme Educational Objectives (PEO)

After having exposed to 3 to 5 years working experience, our graduates should become professionals who demonstrate the following competencies:

Code	Intended Educational Objectives
PEO1	Graduates with competency to work in biomedical industry.
PEO2	Graduates with leadership positions in the biomedical engineering sector
PEO3	Graduates embrace professional development through biomedical engineering practice and life-long learning.
PEO4	Graduates who conduct their professional work ethically and contribute towards societal responsibilities.

Programme Learning Outcomes (PLO)

After having completed the programme, graduates should be able to demonstrate the following competencies:

Code	Intended Learning Outcomes
PLO1	Apply knowledge of science and engineering fundamentals to the solution of complex biomedical engineering problems.
PLO2	Identify, formulate and solve complex biomedical engineering problems through structured literature research and scientific approach using first principles of mathematics, natural sciences and engineering sciences.
PLO3	Design solutions for complex biomedical engineering problems with consideration for public health and safety, cultural, societal, and environmental needs.
PLO4	Conduct investigation into complex Biomedical Engineering problems using research-based knowledge and methodology to provide scientific conclusions.
PLO5	Select and apply appropriate techniques, resources, and modern medical engineering and IT tools, to complex biomedical engineering activities, with an understanding of the limitations.
PLO6	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues to professional biomedical engineering practice.
PLO7	Understand the role of biomedical engineers in society regarding social, cultural, environmental and global responsibilities for sustainable development.
PLO8	Ability to evaluate and make appropriate professional decision by taking into account ethical principles, social and environmental responsibilities.

PLO9	Communicate effectively on complex engineering activities through written, oral, visual and graphical forms to colleagues and society at large.
PLO10	Develop leadership attributes and be committed in achieving common goals in multi-disciplinary setting using good team working skills.
PLO11	Ability to adapt with the latest development within the biomedical engineering field for life-long learning and continuous knowledge improvement.
PLO12	Demonstrate knowledge and understanding of management and financial aspects of biomedical engineering and develop entrepreneurship skills.

Entry Requirements

The minimum qualifications for candidates who intend to do a Bachelor of Engineering (Bio-Medical) are as follows:

1) Minimum results based on **the Malaysian High School Certificate (STPM)** (results would be based on the general requirements as well as other conditions as the pre-requisites for the programme set by the university).

University General Requirements:

i. Passed Malaysian Certificate Examination (SPM) or equivalent with a credit in Bahasa Melayu/Bahasa Malaysia or a credit in Bahasa Melayu/Bahasa Malaysia, July paper
ii. Passed MOEM Matriculation/UM Science Foundation with CGPA of at least 2.00
iii. Obtained at least a Band 2 in Malaysia University English Test (MUET).

Special Requirements for the Programme

- Passed with a credit in Mathematics at SPM level or equivalent
- Obtained at least a Grade B- (CGPA 2.67) Biology at Matriculation/Foundation level
- Passed with at least Grade C+ (2.33) in Matriculation/Foundation in any TWO (2) the following subjects: Chemistry, Mathematics and Physics
- Not having any health problems that will prevent student from taking up practical work

2) Minimum requirements for **Matriculation Certificates (KPM) / Asasi Sains UM** (fulfil the general requirements set by the university as well as other conditions of the programme).

General University Requirements

- Passed Malaysian Certificate Examination (SPM) or equivalent with a credit in Bahasa Melayu/Bahasa Malaysia or a credit in Bahasa Melayu/Bahasa Malaysia, July paper
- Passed MOEM Matriculation/UM Science Foundation with CGPA of at least 2.00
- Obtained at least a Band 2 in Malaysia University English Test (MUET)

Special Requirements of the Programme:

- Passed with a credit in Mathematics at SPM level or equivalent
- Obtained at least a Grade B- (CGPA 2.67) Biology at Matriculation/Foundation level
- Passed with at least Grade C+ (2.33) in Matriculation/Foundation in any TWO (2) the following subjects: Chemistry, Mathematics and Physics
- Not having any health problems that will prevent student from taking up practical work

3) Minimum qualifications for students with **Certificates/Diplomas** (fulfill the general requirements set by the university as well as specific requirements of the programme).

General University Requirements

- Passed Malaysian Certificate Examination (SPM) or equivalent with a credit in Bahasa Melayu/Bahasa Malaysia or a credit in Bahasa Melayu/Bahasa Malaysia, July paper
- Obtained a Diploma or equivalent qualification recognized by the Malaysian Government and approved by the Senate,

or

- Passed STPM examination in 2009 or before and obtained the following:
- Grade C (CGPA 2.00) in General Paper; and
- Grade C (CGPA 2.00) in TWO (2) other subjects

or

- Passed Matriculation Examination in 2009 or before and obtained at least CGPA 2.00
- Obtained at least a Band 2 in Malaysia University English Test (MUET)

Special Requirements of the Programme:

- Obtained a Diploma related to the applied course from UTM or equivalent with at least CGPA 2.50

or

- For those who obtained a CGPA 2.50 but have at least TWO (2) years working experience in related field are eligible to apply; and
- Passed with a credit in Mathematics at SPM level

or

- Obtained at least Grade C in any of Mathematics subjects

Note :-
Year of entry and duration of study will be based on the credit exemptions or credit transfer awarded by the university.

Award Requirements

To graduate, students must:

- Attain a total of not less than 138 credit hours with a minimum CGPA of 2.0.
- Professional Skill Certificate (PSC)
  1. How to Get Yourself Employed (HTGYE)
  2. ISO 9001: 2008 Quality Management System Requirement (ISO)

3. Occupational Safety and Health Awareness (OSHA)
4. How to Manage Your Personal Finance (HTMYPF)
5. Test of English Communication Skills for Graduating Students (TECS):
    (i) TECS 1001 (Paper I – Oral Interaction)
    (ii) TECS 1002 (Paper II - Writing)

Cross-Campus Programme

Students are given the opportunity to enroll in a few courses in participating universities. The grades and credits obtained during this period are transferable.

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 eighteen (18) 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.

Professional Skills Certificate (PSC)

Students must enroll in certificate programmes offered by the Centres of Excellence in the University and the School of Professional and Continuing Education (SPACE) as part of the award requirement:

1. How to Get Yourself Employed (HTGYE)
2. ISO 9001: 2008 Quality Management System Requirement (ISO)
3. Occupational Safety and Health Awareness (OSHA)
4. How to Manage Your Personal Finance (HTMYPF)
5. Test of English Communication Skills for Graduating Students (TECS):
    (i) TECS 1001 (Paper I – Oral Interaction)
    (ii) TECS 1002 (Paper II - Writing)

Course Menu

YEAR 1 (SEMESTER 1)			
Code	**Courses**	**Credit**	**Pre-req**
SMBE 1012	Introduction to Biomedical Engineering	2	
SMBE 1513	Basic Anatomy and Physiology	3	
SKEU 1023	Circuit Theory	3	
SSCE 1693	Engineering Mathematics 1	3	
ULAB 1122	Academic English Skills	2	
UHAS 1172	Malaysian Dynamics (Local)	2	
ULAM 1012	Malay Language Communication 2 (International)		
UHAK1 012	Graduate Success Attributes	2	
TOTAL CREDIT HOURS		**17**	

YEAR 1 (SEMESTER 2)			
Code	**Courses**	**Credit**	**Pre-req**
SMBE 1523	Advanced Anatomy and Physiology	3	SMBE 1513
SMBE 1313	Statics and Dynamics	3	
SKEU 1223	Digital Electronics	3	
SSCE 1793	Differential Equations	3	
UICI 1012	Islamic and Asian Civilization (local)	2	
UHAK 1022	Malaysian Studies (international)		
ULA* 1112	English of Language Skills	2	
TOTAL CREDIT HOURS		**16**	

YEAR 2 (SEMESTER 1)			
Code	**Courses**	**Credit**	**Pre-req**
SKEU 2073	Signals and Systems	3	
SKEU 1063	Electronic Devices	3	
UHAK	Introduction to Entrepreneurship	2	

1032			
SMBE 2712	Laboratory 1	2	
SSCE 1993	Engineering Mathematics 2	3	SSCE 1693
ULAB 2122	Advanced Academic English Skills	2	ULAB 1122
SMBE 2033	Computer Programming for Biomedical Engineer	3	
TOTAL CREDIT HOURS		**18**	

YEAR 2 (SEMESTER 2)			
Code	**Courses**	**Credit**	**Pre-req**
UKQ* 2**2	Elective of Service Learning Co-Curriculum	2	
UICL 2**2	Elective of Knowledge Enhancement	2	
UHAK 2**2	Elective of Generic Skill		
UICL 2302	Science and Technology Thinking	2	
SKEU 2523	Electromagnetic Field Theory	3	SSCE 1993
SSCE 2193	Engineering Statistics	3	
SKEU 3133	System Modelling and Analysis	3	
SMBE 2513	Basic Rehabilitation	3	
TOTAL CREDIT HOURS		**18**	

YEAR 3 (SEMESTER 1)			
Code	**Courses**	**Credit**	**Pre-req**
SKEU 3063	Electronic Circuits and Systems	3	SKEU 1063
SKEU 3533	Communication Principles	3	SKEU 2073
SMBE 3712	Laboratory 2	2	
SMBE 3313	Biomedical Materials	3	
SSCE 2393	Numerical Methods	3	
SMBE 3423	Clinical Engineering	3	ULAB 2122
TOTAL CREDIT HOURS		**17**	

YEAR 3 (SEMESTER 2)			
Code	**Courses**	**Credit**	**Pre-req**
SMBE 3323	Solid Mechanics	3	
SMBE 3023	Biomedical Imaging	3	
SMBE 3722	Laboratory 3	2	
SMBE 3033	Microprocessor Systems	3	
SMBE 3043	Instrumentation and Measurement in Biomedical	3	
ULAB 3162	English for Professional Purposes	2	ULAB 2122
TOTAL CREDIT HOURS		**16**	

SHORT SEMESTER			
Code	**Courses**	**Credit**	**Pre-req**
SMBU 4915	Industrial Training (HW)	5	SMBE 3423
TOTAL CREDIT HOURS		**5**	

YEAR 4 (SEMESTER 1)			
Code	**Courses**	**Credit**	**Pre-req**
SMBE 4313	Biomedical Systems Design	3	
SMBE 4413	Biochemistry for Biomedical Engineers	3	
SMBE 4712	Laboratory 4	2	
SMBU 4812	Project Part 1	2	
SMBE 4023	Biomedical Signal Processing	3	SKEU 2073
SMBE 4**3	Elective 1	3	
UKQE 3001	Extracurricular Experiential Learning (ExCEL)	1	
TOTAL CREDIT HOURS		**17**	

YEAR 4 (SEMESTER 2)			
Code	**Courses**	**Credit**	**Pre-req**
SMBU 4824	Project Part 2	4	SMBU 4812
SMBE 4**3	Elective 2	3	
SMBE 4**3	Elective 3	3	
SHAS 4542	Engineering Management	2	

SMBE 4032	Professional Biomedical Engineering Practice	2	
TOTAL CREDIT HOURS		**14**	

Elective Courses

Code	Courses	Credit	Pre-req
SMBE 4043	Biomedical Image Processing	3	
SMBE 4053	Biosystem Modeling	3	
SMBE 4063	Advanced Biomedical Signal Processing	3	SMBE 4023
SMBE 4073	Biosensor and Transducers	3	
SMBE 4083	Artificial Intelligence	3	
SMBE 4323	Biomedical Devices	3	
SMBE 4333	Biologically-inspired Devices	3	
SMBE 4343	Cell and Tissue Engineering	3	
SMBE 4423	Biomedical Informatics	3	
SMBE 4433	Biomedical Instrumentation Management	3	
SMBE 4513	Rehabilitation Engineering	3	SMBE 2513
SMBE 4523	Sports Technology in Exercise Rehabilitation	3	
SMBE 4113	Bio-Fabrication	3	
SMBE 4123	Bio-Material Characterization and Analysis	3	
SMBE 4133	Machining and Testing for Biomedical Engineer	3	
SMBE 4153	Electronic CAD Digital System Design	3	
SMBE 4163	Advance Computer Programming and Data Structure	3	

**Choose three (3) courses from this group.

Elective of Generic Skill Courses

Code	Courses	Credit	Pre-req
UHAK 2012	Leadership in Organization	2	
UHAK 2022	Critical and Creative Thinking	2	
UHAK	The Human Side of Knowledge	2	

2032	Management		
UHAK 2042	Development and Global Issues	2	
UHAK 2052	Guidance and Counselling	2	
UHAK 2062	Psychology of Adjustment	2	
UHAK 2072	Fundamental of Intellectual Property	2	
UHAK 2082	Law of Entrepreneur	2	
UHAK 2092	Entrepreneurship and Enterprise Development	2	
UHAK 2012	Social Entrepreneurship	2	
UHAK 2112	Engineering Communication	2	
UHAK 2122	Human Communication	2	
UHAK 2132	Professional Ethic	2	

Elective of Knowledge Enhancement Courses

Code	Courses	Credit	Pre-req
UICL 2012	Al-Qur'an and Human Civilization	2	
UICL 2032	Life institution and Sustainable Development	2	
UICL 2042	Future Study	2	
UICL 2052	Family Law	2	
UICL 2062	World Science	2	
UICL 2072	Sustainable Economy	2	
UICL 2082	Practices and Concept of Halal Management	2	
UICL 2092	Philosophy of Islamic Art	2	
UICL 2102	Islam and Health	2	
UICL 2132	Islamic Entrepreneurship	2	

Elective of Language Skills Courses

Code	Courses	Credit	Pre-req
ULAA 1112	Arabic Language	2	
ULAJ	Japanese Language 1	2	

1112			
ULAC 1112	Mandarin Language 1	2	
ULAF 1112	France Language	2	
ULAN 1112	Persian Language	2	

Total Credits Earned: 138

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 course are not allowed to graduate.

No	Code	Course	Credit Earned (JKD)	Credit Counted (JKK)	Tick (√) If Passed
Bio-Medical Engineering Courses					
1	SMBE 1012	Introduction to Biomedical Engineering	2	2	
2	SMBE 1513	Basic Anatomy and Physiology	3	3	
3	SKEU 1023	Circuit Theory	3	3	
4	SSCE 1693	Engineering Mathematics 1	3	3	
5	ULAB 1122	Academic English Skills	2	2	
6	UHAS 1172	Malaysian Dynamics (Local)	2	2	
7	ULAM 1012	Malay Language Communication 2 (International)			
8	UHAK 1012	Graduate Success Attributes	2	2	
9	SMBE 1523	Advanced Anatomy and Physiology	3	3	
10	SMBE 1313	Statics and Dynamics	3	3	
11	SKEU 1223	Digital Electronics	3	3	
12	SSCE 1793	Differential Equations	3	3	
13	UICI 1012	Islamic and Asian Civilization (local)	2	2	
14	UHAK1022	Malaysian Studies (international)			
15	ULA* 1112	English of Language Skills	2	2	

16	SKEU 2073	Signals and Systems	3	3	
17	SKEU 1063	Electronic Devices	3	3	
18	UHAK 1032	Introduction to Entrepreneurship	2	2	
19	SMBE 2712	Laboratory 1	2	2	
20	SSCE 1993	Engineering Mathematics 2	3	3	
21	ULAB 2122	Advanced Academic English Skills	2	2	
22	SMBE 2033	Computer Programming for Biomedical Engineer	3	3	
23	UKQ* 2**2	Elective of Service Learning Co-Curriculum	2	2	
25	UICL 2**2	Elective of Knowledge Enhancement	2	2	
27	UHAK 2**2	Elective of Generic Skill			
28	UICL 2302	Science and Technology Thinking	2	2	
29	SKEU 2523	Electromagnetic Field Theory	3	3	
30	SSCE 2193	Engineering Statistics	3	3	
31	SKEU 3133	System Modeling and Analysis	3	3	
32	SMBE 2513	Basic Rehabilitation	3	3	
33	SKEU 3063	Electronic Circuits and Systems	3	3	
34	SKEU 3533	Communication Principles	3	3	
35	SMBE 3712	Laboratory 2	2	2	
36	SMBE 3313	Biomedical Materials	3	3	
37	SSCE 2393	Numerical Methods	3	3	
38	SMBE 3423	Clinical Engineering	3	3	
39	SMBE 3323	Solid Mechanics	3	3	
40	SMBE 3023	Biomedical Imaging	3	3	
41	SMBE 3722	Laboratory 3	2	2	
42	SMBE 3033	Microprocessor Systems	3	3	
43	SMBE 3043	Instrumentation and Measurement in Biomedical	3	3	
44	ULAB 3162	English for Professional Purposes	2	2	
45	SMBU 4915	Industrial Training (HW)	5	HL	
46	SMBE 4313	Biomedical Systems Design	3	3	
47	SMBE 4413	Biochemistry for Biomedical Engineers	3	3	
48	SMBE 4712	Laboratory 4	2	2	
49	SMBU 4812	Project Part 1	2	2	
50	SMBE 4023	Biomedical Signal	3	3	

		Processing			
51	SMBE 4**3	Elective 1	3	3	
52	UKQE 3001	Extracurricular Experiential Learning (ExCEL)	1	1	
53	SMBU 4824	Project Part 2	4	4	
54	SMBE 4**3	Elective 2	3	3	
55	SMBE 4**3	Elective 3	3	3	
56	SHAS 4542	Engineering Management	2	2	
57	SMBE 4032	Professional Biomedical Engineering Practice	2	2	
TOTAL CREDIT TO GRADUATE (a + b + c)			**138**	**133**	
Other Compulsory Courses					
Professional Skills Certificate (PSC) (UTMSPACE/ School)					
1	GLL 1001	How to Get Your Self Employed			
2	GLL 1029	ISO 9001:2008 Quality Management System Requirement			
3	GLL 1040	Occupational Safety, Health and Environment			
4	GLL 1041	How to Manage Your Personal Finance			
Test of English Communication Skill (TECS) (Language Academy, Faculty of Social Sciences and Humanities)					
1	TECS 1001	Oral Interaction			
2	TECS 1002	Writing			

Course Synopsis

Core Courses

SKEU 1023 Circuit Theory
This course introduces students to the basic laws, theorems and methods of DC and AC circuit analysis such as Ohms law, Kirchhoff Current and Voltage Laws, Thevenin and Norton theorems, concept of series and parallel circuits etc. Based on these, the students are expected to be able to solve variables in any given DC and AC electric circuits. With the knowledge learned, the student would be able to apply the basic laws, theorem and methods of analysis for solving various problems in circuit analysis with confidence.

SKEU 1223 Digital Electronics
This course emphasizes on the design, analysis, planning and implementation of complex digital systems using programmable logic, with specific focus on programmable logic devices. In order to facilitate the learning process, computer-aided design (CAD) software is used throughout the course. Some practical or almost actual environment problems and solutions are provided. With the knowledge learned, the student would be able to analyze the counter and register circuits completely with confidence and design synchronous counters.

SKEU 2073 Signals and Systems
This course introduces the students to the different types of signals and systems. Emphasis mainly will be on continuous signal. Signal representation in both the time (Fourier series) and frequency domain (Fourier and Laplace transform) will be discussed. The concept of transfer function is introduced and the applications of the Laplace transform (such as for the solution of differential equations, and circuit analysis) is presented. Finally, the use of Bode plot in filter design will be covered.

SKEU 1063 Electronics Devices
This is the first course in the field of electronics. It consists of basic electronic devices such as the diode, the bipolar junction transistor, and the field effect transistor. Course content will include the devices' basic structure, biasing and basic applications. With the knowledge learned, the student would be able to apply the basic laws, theorem and methods of analysis for solving various basic biasing circuits using data sheet with confidence.

SMBE 2033 Computer Programming Techniques for Biomedical Engineer
As a fundamental course, this course equips the students with theory and practice on problem solving techniques by using the structured approach. From this course, the student will be equipped with skills of programming to solve simple to moderate problems. The course covers the following: preprocessor directives, constants and variables, data types, input and output statements, text files, control structures: sequential, selection and loop, built-in and user-defined functions, one dimensional and two dimensional arrays.

SKEU 2523 Electromagnetic Field Theory
This course introduces students to some major views and theories in the area of electrostatic, magnetostatic and electromagnetic fields. This elementary electromagnetic field theory is summarized in Maxwell's equations for static and time varying fields in integral and differential forms, and also a time domain analysis of wave propagation.

SKEU 3133 System Modeling and Analysis
This course introduces the students to the fundamental ideas and definitions of control systems such as block diagrams, plants or processes, open loop and close loop control systems, transfer functions and transient and steady state responses. Students will be taught how to obtain mathematical models of actual physical systems such as electrical, mechanical, electromechanical and simple fluid flow systems in transfer function and state-space equation. Methods of system representation such as block diagram representation and signal flow graphs will be examined. The students will also be exposed to techniques of analysing control systems such as time domain analysis and stability. Finally, an introduction to the design and analysis of control systems using MATLAB will also be given.

SKEU 3063 Electronic Circuits and System
This course introduces students to some major views and theories in amplifiers and its application. It will examine some key issues in basic definition, construction of analogue amplifiers, operational amplifiers and analogue system with special

focus on analysis of transistor amplifiers through small signal equivalent circuits. This course also covers some topics in functional electronic circuits. The circuits are derived from a diverse electronic circuitry existed in many electronic instrumentations. The course will also provide practice in carrying out a computer simulation and modelling of the amplifier's circuits using PSPICE or MultiSim software. The function, the behaviour and the characteristics of the functional circuits are analysed.

SKEU 3533 Communication Principles
This course introduces the students the basic principles of communication systems. The fundamental concepts of analogue modulation in particular amplitude and frequency modulations will be strongly emphasized. Topics include types of modulated waveforms, transmitter and receiver structures. The two most significant limitations on the performance of a communications system; bandwidth and noise will be discussed. The concept of sampling, quantization and line coding techniques in rendering an information signal to be compatible with a digital system are explained prior to the study of coded pulse modulation and pulse code modulation (PCM). The waveforms and spectral analysis of bandpass digital modulations are introduced. The system performance in terms of bit error rate (BER) will also be covered. Finally, multiplexing, a method to utilize the communication resource efficiently is studied where two techniques will be explored; time-division and frequency-division multiplexing.

SMBE 3033 Microprocessor System
This course introduces the principles and applications of microprocessors. Topics emphasized are processor architecture in detail incorporation with HLL language and fundamentals of designing and implementing the embedded system. This course emphasizes on understanding the fundamentals of microprocessor operation, writing coherent and error-free HLL programmes, and designing basic microprocessor-based circuits. With the knowledge learned, the student would be able to design microprocessor-based systems using HLL programmes completely.

SMBE 2712 Laboratory 1
The course includes the experiments on basic electrical, electronic, signal processing, technical drawing and programming that are related to biomedical engineering. It exposes the students to some common electrical and electronic components, circuits and theorem such as Thevenin and Norton theorem, RLC circuits and MSI circuits. On the other hand, this teaching laboratory also provides the skill of programming for embedded system, digital signal processing in Matlab and technical drawing using software.

SMBE 3712 Laboratory 2
The purpose of this course is to provide students with practical experience in using lab electrical instruments, equipment, analyse experimental results, read components data sheets, and develop report-writing skills. Minimum 10 experiments from participating third year laboratories included but not limited to Basic Electronic, instrumentation, Microcontroller, Neuroscience, Physio Therapy, Biomaterials and Biomechanics. The students should be able to improve their communication skills and team-working environment.

SMBE 3722 Laboratory 3
The course provides students with the opportunity to integrate technical knowledge and generic skills attained in the earlier years. This is to be achieved within the context of a medical engineering project conducted in a small team (typically six students) under the supervision of an academic staff. Topics supplementing this course include Bioinstrumentation, Biomechanics and Biomaterial, Medical Imaging, Biomedical Signal Processing and Clinical engineering. The laboratory is conducted based on Conceive-Design-Implement-Operate (CDIO) in which students are required to solve real and complex engineering problem by collecting information and feedback from the end user, design suitable experimental procedures for their innovations, present their innovations and finally submit the report.

SMBE 4712 Laboratory 4
This course involves experiments in many different areas of biomedical engineering including but not limited to Bioinstrumentation, Biomechanics & Biomaterials, Medical Imaging, Biomedical Signal Processing and Clinical Engineering. This laboratory session is conducted as a Problem-Based Learning (PBL) approach. The students are grouped into 4-5 students per a group, and they will be given problems to solve that require them to do pre-labs and conduct experiments within 4 weeks. The students are required to solve the given problems as a team, design suitable experimental procedures, conduct the experiments, present the problem solutions and submit a full formatted report.

SSCE 1693 Engineering Mathematics 1
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 derivatives, 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 in detail.

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 1993 Engineering Mathematics 2
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 derivatives, 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 in detail.

SSCE 2193 Engineering Statistics
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 also introduced to some nonparametric methods in analysing data.

SSCE 2393 Numerical Methods
This course discuss problem solving using numerical methods that involve non-linear equations, systems of linear equation, interpolation and curve fitting, numerical differentiation and numerical integration, Eigen value problems, ordinary differential equations and partial differential equations.

SMBE 1513 Basic Anatomy and Physiology
This course is a study of anatomical terminologies, body's structures, orientation and physiological event of human body systems through lectures, models and diagrams. Knowledge in anatomy is fundamental in biomedical engineering programmes because it provides the pathway to integrate between the engineering technology and multiple related medical disciplines. Emphasis is placed on the most important systems of organs (respiration, heart and circulation, nervous system, digestion, secretion, skeleton and muscles, immune system, reproductive system and sensory organs). Each topic is preceded by some comments concerning evolution and/or embryology and a few topics in applied physiology will be presented. The content of the lectures is adapted to engineers, an emphasis is placed on medical terminology and the project component is mainly focusing on biomedical technology related to human physiology and structure. Even after graduation, knowledge in anatomy is still applicable in many medical disciplines such as research and technology developments, medical technology consultancy, hospital management and health care industries.

SMBE 1012 Introduction to Biomedical Engineering
This is a course specially designed to introduce biomedical and health science engineering and motivate students to understand the programme of biomedical engineering at UTM. This course introduces the programme offered and gives an opportunity for student to comprehend what they are entitled to for the next 4 years. It also gives an overview on how to cope with the university environment. Lastly, this course will facilitate the students to plan their career path towards a biomedical engineer.

SMBE 1523 Advanced Anatomy And Physiology
This course is an advanced study of anatomical terminologies, body structures, orientation and physiological events of human body systems through lectures, models and diagrams. Knowledge in anatomy & physiology are fundamental in biomedical engineering programmes because it provides the pathway to integrate between the engineering technology and medical disciplines. Even after graduation, knowledge in anatomy & physiology can be applicable in many medical disciplines such as research and technology developments, medical technology consultancy, hospital management and health care industries.

SMBE 1313 Statics and Dynamics
Mechanics & biology have always fascinated humankind. In Biomedical Engineering programmes, statics and dynamics are two basic important subjects to equip undergraduates with the necessary tools to solve bio-mechanic related problems. This course covers the concepts and principles of statics and dynamics that are applied in the biomedical field. Covered in the course will be explanations of point and rigid body behavior under static loads and during motion. Emphasis is placed on the importance of satisfying equilibrium, analysing structure, biomechanics of human joints, kinematics and kinetics of rigid bodies.

SMBE 2513 Basic Rehabilitation
This course aims to introduce students to the basics of rehabilitation so that they can understand important rehabilitation concepts and issues in disability management, within the context of rehabilitation engineering. It will equip students with basic knowledge and skills for the application of science, technology and engineering to the design and development of assistive (adaptive) technology and rehabilitation techniques. It will provide students with an understanding of the nature of problems confronting people with disabilities and an ability to provide technical solutions for these problems.

SMBE 3313 Biomedical Materials
This course provides an introduction to the fundamentals of and recent advances in biomedical materials. It covers a broad spectrum of biomedical materials which include metals, ceramics, polymers and composites. It takes an interdisciplinary approach to describing the chemistry and physics of materials, their biocompatibility, and the consequences of implantation of devices made of these materials into the human body. The course is also designed to familiarise students with failure of materials through fracture, fatigue, wear and corrosion.

SMBE 3323 Solid Mechanics
The course provides students with the knowledge to determine the strength and stiffness of structures being used. The structures that will be studied in this course are bars, pins, bolts, shafts and beams and the types of applied loading are axial forces, deformations due to the change in temperature, torsional loads, transverse loads and combination of these loads. At the end of the course, students should be able to determine the mechanical properties of the materials with respect to their strength and stiffness. Students should be able to calculate stresses, strains and deformations in structures due to various types of loading conditions. The students should also be able to use the acquired knowledge to solve real problems either coming from research problems, or from real-world biomedical problems.

SMBE 3023 Biomedical Imaging
A course is for introducing and exposing students to the world of medical tomography. It focuses on physical, operation and signal formation of medical tomography techniques from various imaging modalities such as MRI, ultrasound, CT-scan, nuclear medicine and X-ray.

SMBE 3423 Clinical Engineering
This course introduces students to major principles of clinical engineering as part

of the preparation for industrial training. The scope of clinical engineering covers pre-market, market and post-market life-cycle of medical devices as well as risk and personnel management. These include procurement planning, incident investigation, equipment management, productivity, cost effectiveness, information systems integration, and patient safety activities. Students will also be exposed to the related law, standard and regulation for medical devices. Other than that, principle of medical devices will also be discussed in the course

SMBE 3043 Instrumentation and Measurement In Biomedical
This course introduces students to biomedical measurement systems and biomedical instrumentation design. The architecture of electronic instruments used to measure physiological parameters is addressed, as well as the analysis of major process functions integrated in these instruments.

SMBE 4915 Industrial Training (HW)
Industrial Training Programme is a compulsory component of the undergraduate curriculum at the Faculty of Biomedical & Health Science Engineering. Placements at the participating industries are structured for undergraduates in the third semester of their third year study. The industries where the students will be attached to during their training is listed in the supporting document (LI-CL). These industries cover all areas in Biomedical Engineering such as biomedical instrumentation and signal processing, clinical science and engineering, therapy and rehabilitation and biomechanics and biomaterial. The nature of jobs involved in the training includes designing, manufacturing, testing, maintaining, fabricating and etc.

SMBU 4812 Project Part I
The aim of the Final Year Project (FYP) is to give students opportunity to apply the knowledge that they have gained while studying in FKBSK to solve practical engineering problems. By doing so, it is hoped that the students will gain knowledge and experience in solving problems systematically thus when they graduate, they will be ready to work as reliable and productive engineers.

SMBU 4824 Project Part II
This course is a continuation from SMBE 4812.Students must submit a project thesis and present it at the end of the semester. Grades will be given for both.

Elective Courses

SMBE 4043 Biomedical Image Processing
This course introduces students to introductory and intermediate levels of image processing techniques. The area of coverage would be the digitization process as a mean to acquire the digital image. Next would be the enhancement and restoration processes which are to improve the quality of the image for next stage processing. Both the spatial domain and frequency domain approaches will be covered. The next stage would be the segmentation process. This is an important step towards advanced level processing. Finally, the topic of compression and coding will be covered. MATLAB will be used extensively for better understanding. By adapting this knowledge, students will be able to develop essential technical skills in solving biomedical image problems with some degree of accuracy. It

focuses on medical image processing of image obtained from the various imaging modalities such as MRI, ultrasound, CT-scan, nuclear medicine and X-ray.

SMBE 4053 Biosystem Modeling
The objective of this course is to introduce students to the mathematical model, methods and their biological application, and model of subsystem in human body. This course introduces students to some major views and theories in modeling the subsystem in human body. It is almost impossible to cover all subsystems in human body. As guidance, topics may include: the maintenance of cell homeostasis, excitation and conduction in nerve fibers, synaptic transmission and the neuromuscular junction, properties of muscles, the lung - physical and mechanical aspects of respiration, volume and composition of body fluids - the kidney, the cardiovascular systems, the heart as a pump, neural control of the heart and circulation, and the autonomic nervous system. The course will also provide practice in carrying out a computer simulation and modeling of bio system using Matlab/Simulink/LabView software.

SMBE 4063 Advanced Biomedical Signal Processing
This course presents two fundamental concepts of signal processing: linear systems and stochastic processes. Various estimation, detection and filtering methods are taught and demonstrated on biomedical signals. All methods will be developed to answer concrete question on specific biomedical signal such as ECG, EEG and etCO2. The focus of the course is a series of labs that provide practical experience in processing biomedical data, with examples from cardiology, neurology, respiratory and speech processing.

SMBE 4073 Biosensors and Transducers
This course is intended to introduce the function of biosensor and a transducer in the medical electronics industry. An overview of biosensors and an in-depth and quantitative view of device design including fabrication technique. Discussion of the current state of the art biosensor to enable continuation into advanced biosensor design and fabrication. Topics emphasize biomedical, bio-processing, military, environmental, food safety, and bio-security applications.

SMBE 4083 Artificial Intelligence
This course introduces students to the fundamentals of two techniques of artificial intelligence (AI), namely, fuzzy logic and neural networks. Both techniques have been successfully applied by many industries in consumer products and industrial systems. Fuzzy logic offers flexibility in developing rule-based systems using natural language type of rules. Neural networks on the other hand, have strong generalization and discriminant properties and offer a simple way of developing system models and function approximation. They are highly applicable for many pattern recognition applications. This course gives the students appropriate knowledge and skills to develop, design and analyze effectively these two AI techniques for practical problems with some degree of accuracy. The students will also be given a hands-on programming experience in developing fuzzy logic and neural networks system to effectively solve real world problems.

SMBE 4323 Biomedical Devices

A biomedical device is a product which is used for medical purposes in patients, in diagnosis, therapy or surgery. It includes a wide range of products varying in complexity and application and sometimes categorized into either passive or active devices. Examples include tongue depressors, medical thermometers, blood sugar meters, total artificial hearts, joint replacement devices, fibrin scaffolds, stents and X-ray machines. The global market of biomedical devices reached roughly 209 billion US Dollar in 2006 and is expected to grow with an average annual rate of 6 - 9% through 2010. Due to its importance, this course will introduce to students some of the many types of devices that are currently being used in the medical field.

SMBE 4333 Biological Inspired Devices
The course provides students with an overview of non-conventional engineering approaches is biology, and to show how these approaches can be used to design and develop better (simpler, more robust, energy-efficient) solutions, especially in the development of novel biomedical devices. The focus of the course will be mainly on the physical part (i.e. the structure and function) of organisms or parts of the organism, rather than the signal processing part. The students will practice on implementing bio-inspired mechanism in solving engineering problems.

SMBE 4343 Cell and Tissue Engineering
Tissue engineering integrates principles of engineering and life sciences towards the fundamental understanding of structure-function relationships in normal and pathological tissues. The course will cover the introduction and fundamentals of tissue engineering, extracellular matrix, cells, biomaterials in tissue engineering, scaffold in tissue engineering, in vitro and in vivo strategies, clinical applications of tissue engineering and ethical and regulatory issues in tissue engineering.

SMBE 4423 Biomedical Informatics
The course provides the student with the basic theoretical knowledge and practical experience from the area of medical informatics and radiobiology. The medical informatics knowledge covers area of processing of medical data, fundamentals of medical information system design, computer-aided medical diagnostics, and telemedicine. The radiobiology covers the physics of radiation, application of radiation in diagnostic and therapeutic, and radiation safety.

SMBE 4513 Rehabilitation Engineering
This course will focus on the principles and application of rehabilitation sciences & assistive technology from the rehabilitation engineering perspective. It aims to provide the students with in-depth understanding pertaining important issues in rehabilitation engineering and equip students with knowledge and skills for the application of science, technology and engineering to the design and development of assistive (adaptive) technology and rehabilitation systems. It will also provide students with an understanding of the nature of problems confronting people with disabilities and an ability to provide technical solutions for these problems. Interdisciplinary interaction and team working for optimal disability management will be stressed, with emphasis being given to the role of the rehabilitation

engineering professional in the team.

SMBE 4523 Sports Technology in Exercise Rehabilitation
The course provides fundamental concept of sports science, technology and exercise rehabilitation. It focuses on total fitness, the biomechanics of sports, common injuries that occur in sport and how to prevent it. The application of technology in the process in exercise rehabilitation, assessment of injury, sports massage and psychological aspect of injuries are also addressed.

SMBE 4433 Biomedical Instrumentation Management
Healthcare technology management provide an overview of systematic process in which qualified health care professionals, typically clinical engineers, in partnership with other healthcare leaders, plan for and manage health technology assets to achieve the highest quality care at the best cost. It explains the basic concepts of managed care and describes the various types of health plan in operation today. This course will cover the strategic planning as well as technology assessment and facilities planning proceed with technology procurement and conclude with service or maintenance management.

SMBE 4113 Bio-Fabrication
This subject provides the importance of additive manufacturing and its role in prototyping, development, transplant, implant and innovation of biomedical products. Different process technologies for additive manufacturing and bioprinting devices, systems, capabilities, materials and applications will be covered. It takes an interdisciplinary approach to describing the chemistry and physics of devices, materials, their compatibility, and the applications of additive manufacturing and machining of advanced materials in a wide range of applications of biomedical products.

SMBE 4123 Bio-Material Characterization and Analysis
This course is intended to expose the students with the most important characterization instruments to analyze the physico-chemical properties of a biomaterial. A range of advanced techniques for the materials characterization analysis, including materials composition, surface morphological, thermal, spectroscopy and chromatography analyses are introduced by discussing the basic underlying principle and the analysis procedures. Several case studies and recording data are evaluated and analyzed to improve the student's understanding in selecting types of characterization instruments in analyzing a biomaterial. Depending on the availability and functionality of instruments, lab visits and demonstrations will be scheduled following the class.

SMBE 4133 Machining and Testing for Biomedical Engineer
This course is designed for students to learn and experience the process of machining, testing and advance analysis. This course will be focusing on selected biomedical related parts and carry out course learning using conventional and advanced manufacturing techniques such as using 3D printed machine, and Computer Numerical Control (CNC) machining techniques. Once parts are manufactured, mechanical testing will be carried out using conventional and advanced method employing Universal Testing Machine (UTM) to determine

mechanical properties of parts. Further analysis will also be done to corroborate findings with theoretical foundation of material.

SMBE 4153 Electronic CAD Digital System Design

This course presents design methods to construct digital systems, including combinational circuit and sequential circuit. Topics include: (1) Computer-Aided Design (CAD) tools for design, (2) Hardware Description Languages (HDL) for simulation and synthesis, and (3) state machine specification, design, and simulation. In this course, some of the important features of HDL will be examined. The course will enable students to design, simulate, model and analyze digital designs. The dataflow, structural, and behavioral modeling techniques will be discussed and related to how they are used to design combinational and sequential circuits. The use of test benches to exercise and verify the correctness of hardware models will also be described. Practical experience is gained by implementing various designs on a prototype FPGA board.

SMBE 4163 Advance Computer Programming and Data Structure

This course discusses programming problems, why they are problems, and the approach C++ has taken to solve such problems using object oriented programming approach (OOP). From this course, the students will be equipped with skills of advanced C++ programming language to solve moderate to advanced problems that related with biomedical engineering or healthcare application using OOP approach. It will also covers some basic data structure such as list structure and tree structure. The course covers the following syllabus: Introduction to objects, fast recap of C language syntax, data abstraction, class and object implementation, object initialization and cleanup, function and operator overloading, constants, inline functions, inline functions, name controls, etc. This course covers hands-on tutorial to expose the students to some modern C++ Integrated Development Environment (IDE) for biomedical and healthcare application development. This course also applies the group design project. The students will be divided in groups to propose a group project to solve complex problems that related with biomedical engineering or healthcare application. Before attending this course, the students should have prior knowledge in C programming language, number representation (binary, octal, hexadecimal, decimal), signed/unsigned number arithmetic (1's compliment and 2's compliment), and simple logic functions (AND, OR, XOR, NOT, etc).