Transforming Higher Education
for a Sustainable Tomorrow

BACHELOR OF APPLIED SCIENCE

2019/2020

50 YEARS OF LEADING KNOWLEDGE FOR CHANGE

BACHELOR OF APPLIED SCIENCE

2019/2020

www.usm.my

Bachelor of Applied Science

Academic Session 2019/2020

USM Vision

Transforming Higher Education for a Sustainable Tomorrow

USM Mission

USM is a pioneering, transdisciplinary research intensive university
that empowers future talents and enables the bottom billions
to transform their socio-economic well-being

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FOR ALL SCHOOLS (EXCEPT FOR SCHOOL OF MEDICAL SCIENCES AND SCHOOL OF DENTAL SCIENCES)

Registration for New Students (1 & 2 September 2019) / Orientation Week 3-6 September 2019)

SEM	WEEK	ACTIVITY	DATE				REMARKS
ONE	1	Teaching & Learning (T&L - 7 Weeks)	Monday,	09.09.2019	- Sunday,	15.09.2019	09.09.2019, Monday - Agong's Birthday
	2		Monday,	16.09.2019	- Sunday,	22.09.2019	16.09.2019, Monday - Malaysia Day
	3		Monday,	23.09.2019	- Sunday,	29.09.2019	
	4		Monday,	30.09.2019	- Sunday,	06.10.2019	
	5		Monday,	07.10.2019	- Sunday,	13.10.2019	
	6		Monday,	14.10.2019	- Sunday,	20.10.2019	
	7		Monday,	21.10.2019	- Sunday,	27.10.2019	27.10.2019, Sunday - Deepavali**
	8	Mid Semester Break	Monday,	28.10.2019	- Sunday,	03.11.2019	28.10.2019, Monday - Deepavali** (Replacement)
	9	Teaching & Learning (T&L - 6 Weeks)	Monday,	04.11.2019	- Sunday,	10.11.2019	09.11.2019, Saturday - Prophet Muhammad's Birthday
	10		Monday,	11.11.2019	- Sunday,	17.11.2019	11 & 12.11.2019, Monday & Tuesday - Sultan of Kelantan's Birthday
	11		Monday,	18.11.2019	- Sunday,	24.11.2019	
	12		Monday,	25.11.2019	- Sunday,	01.12.2019	
	13		Monday,	02.12.2019	- Sunday,	08.12.2019	
	14		Monday,	09.12.2019	- Sunday,	15.12.2019	
	15		Monday,	16.12.2019	- Sunday,	22.12.2019	
	16	Revision Week	Monday,	23.12.2019	- Sunday,	29.12.2019	25.12.2019, Wednesday - Christmas
	17	Examination (3 Weeks)	Monday,	30.12.2019	- Sunday,	05.01.2020	01.01.2020, Wednesday - New Year of 2020
	18		Monday,	06.01.2020	- Sunday,	12.01.2020	
	19		Monday,	13.01.2020	- Sunday,	19.01.2020	
	20	Mid Semester Break (4 Weeks)	Monday,	20.01.2020	- Sunday,	26.01.2020	25 & 26.01.2020, Saturday & Sunday -Chinese New Year**
	21		Monday,	27.01.2020	- Sunday,	02.02.2020	28.01.2020, Tuesday untill 13.02.2020, Thursday - PPJJ Intensive Course
	22		Monday,	03.02.2020	- Sunday,	09.02.2020	
	23		Monday,	10.02.2020	- Sunday,	16.02.2020	08.02.2020, Saturday - Thaipusam ** 28.01.2020, Tuesday untill 13.02.2020, Thursday - PPJJ Intensive Course
TWO	1/24	Teaching & Learning (T&L - 7 Weeks)	Monday,	17.02.2020	- Sunday,	23.02.2020	
	2/25		Monday,	24.02.2020	- Sunday,	01.03.2020	
	3/26		Monday,	02.03.2020	- Sunday,	08.03.2020	
	4/27		Monday,	09.03.2020	- Sunday,	15.03.2020	
	5/28		Monday,	16.03.2020	- Sunday,	22.03.2020	
	6/29		Monday,	23.03.2020	- Sunday,	29.03.2020	
	7/30		Monday,	30.03.2020	- Sunday,	05.04.2020	
	8/31	Mid Semester Break	Monday,	06.04.2020	- Sunday,	12.04.2020	
	9/32	Teaching & Learning (T&L - 7 Weeks)	Monday,	13.04.2020	- Sunday,	19.04.2020	
	10/33		Monday,	20.04.2020	- Sunday,	26.04.2020	24.04.2020, Friday - Ramadhan (Kelantan)
	11/34		Monday,	27.04.2020	- Sunday,	03.05.2020	01.05.2020, Friday - Labour Day
	12/35		Monday,	04.05.2020	- Sunday,	10.05.2020	07.05.2020, Thursday - Wesak Day 10.05.2020, Sunday - Nuzul Al-Quran
	13/36		Monday,	11.05.2020	- Sunday,	17.05.2020	11.05.2020, Monday - Nuzul Al-Quran (Replacement)
	14/37		Monday,	18.05.2020	- Sunday,	24.05.2020	24.05.2020, Sunday - Eid-ul Fitr**
	15/38		Monday,	25.05.2020	- Sunday,	31.05.2020	25.05.2020, Monday - Eid-ul Fitr** 26.05.2020, Tuesday - Eid-ul Fitr** (Replacement) 30 & 31.05.2020, Saturday & Sunday - Pesta Kaamatan (Sabah)
	16/39	Revision Week	Monday,	01.06.2020	- Sunday,	07.06.2020	01 & 02.06.2020, Monday & Tuesday, Hari Gawai (Sarawak) 03.06.2020, Wednesday - PPJJ Examination
	17/40	Examination (3 Weeks)	Monday,	08.06.2020	- Sunday,	14.06.2020	
	18/41		Monday,	15.06.2020	- Sunday,	21.06.2020	
	19/42		Monday,	22.06.2020	- Sunday,	28.06.2020	
*KSCP / COURSES DURING LONG VACATION	20/43	Long Vacation / Industrial Training/ KSCP (10Weeks)	Monday,	29.06.2020	- Sunday,	05.07.2020	
	21/44		Monday,	06.07.2020	- Sunday,	12.07.2020	07.07.2020, Tuesday - Penang Heritage 11.07.2020, Saturday - Penang Governer's Day
	22/45		Monday,	13.07.2020	- Sunday,	19.07.2020	
	23/46		Monday,	20.07.2020	- Sunday,	26.07.2020	
	24/47	*T&L	Monday,	27.07.2020	- Sunday,	02.08.2020	31.07.2020, Friday - Eid-ul adha**
	25/48		Monday,	03.08.2020	- Sunday,	09.08.2020	
	26/49	*Examination	Monday,	10.08.2020	- Sunday,	16.08.2020	
	27/50		Monday,	17.08.2020	- Sunday,	23.08.2020	20.08.2020, Thursday - Awal Muharram
	28/51		Monday,	24.08.2020	- Sunday,	30.08.2020	
	29/52		Monday,	31.08.2020	- Sunday,	06.09.2020	31.08.2020, Monday - National Day

*Courses during the Long Vacation (KSCP)

**This Academic Calendar is subject to change

1.0 BACHELOR OF APPLIED SCIENCE

1.1 General Information

The Bachelor of Applied Science programme with Honours is offered by the School of Pure Sciences (Physics, Biology, Chemistry and Mathematics) to increase the intake of Applied Science students as well as to instill the aspects of Applied Science in the offered courses.

In line with the government's aspiration and emphasis to expand heavy industries and the transfer of technology, a strong training in all fields of applied science and industrial technology is needed. Due to increasing demand, a Bachelor of Applied Science programme is offered by the School of Pure Sciences to produce graduates who are capable of carrying out research and development works in industries. All efforts are carried out to fulfil and to provide manpower needs at the degree level in all fields of applied science and industrial technology.

1.2 Areas of Specialization

Type of Course	School
Applied Physics	Physics
Engineering Physics	Physics
Medical Physics	Physics
Geophysics	Physics
Aquatic Biology	Biological Sciences
Environmental Biology	Biological Sciences
Biotechnology	Biological Sciences
Agrobiology	Biological Sciences
Entomology and Parasitology	Biological Sciences
Analytical Chemistry	Chemical Sciences
Industrial Chemistry	Chemical Sciences
Applied Statistics	Mathematical Sciences
Operations Research	Mathematical Sciences
Mathematical Modelling	Mathematical Sciences
Mathematics and Economics	Mathematical Sciences

1.3 Programme Structure

Students from the School of Physics, Biological Sciences, Chemical Sciences, and Mathematical Sciences can choose a Major-Minor or a Major-Elective specialization programs. Both specialization programs require a specific minimum credit units for graduation, to be accumulated in the duration of 8 – 14 semesters. Courses are divided into several parts as follows:

Type of Course	Code Type
Basic Core	T
Minor	M
Elective	E
University	U

1.4 Courses Offering

Students are required to register for the undergraduate courses in two semesters, that is Semester 1 and Semester 2. Courses are offered and examined in the same semester.

Courses offered are categorized into four levels, via levels 100, 200, 300, and 400 suitable to the requirements of a four-year study program.

Courses offered according to the needs of the degree program structure of the Pure Science Schools are grouped as Basic course, Core course, Minor/Elective course, University/Optional course and Audit course.

Core Courses

Core course is a compulsory course package which aims at giving a deeper understanding of an area of specialization /major. Students need to accumulate certain units of the core courses which have been identified by each School.

Minor Courses

Students are allowed to take a Minor in any of the area of Minors offered by the University. Examples of Minor packages include Management, Computer Sciences, English Language and Journalism. Please refer to the Minor Program Guide Book for a complete list and further details.

Elective Courses

Students need to accumulate certain units of the Elective courses which have been identified by each school. Students who do not choose a Minor area are also required to take Elective courses. In this case, students need to accumulate units from other courses which are acknowledged by the School.

Optional Courses

Optional Courses are courses chosen by students from among those that are outside their program of study. For Science students, an Optional course is a course that is outside those that are offered by the Pure Science Schools.

The main objective of an Optional Course is as a substitute course for students who do not take co-curricular courses, and Skill/Analysis courses.

Audit Courses

In principle, the university allows students to register for any courses on an audit basis for the purpose of enhancing the students' knowledge in specific fields during the duration of their study. However, the units of any such audit courses will not be taken into consideration for graduation purposes.

The registration procedures for courses on an audit basis are as follows:-

[a] Students can register for courses on an audit basis for the purpose of augmenting his/her knowledge in specific fields. Registration for the said course must be done within the course registration week.

[b] Only students of active status are allowed to register for courses on an audit basis.

[c] Courses registered for on an audit basis are designated as code 'Y' courses. This designation will be indicated on the relevant academic transcript. A space at the bottom of the academic transcript will be reserved for listing the courses registered for on an audit basis.

[d] Courses registered for on an audit basis will not be taken into consideration in determining the minimum and maximum units of courses registered for.

[e] Students must fulfil all course requirements. Students who register for courses on an audit basis, are not obligated to sit for any examinations pertaining to that course. A grade 'R' will be awarded irrespective as to whether the student had or had not sat for the examination.

1.5 Course Codes

Every course offered in USM is given a code in the form XYZ klm/n where

X - represent each school of sciences as follows:

B	School of Biological Sciences
K	School of Chemical Sciences
M	School of Mathematical Sciences
Z	School of Physics

Y & Z - represent classification of courses in each school
k - digit that signify the course level
l & m - digits according to the course series in that level
n - number of units for the course

1.6 Classification of year equivalent

Students [according to their respective Programme of study] are classified by the year equivalent to first, second, third or fourth year based on the number of credits accumulated, as follows: -

Year Equivalent	Total Credits Accumulated
First	0 - 30
Second	31 - 61
Third	62 - 92
Fourth	>92

1.7 Graduation Requirements

Students must fulfil the following requirements to graduate:

[a] Fulfil the minimum required residential requirements during the course of studies.
[b] Fulfil all the credit requirements of the course and required units for each component [Core, Elective/Minor, Option and University Courses].
[c] Obtain a CGPA of 2.00 and above for Core Components.
[d] Obtain a CGPA of 2.00 and above for the programme.
[e] Achieve a minimum grade C or a grade point of 2.00 for Bahasa Malaysia, English Language, Islamic and Asian Civilization and Ethnic Relations course.
[f] Achieve a minimum grade C or a grade point of 2.00 for certain courses [if required]

2.0 ACADEMIC SYSTEM AND GENERAL INFORMATION

2.1 Course Registration

Registration of courses is an important activity during the period of study at the university. It is the first step for the students to sit for the examination at the end of each semester. Signing up for the right courses each semester will help to facilitate the graduation of each student from the first semester till the final semester.

2.1.1 Course Registration Secretariat for the Bachelor's Degree and Diploma Programmes

Student Data and Records Unit
Academic Management Division
Registry
Level 1, Chancellory Building

Tel. No.	:	04-653 2925/2924/2923
Fax No.	:	04-657 4641
E-Mail	:	sdrp@usm.my
Website	:	http://bpa.usm.my/index.php/ms/

2.1.2 Course Registration Platform

1. *E-Daftar* (E-Registration)

E-daftar is a platform for online course registration. The registration is done directly through the Campusonline portal**.**

Registration under *e-daftar* for Semester 1 usually starts after the release of official examination results of Semester 2.

For Semester 2, registration will start from after the Semester 1 official examination results are released until before Semester 2 begins. Meanwhile for Courses During the Long Vacation (KSCP) period, registration will be opened one month after Semester 2 examination.

The date of registration under *e-daftar* will be announced to the students during the Revision Week of every semester and will be displayed in the USM's official website.

Under *e-daftar*, students can register for any courses offered by USM, except co-curriculum courses. Registration of co-curriculum courses is still placed under the administration of the

Director of the Centre for Co-Curriculum Programme at the Main Campus or the Coordinator of the Co-Curriculum Programme at the Engineering Campus and the Coordinator of the Co-Curriculum Programme at the Health Campus.

Co-Curriculum courses will be included in the students' course registration account prior to the *e-daftar* activity, if their pre-registration application is successful.

Access to *E-Daftar* System

a. *E-daftar* System can be accessed through the Campusonline portal **(https://campusonline.usm.my)**.
b. Students need to use their USM e-mail ID and password to access their profile page, which includes the *e-daftar* menu.
c. Students need to print the course registration confirmation slip upon completion of the registration process or after updating the course registration list (add/ drop) within the *e-daftar* period.

2. Course Registration at Schools/Centres

Registration activities are conducted at the Schools/Centres and are applicable to students who are academically active and under Probation (P1/P2) status. Students who face difficulties registering their courses during the *e-daftar* period can register their courses during the official period of course registration alternatively.

The official period for registration normally starts on the first day of the semester until 6th week based on the Academic Calendar. After this official date, the registration will be considered late and a penalty of RM50.00 will be imposed if no reasonable excuse is given.

After week six, all registration, including adding and dropping of courses will be administered by the Examination and Graduation Unit, Academic Management Division, Registry.

2.1.3 General Guidelines before Students Register for Courses

1. Information and documents required to be referred to by students before course registration:

a. Refer to the website of the respective school to get updated information for courses offered or course registration.

b. Decide on courses to be registered according to the semester as stipulated in the Study Programme Guide Book.

c. List the courses to be registered and number of units (unit value) for each course.

d. Print Cumulative Statement of Grades (Cangred).

e. Check Teaching and Learning Timetable for the courses that you need to register (to avoid overlapping in timetable).

f. Read and comprehend the reminders regarding policies/general requirements for the course registration.

2. The number of maximum and minimum units that can be registered in every semester is stated below:

Academic Status	PNG	Minimum Units	Maximum Units
Active	2.00 & Above	9	21
P1	1.99 & Below	9	12
P2		9	10

- Students who meet the minimum period of residency (6 semesters for a 3 year programme, 7 semesters for a 3.5 year programme or 8 semesters for a 4 year programme) are allowed to register courses with a total of less than 9 units. The semester in which the student is on leave is not considered for the residency period.

3. Type of course codes during registration:

T = Core courses
E = Elective courses
M = Minor courses
U = University courses

} Grade and number of units obtained from these courses are considered for graduation

Two (2) other course codes are:
Y = audit courses
Z = prerequisite courses

} Grade and number of units obtained are not considered for graduation

4. Advice and approval of the Academic Advisor

5. Students are not allowed to register and repeat any course for which they have achieved a grade 'C' and above.

2.1.4 Information/Document Given to All Students through Campus Online Portal (https://campusonline.usm.my)

1. Information of Academic Advisor
2. Academic information such as academic status, GPA value, CGPA value and year of study
3. Cangred and Course Registration Form
4. List of courses offered by all the schools/centres
5. Teaching and learning timetable for all the schools/centres/units from all the three campuses
6. List of pre-registered courses which have been added into the students' course registration record (if any)
7. Reminders about the university course registration policies/general requisites

2.1.5 Registration of Language and Co-Curricular Courses

1. Registration of Language courses through *e-daftar* is allowed.

    a. However, if any problem arises, registration for language courses can still be carried out/updated during the official period of OCR at the office of the School of Languages, Literacies and Translation.

    b. All approval/registration/dropping/adding of language courses is under the responsibility and administration of the School of Languages, Literacies and Translation.

    c. Any problems related to the registration of language courses can be referred to the School of Languages, Literacies and Translation. The contact details are as follows:

General Office	: 04-653 4542/ 5243/ 5248	for Main Campus students
Malay Language Programme Chairperson	: 04-653 3974	
English Language Programme Chairperson	: 04-653 3406	
Foreign Language Programme Chairperson	: 04-653 3396	
Engineering Campus Programme Chairperson	: 04-599 5407	
	: 04-599 6385	
Health Campus Programme Chairperson	: 09-767 1252	

2. Registration of **co-curricular courses through *E-Daftar*** is not allowed.

   a. Registration for co-curricular courses is either done through pre-registration before the semester begins or during the first/second week of the semester. Co-curricular courses will be included in the students' course registration account prior to the *e-daftar* activity, if their pre-registration application is successful.

   b. All approval/registration/dropping/adding of co-curricular courses is under the responsibility and administration of:

      Director of the Centre for Co-Curricular Programme, Main Campus (04-653 5242/5243/5248)

      Coordinator of the Centre for Co-Curricular Programme, Engineering Campus (04-599 5097/6385)

      Coordinator of the Centre for Co-Curricular Programme, Health Campus (09-767 7547)

3. **Dropping of Language and Co-Curricular courses, if necessary, must be made within the first week**. After the first week, a fine of RM50.00 will be imposed for each course.

2.1.6 Registration of 'Audit' Courses (Y code)

Registration for the 'Audit' course (Y code) **is not allowed on the *E-Daftar***. It can be done during the official period of OCR at the School or Centre involved.

Students who are interested must complete the course registration form which can be printed from the Campusonline Portal or obtained directly from the School. Approval from the lecturers of the courses and the Dean/ Deputy Dean (Academic) of the respective school is required.

Registration of 'Audit' courses (Y code) is not included in the calculation of the total registered workload units. Grades obtained from 'Audit' course are not considered in the calculation of CGPA and total units for graduation.

2.1.7 Registration of Prerequisite Courses (Z code)

Registration of Prerequisite courses (Z code) is included in the total registered workload (units). Grades obtained from the Prerequisite

courses are not considered in the calculation of CGPA and units for graduation.

2.1.8 Late Course Registration and Late Course Addition

Late course registration and addition are not allowed after the official period of the OCR ends unless with valid reasons. General information on this matter is as follows:

1. **Late course registration and addition are only allowed in the first to the third week** with the approval of the dean. Students will be fined RM50.00 if the reasons given are not acceptable.

2. Application to add a course **after the third week** will not be considered, except for special cases approved by the University.

2.1.9 Dropping of Courses

Dropping of courses is allowed until the **end of the sixth week**.

For this purpose, students must meet the requirements set by the University as follows:

1. All Drop Forms must be completed by the student and signed by the lecturer of the course involved and the Dean/Deputy Dean of their respective Schools and submitted to the general office of the School/Centre which is responsible for offering the courses involved.
2. Students who wish to drop a language course must obtain the signature and stamp of the Dean/Deputy Dean (Academic) of the School of Languages, Literacies and Translation.
3. Students who wish to drop the Co-Curricular courses must obtain the approval of the Director/Co-ordinator of Co-Curricular Programme.
4. The option for dropping courses cannot be misused. Lecturers have the right not to approve the course that the student wishes to drop if the student is not serious, such as poor attendance record at lectures, tutorials and practical, as well as poor performance in coursework. The student will be barred from sitting for the examination and will be given grade 'X' and is not allowed to repeat the course during KSCP.

2.1.10 Course Registration Confirmation Slip

The course registration confirmation slip that has been printed/obtained after registering the course should be checked carefully to ensure there are no errors, especially the code type of the registered courses.

Any data errors for course registration must be corrected immediately whether during the period of *E-Daftar* (for students with active status only) or during the registration period at the Schools.

2.1.11 Revising and Updating Data/Information/Students' Personal and Academic Records

Personal and academic information for each student can be checked through the Campusonline portal.

Students are advised to always check all the information displayed on this website.

1. The office of the Student Data and Records Unit must be notified of any application/notification for correction/updating of personal data such as the spelling of names, identification card number and address (permanent address and correspondence address).

2. The office of the Student Data and Records Unit must be notified of any application/ notification for correction of academic data such as information on major, minor, MUET result and the course code.

2.1.12 Academic Advisor

Each School will appoint an Academic Advisor for each student. Academic Advisors will advise their students under their responsibility on academic matters.

2.2 Interpretation of Unit/Credit/Course

2.2.1 Unit

Each course is given a value, which is called a **UNIT**. The unit is determined by the scope of its syllabus and the workload for the students. In general, a unit is defined as follows:

Type of Course	Definition of Unit
Theory	1 unit is equivalent to 1 contact hour per week for 13 – 14 weeks in one semester

Practical/Laboratory/ Language Proficiency	1 unit is equivalent to 1.5 contact hours per week for 13 – 14 hours in one semester
Industrial Training/ Teaching Practice	1 unit is equivalent to 2 weeks of training

Based on the requirements of Malaysian Qualifications Framework (MQF):

One unit is equivalent to 40 hours of student learning time

[1 unit = 40 hours of Student Learning Time (SLT)]

2.2.2 Accumulated Credit Unit

Units registered and passed are known as credits. To graduate, students must accumulate the total number of credits stipulated for the programme concerned.

2.3 Examination System

Examinations are held at the end of every semester. Students have to sit for the examination of the courses they have registered for except for courses with 100% coursework. Students are required to settle all due fees and fulfil the standing requirements for lectures/tutorials/practical and other requirements before being allowed to sit for the examination of the courses they have registered for. Course evaluation will be based on the two components of coursework and final examinations. Coursework evaluation includes tests, essays, projects, assignments and participation in tutorials.

2.3.1 Duration of Examination

Evaluated Courses	Examination Duration
2 units	1 hour for coursework of more than 40%
2 units	2 hours for coursework of 40% and below
3 units or more	2 hours for coursework of more than 40%
3 units or more	3 hours for coursework of 40% and below

2.3.2 Barring from Examination

Students will be barred from sitting for the final examination if they do not fulfil at least 70% of the course requirements, such as absence from lectures and tutorials, and have not completed/fulfilled the required components of coursework. A grade 'X' would be awarded for a course

for which a student is barred. Students will not be allowed to repeat the course during the *Courses During the Long Vacation* (KSCP) period.

2.3.3 Grade Point Average System

Students' academic achievement for registered courses will be graded as follows:

Alphabetic Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
Grade Points	4.00	3.67	3.33	3.00	2.67	2.33	2.00	1.67	1.33	1.00	0.67	0

Students who obtained a grade 'C-' and below for a particular course would be given a chance to improve their grades by repeating the course during KSCP (see below) or the normal semester. Students who obtained a grade 'C' and above for a particular course are not allowed to repeat the course whether during KSCP or normal semester.

The achievement of students in any semester is based on Grade Point Average (GPA) achieved from all the registered courses in a particular semester. GPA is the indicator to determine the academic performance of students in any semester.

CGPA is the Cumulative Grade Point Average accumulated by a student from one semester to another during the years of study.

The formula to compute GPA and CGPA is as follows:

$$\text{Grade Point Average} = \frac{\sum_{i=1}^{n} U_i M_i}{\sum_{i=1}^{n} U_i}$$

where:

n	=	Number of courses taken
U_i	=	Course units for course i
M_i	=	Grade point for course i

Example of calculation for GPA and CGPA:

	Course	Unit	Grade Point (GP)	Grade (G)	Total GP
Semester I	ABC XX1	4	3.00	B	12.00
	ABC XX2	4	2.33	C+	9.32
	BCD XX3	3	1.67	C-	5.01
	CDE XX4	4	2.00	C	8.00
	EFG XX5	3	1.33	D+	3.99
	EFG XX6	2	2.67	B-	5.34
		20			43.66

$$GPA = \frac{43.66}{20} = 2.18$$

	Course	Unit	Grade Point (GP)	Grade (G)	Total GP
Semester II	ABC XX7	3	1.00	D	3.00
	ABB XX8	4	2.33	C+	9.32
	BBC XX9	4	2.00	C	8.00
	BCB X10	4	2.67	B-	10.68
	XYZ XX1	3	3.33	B+	9.99
		18			40.99

$$GPA = \frac{40.99}{18} = 2.28$$

$$CGPA = \frac{\text{Total Accumulated GP}}{\text{Total Accumulated Unit}} = \frac{43.66 + 40.99}{20 + 18} = \frac{84.65}{38} = 2.23$$

From the above examples, the CGPA is calculated as the total grade point accumulated for all the registered courses and divided by the total number of the registered units.

2.3.4 Courses During the Long Vacation Period *(Kursus Semasa Cuti Panjang)* (KSCP)

KSCP is offered to students who have taken a course earlier and obtained a grade of 'C-', 'D+', 'D', 'D-', 'F' and 'DK' only. Students who obtained a grade 'X' or 'F*' are not allowed to take the course during KSCP.

The purpose of KSCP is to:

1. Give an opportunity to students who are facing time constraints for graduation.
2. Assist students who need to accumulate a few more credits for graduation.

3. Assist probationary students to enhance their academic status.
4. Assist students who need to repeat a prerequisite course, which is not offered in the following semester.

However, this opportunity is only given to students who are taking courses that they have attempted before and achieved a grade as stipulated above, provided that the course is being offered. Priority is given to final year students. Usually, formal lectures are not held, and teaching is via tutorials.

The duration of KSCP is 3 weeks, i.e. 2 weeks of tutorial and 1 week of examination, all held during the long vacation. The KSCP schedule is available on the University's Academic Calendar.

The Implementation of KSCP

1. Students are allowed to register for a maximum of 3 courses and the total number of units registered must not exceed 10.

2. Marks/grades for coursework are taken from the highest marks/the best grades obtained in a particular course in the normal semester before KSCP. The final overall grade is determined as follows:

   Final Grade = The best coursework marks or grade +
   Marks or grade for KSCP examination

3. GPA calculation involves the **LATEST** grades (obtained in KSCP) and also involves courses taken in the second semester and those repeated in KSCP. If the GPA during KSCP as calculated above is 2.00 or better, the academic status will be active, even though the academic status for the second semester was probation status. However, if the GPA for KSCP (as calculated above) is 1.99 or below, the academic status will remain as probation status for the second semester.

4. Graduating students (those who have fulfilled the graduation requirements) in the second semester are not allowed to register for KSCP.

2.3.5 Academic Status

Active Status: Any student who achieves a GPA of 2.00 and above for any examination in a semester will be recognised as ACTIVE and be allowed to pursue his/her studies for the following semester.

Probation Status: A probation status is given to any student who achieves a GPA of 1.99 and below. A student who is under probation status for three consecutive semesters (P1, P2, FO) will not be allowed to pursue his/her studies at the university. On the other hand, if the CGPA is 2.00 and above, the student concerned will be allowed to pursue his/her studies and will remain at P2 status.

2.3.6 Termination of Candidature

Without any prejudice to the above regulations, **the University Examination Council has the absolute right to terminate any student's studies if he/she does not fulfil the accumulated minimum credits.**

The University Examination Council has the right to terminate any student's studies due to certain reasons (a student who has not registered for courses, has not attended any examination without valid reasons), as well as medical reasons can be disqualified from pursuing his/her studies.

2.3.7 Examination Results

Full results (with grade) will be announced by the University through the Campus Online portal (campusonline.usm.my) after the School Examination Council meeting which is approximately one month after the final examination.

Students can print their official results document namely 'SEMGRED' through the Campus Online portal (campusonline.usm.my) on the same day/date of the results announcement.

2.4 Unit Exemption

2.4.1 Unit Exemption

Unit exemption is defined as the total number of units given to students who are pursuing their studies in USM that are exempted from the graduation requirements. Students only need to accumulate the remaining units for graduation purposes. Only passes or course grades accumulated or acquired in USM will be included in the calculation of the Cumulative Grade Point Average (CGPA) for graduation purposes.

2.4.2 Regulations and Implementation of Unit Exemption

1. Diploma holders from recognised Public and Private Institutions of Higher Learning:

a. Unit exemption can only be given to courses taken at diploma level. However, unit exemption is not permitted for *Mata Pelajaran Umum* (MPU) courses such as Language, Ethnic Relations and TITAS courses taken at the diploma level.

b. Courses for unit exemption may be combined (in two or more combinations) in order to obtain exemption of one course at degree level. However if the School would like to approve only one course at the diploma level for unit exemption of one course at degree level, the course at diploma level must be equivalent to the degree course and have the same number of or more units.

c. Courses taken during employment (in service) for diploma holders cannot be considered for unit exemption.

d. The minimum achievement at diploma level that can be considered for unit exemption is a minimum grade 'C' or 2.0 or equivalent.

e. The total number of semesters exempted should not exceed two semesters.

f. **In order to obtain unit exemption for industrial training**, a student must have continuous work experience for at least two years in the area. If a student has undergone industrial training during the period of diploma studies, the student must have work experience for at least one year. The student is also required to produce a report on the level and type of work performed. Industrial training unit exemption cannot be considered for semester exemption as the industrial training is carried out during the long vacation in USM.

2. <u>IPTS (Private Institution of Higher Learning) USM Supervised/ External Diploma Graduates</u>:

a. Students who are IPTS USM supervised/external diploma graduates are given unit exemption as stipulated by the specific programme of study. **Normally, unit exemption in this category is given as a block according to the agreement** between USM (through the School that offers the programme) with the IPTS.

b. **Students from recognised local or foreign IPTA** (Public Institutions of Higher Learning)/IPTS who are studying at the Bachelor's Degree level may apply to study in this university

and if successful, may be considered for unit exemption, subject to the following conditions:

[1] Courses taken in the previous IPT are equivalent (minimum 80% of the course must be the same) to the courses offered in USM.

[2] Students taking courses at Advanced Diploma level in IPT that are recognised to be equivalent to the Bachelor's Degree course in USM may be considered for unit exemption as in Section 2.5.

[3] The total maximum unit exemption allowed should not exceed 30% of the total unit requirement for graduation.

2.4.3 Total Number of Exempted Semesters

Semester exemption is based on the total units exempted as below:

Total Units Exempted	Total Semesters Exempted
8 and below	None
9 – 32	1
33 to 1/3 of the total units for graduation	2

2.4.4 Application Procedure for Unit Exemption

Any student who would like to apply for unit exemption is required to complete the Unit Exemption Application Form which can be obtained from the Examinations and Graduation Unit or the respective Schools.

The form must be approved by the dean of the school prior to submission to the Examinations and Graduation Unit for consideration and approval.

2.5 Credit Transfer

Credit transfer is defined as the recognition of the total number of credits obtained by USM students taking courses in other IPTAs (Public Institution of Higher Learning) within the period of study at USM, and is combined with credits obtained at USM to fulfil the unit requirements for his/her programme of study. The transferred examination results or grades obtained in courses taken at other IPTAs will be taken into consideration in the Cumulative Grade Point Average (CGPA) calculation.

1. Category of Students Who Can Be Considered for Credit Transfer

a. USM Bachelor's Degree students who have obtained approval to change to other new programmes in USM (Change of Programme-PRP).

b. USM full-time Bachelor's Degree students who would like to attend a specific Bachelor's Degree course at other IPTAs.

c. USM full-time diploma students who would like to attend a specific diploma course at other IPTAs.

2. Specific Conditions

a. Basic and Core Courses

Credit transfer can only be considered for credits obtained from other courses in other IPTAs that are equivalent (minimum 80% of the course must be the same) with the courses offered by the programme.

Courses that can be transferred are only courses that have the same number of units or more. For equivalent courses but with less number of units, credit transfers can be approved by combining a few courses. The credits transferred are the same as the course units offered in USM. Average grade of the combined courses will be taken into account in the CGPA calculation.

b. Elective or Option Courses

Students may take any appropriate courses in other IPTAs subject to permission from the School as well as the approval of the IPTAs.

The transferred credits are credits obtained from courses at other IPTAs. No course equivalence condition is required.

c. Minor Courses

For credit transfer of minor courses, the School should adhere to either conditions (a) or (b), and take into account the programme requirement.

3. General Conditions

a. There is no limit for PRP cases.

b. For students who have collected the credits via exchange or mobility programme, the total maximum credits transferred should not exceed one third of the total number of units for the programme.

c. Credit transfer from other IPTAs can be considered only once for each IPTA.

d. The examination results obtained by a student who has taken courses at other IPTAs will be taken into account for graduation purposes. Grades obtained for each course will be combined with the grades obtained at USM for CGPA calculation.

e. Students who have applied and obtained approval for credit transfer are not allowed to cancel the approval after the examination result is obtained.

f. Students are required to register for courses at other IPTAs with not less than the total minimum units as well as not exceeding the maximum units as stipulated in their programme of study. However, for specific cases (e.g. students on an extended semester and only require a few units for graduation), the Dean may allow such students to register less than the minimum units and the semester will not be considered for the residential requirement. In this case, the CGPA calculation will be similar to that requirement of the KSCP.

g. USM students attending courses at other IPTAs who have failed in any courses will be allowed to re-sit the examinations of the courses if there is such a provision in that IPTA.

h. If the method of calculation of examination marks in the other IPTAs is not the same as in USM, grade conversions will be carried out according to the existing scales.

i. USM students who have registered for courses at other IPTAs but have decided to return to study in USM must adhere to the existing course registration conditions of USM.

2.5.1 Application Procedure for Attending Courses/Credit Transfer

USM students who would like to apply to attend courses/credit transfer at other IPTAs should apply using the Credit Transfer Application Form.

The application form should be submitted for the Dean's approval for the programme of study at least three months before the application is submitted to other IPTAs for consideration.

2.6 Academic Integrity

"Integrity without knowledge is weak and useless. Knowledge without integrity is dangerous and dreadful." - *Samuel Johnson*

Academic honesty is important because it is the main pillar in ensuring that manners and ethics with regards to high academic integrity are preserved.

Universiti Sains Malaysia encourages its students to respect and ensure that any matter relating to academic integrity will be well-preserved. Universiti Sains Malaysia always encourages its students to ensure that manners, ethics and integrity would be essential in academics while focusing on their studies in Universiti Sains Malaysia.

The following are practices or acts that are considered as conducts which lack integrity in academics:

1. Cheating

   Cheating in the context of academic include copying during examination, usage of information or other aids in any academic exercise without authorization or in dishonest manner. There are numerous ways and methods of cheating which include:

   a. copying answers from others during test or exam;
   b. any suspicious action that can be described as cheating or an attempt to cheat in an exam;
   c. using unauthorized materials or devices without authorization (calculators, PDAs, mobile phones, pagers, or any smart device, and other unauthorized devices) during tests or exams;
   d. asking or allowing another student to take test or exam on behalf and vice-versa;
   e. sharing answers or programmes in assignments or projects ;
   f. purposely tampering the marks/grades given in any course work, and then re-submitting it for remarking/regarding;
   g. give command, to force, persuade, deceive or threaten others to conduct research, write, program or do any task for personal gain and

   h. submitting any identical or similar work in more than one course without consulting or prior permission from the lecturers concerned.

2. Plagiarism

   The reputation of an academic institution depends on the ability to achieve and sustain academic excellence through the exercise of academic

integrity. Academic integrity is based on honesty, trust, fairness, respect, and responsibility, which form the basis of academic work.

One aspect of the loss of academic integrity is due to plagiarism, which is the act of presenting published and unpublished ideas, writings, works or inventions of others in written or other medium, as one's own original intellectual endeavours without any clear acknowledgement of or reference to the author of the source.

A substantial portion of academic work and research in the university is in the written form and the university is committed in deterring plagiarism.

POLICY ON PLAGIARISM OF UNIVERSITI SAINS MALAYSIA

University Sains Malaysia Policy on Plagiarism describes the University's strong commitment to uphold academic integrity in relation to plagiarism. It will come into effect when there is an infringement of academic conduct relating to plagiarism.

This policy acts as a guideline that both educates and prevents and can be used as the basis if anyone that is part of the university violates any rules and regulations of the University.

The policy applies to all students, former students, staff and former staff which include fellows, post-doctorates, visiting scholars, as well as academic, non-academic, research, contract and temporary staff who are studying, serving or have served; or have graduated from the university.

Plagiarism is defined as the act of presenting, quoting, copying, paraphrasing or passing off of ideas, images, processes, works, data, own words or those of other people or sources without proper acknowledgement, reference or quotation of the original source(s). The acts of plagiarism include, but are not limited to, the following:

a. quoting verbatim (word-for-word replication of) works of other people;
b. paraphrasing another person's work by changing some of the words, or the order of the words, without due acknowledgement of the source(s);
c. submitting another person's work in whole or part as one's own;
d. auto-plagiarising or self-plagiarising (one's own work or previous work) that has already been submitted for assessment or for any other academic award and pass it as a new creation without citing the original content; and
e. insufficient or misleading referencing of the source(s) that would enable the reader to check whether any particular work has indeed

been cited accurately and/or fairly and thus to identify the original writer's particular contribution in the work submitted.

The University will take action of every report and offences relating to plagiarism and if the student is found guilty, the student can be charged by the university according to the Students Disciplinary Rules.

3. Fabrication

Fabrication refers to a process of invention, adaptation or copying with the intention of cheating. This is an act of deceiving other people. Fabrication is somewhat related to matters which have been 'created' or altered.

Invention or task outcome or academic work without acknowledgement, alteration, falsification or misleading use of data, information or citation in any academic work constitutes fabrication. Fabricated information neither represent the student's own effort nor the truth concerning a particular investigation or study, and thus violating the principle of truth in knowledge. Some examples are:

a. creating or exchanging data or results, or using someone else's results, in an experiment, assignment or research;
b. citing sources that are not actually used or referred to;
c. listing with intent, incorrect or fictitious references;
d. forging signatures of authorization in any academic record or other university documents; and
e. developing a set of false data.

4. Collusion

Collusion refers to the cooperation in committing or to commit or to do work with negative intentions. Some examples of collusion include:

a. paying, bribing or allowing someone else to do an assignment, test/exam, project or research for you;
b. doing or assisting others in an assignment, test/exam, project or research for something in return;
c. permitting your work to be submitted as the work of others; and
d. providing material, information or sources to others knowing that such aids could be used in any dishonest act

5. Other violations relating to academic integrity

a. Attending
b. lecture, tutorial, class or other form of teaching relating to their courses late.

c. Sending or submitting any assignment relating to their courses late.
d. Hiring someone else to do the assignment or thesis.
e. Carrying out businesses by providing services to write assignments or theses of students.
f. Any other violations that USM deems as violating academic integrity.

2.6.1 Consequences of Violating Academic Integrity

Students are responsible in protecting and upholding academic integrity in USM.

If, in any specific event, should a student encounter any incident that denotes academic dishonesty, the student needs to submit a report to the relevant lecturer. The lecturer is then responsible to investigate and substantiate the violation and report the matter to the Dean of the School.

1. If any violation of academic integrity is considered as not of a serious nature, the Dean of the School may take administrative action on the students.

2. However, if the violation is deemed serious by the school, this matter shall be brought to the attention of the Secretariat of the University Student Disciplinary Committee (Academic Cases) at Legal Office, Level 2, Building E42, Chancellory II, Universiti Sains Malaysia for further disciplinary action as specified in the Rules.

3. If a student is caught copying or cheating during examination, the Investigation Committee of *Copying/Cheating in Examination* will pursue the matter according to the University's procedures. If the investigation found that there is a case, the student(s) will be brought to the Student's Disciplinary Committee of the University. In this matter, the rule on conduct during examination shall be applied.

4. Rule 48 of Universiti Sains Malaysia (Discipline of Students) provides that a student who commits a disciplinary offence and is found guilty of the offence shall be liable to any one or any appropriate combination of two or more of the following punishments as follows:

    a. a warning ;
    b. a fine not exceeding two hundred ringgit;
    c. exclusion from any specific part or parts of the University for a specified period;

d. suspension from being a student of the University for a specified period; and
e. expulsion from the University.

Any student(s) who is found guilty and suspended from being a student of the University for a specific period as decided by the Student's Disciplinary Committee (Academic Cases) or the Student's Disciplinary Committee (General Cases), such suspension period shall not be counted in calculating the candidature period of study of the student.

2.7 USM Mentor Programme

The Mentor Programme acts as a support-aid that involves staff undergoing special training as consultants and guides to the USM community who would like to share their feelings and any psychosocial issues that could affect their social activities. This programme helps individuals to manage psychosocial issues in a more effective manner, which will eventually improve their well-being in order to achieve a better quality of life.

Objectives

1. To serve as a co-operation and mutual assistance mechanism for dealing with stress, psychosocial problems and many more in order to ensure the well-being of the USM community.
2. To inculcate the spirit of unity and the concept of helping one another by appointing a well-trained mentor as a social agent who promotes a caring society for USM.
3. To produce more volunteers to assist those who need help.

To prevent damage in any psychosocial aspect before they reach a critical stage.

2.8 Student Exchange Programme

2.8.1 Study Abroad Scheme

The student exchange programme is an opportunity for USM students to study for one or two semesters abroad at any USM partner institutions. Ideally, students are encouraged to participate in the exchange programme within their third to fifth semester (3 year degree programme) and within the third to seventh semester (4 year degree programme).

USM students who wish to follow the SBLN programme must discuss their academic plans with the Dean or Deputy Dean of their respective Schools and also with the International Mobility and Collaboration Centre (IMCC) (to ensure that credits obtained from the external higher

education institution can be transferred as part of the credit accumulation for graduation).

Any student who follows the SBLN programme and violates any disciplinary act in the external higher education institution, can be penalised in accordance with the University (Discipline of Students) Rules if the matter is referred to USM.

For further information, please visit www.imcc.usm.my or contact the International Mobility and Collaboration Centre (IMCC) at +604 – 653 2777/2774.

2.8.2 Student Exchange Programme in Local Higher Education Institutions (RPPIPT)

This is a programme that allows students of Higher Learning Institutions to do an exchange programme for a semester among the higher institutions themselves. Students can choose any relevant courses and apply for credit transfers.

USM students who want to participate in RPPIPT have to discuss their academic plans with the Dean or Deputy Dean of their respective Schools and the Division of Academic and International (to ensure that credits obtained from the higher education institution in Malaysia can be transferred as part of the credit accumulation for graduation).

Any student who participates in RPPIPT and violates any of the institution's displinary rules can be penalised according to the University (Discipline of Students) Rules if the matter is referred to USM.

For further information, please contact the Academic & International Division at +604 – 653 2430.

2.9 Ownership of Students' Dissertation/Research Project/Theses and University's Intellectual Property

The copyright of a dissertation/research project/thesis belongs to the student. However, as a condition for the conferment of a degree, the student gives this right unconditionally, directly but not exclusively, and free of royalties to the university to use the contents of the work/thesis for teaching, research and promotion purposes. In addition, the student gives non-exclusive rights to the University to keep, use, reproduce, display and distribute copies of the original thesis with the rights to publish for future research and the archives.

3.0 UNIVERSITY COURSE REQUIREMENTS

3.1 Summary of University Course Requirements

Students are required to take 15-22 credits for the following University courses/options for University needs:

UNIVERSITY COURSE REQUIREMENTS			CREDIT
1.	**General Studies (MPU)**		
	U1	Local Students ▪ HTU223 (Islamic and Asian Civilisations-TITAS) (2 credits) ▪ LKM400 (Bahasa Malaysia IV) (2 credits) International Students ▪ SEA205E(Malaysian Studies) (4 credits)	4
	U2	WUS101 (Entrepreneurship Core) (2 credits)	2
	U3	Local Students ▪ SHE101(Ethnic Relations) (2 credits) International Students ▪ LKM100* (Bahasa Malaysia I) (2 credits)	2
	U4	Co-curricular courses	2
2.	**Language Skill**	English Language Courses	4
3.	**Options**	Skill courses/Foreign Language Courses/ Other courses offered by other schools Students have to choose any of the following: ▪ Co-curricular courses ▪ Skill courses/Foreign Language Courses/ Other courses offered by other schools	1-8
		TOTAL	**15-22**

* International students pursuing Literary programs are required to take two (2) more Bahasa Malaysia courses, namely LKM200 and LKM300.

** Students from the School of Educational Studies are required to choose a uniform body co-curricular package.

** Students from the School of Dental Sciences are required to take co-curriculum courses that consists of three (3) credits. Further information can be obtained from the Academic Office, School of Dental Sciences.

3.2 General Studies Components (MPU)

General studies is one of the strategies and initiatives planned for the purpose of Shift 1, which is Holistic, Entrepreneurial and Balanced Graduates. Malaysia Education Blueprint 2015-2025 (Higher Education) or PPPM (PT) outlines 10 shifts to achieve the aspirations of the nation's higher education system and student aspirations.

General studies are divided into four groups as follows:

1. U1: appreciation of philosophy, values and history;
2. U2: the mastery of soft skills;
3. U3: expansion of the knowledge of Malaysia and its history; and
4. U4: practical community management skills such as community service and co-curriculum.

A. U1 Group

Local Students

All Malaysian students are required to take and pass the following courses. In order to graduate, the minimum passing grade required is Grade C.

(i) HTU223/2 (Islamic and Asian Civilisations - TITAS)

The course synopsis is as follows:

This course aims to increase students' knowledge on history, principles, values, main aspects of Malay Civilization, Islamic Civilization and its culture. With the academic exposure to cultural issues and civilization in Malaysia, it is hoped that students will be more aware of issues that can contribute to the cultivation of the culture of respect and harmony among the plural society in Malaysia. Among the topics in this course are Interaction among Various Civilizations, Islamic Civilization, Malay Civilization, Contemporary Challenges faced by the Islamic and Asian Civilization and the Islamic Hadhari Principles.

(ii) LKM400/2 (Bahasa Malaysia IV)

In order to graduate, the minimum passing grade required is Grade C.

Entry requirements for Bahasa Malaysia are as follows:

No	Qualification	Grade	Entry Level	Type	Unit	Status
1	(a) SPM/MCE/SC (or equivalent qualification) (b) STPM/HSC (or equivalent qualification)	1 - 6 P/S	LKM400	U	2	Graduation Requirement

Note:
To obtain credits for Bahasa Malaysia courses, a minimum of grade C is required. Students may seek advice from the School of Language, Literacies and Translation if they have a different Bahasa Malaysia qualification from the above.

International Students

All international students are required to take and pass the SEA205E/4 (Malaysian Studies) course. In order to graduate, the minimum passing grade required is Grade C. The following is the synopsis of the course:

This course investigates the structure of the Malaysian system of government and the major trends in contemporary Malaysia. Emphasis will be given both to current issues in Malaysian politics and the historical and economic developments and trends of the country. The second part of the course focuses on specific issues: ethnic relations, national unity and the national ideology; development and political change; federal-state relations; the role of religion in Malaysian politics; politics and business; Malaysia in the modern world system; civil society; law, justice and order; and directions for the future.

B. U2 Group

All students are required to take and pass the WUS101/2 (Core Entrepreneurship) course. In order to graduate, the minimum passing grade required is Grade C. The following is the synopsis of the course:

This course provides basic exposure to students on entrepreneurship and business fields, with emphasis on the implementation of the learning aspects while experiencing the process of executing business projects in campus. The main learning outcome is the assimilation of culture and entrepreneurship work ethics in their everyday life. This initiative is made to open the minds and arouse the spirit of

entrepreneurship among target groups that possess the potential to become successful entrepreneurs.

For more information, please refer to the Centre for Co-Curricular Programme website.

C. U3 Group

Local students

All local students are required to take and pass the SHE101/2 (Ethnic Relations) course. In order to graduate, the minimum passing grade required is Grade C. The following is the synopsis of the course:

This course is an introduction to ethnic relations in Malaysia. This course is designed with 3 main objectives: (1) to introduce students to the basic concepts and the practices of social accord in Malaysia, (2) to reinforce basic understanding of challenges and problems in a multi-ethnic society, and (3) to provide an understanding and awareness in managing the complexity of ethnic relations in Malaysia. At the end of this course, it is hoped that students will be able to identify and apply the skills to issues associated with ethnic relations in Malaysia.

International students

All international students are required to take and pass the LKM100/2 (Bahasa Malaysia I) course. In order to graduate, the minimum passing grade required is Grade C.

(i) International students pursuing Bachelor's Degree in Arts are required to take the following courses:

Code	Type	Credit
LKM100	Z	2
LKM200	U	2
LKM300	U	2

(ii) International students pursuing Bachelor's Degrees in Science are required to take the following course:

Code	Type	Credit
LKM100	U	2

D. Group U4

All students are required to register for a co-curricular course in order to complete the minimum requirement of two (2) credit hours in the MPU structure.

Students who choose to take packaged co-curricular courses are required to complete all levels of the package. Students can choose the courses offered by the Core group as follows:

(i) Core of Volunteerism (6 - 10 credits)

All courses offered under this core are the uniformed courses offered in the following packages:

PALAPES Army	PALAPES Navy	PALAPES Air Force	SUKSIS (Students' Police Volunteers)
WTD103/3	WTL103/3	WTU103/3	WPD101/2
WTD203/3	WTL203/3	WTU203/3	WPD201/2
WTD304/4	WTL304/4	WTU304/4	WPD301/2

SISPA (Siswa Siswi Pertahanan Awam Malaysia)	Kelanasiswa (Rovers)	St John Ambulance	Red Crescent Emergency Aid Team
WPA103/2	WLK102/2	WJA102/2	WBM102/2
WPA203/2	WLK202/2	WJA202/2	WBM202/2
WPA303/2	WLK302/2	WJA302/2	WBM302/2

For more information, please refer to the Centre for Co-Curricular Programme website.

(ii) Core of Sports (1 - 3 credits)

The courses offered are as follows:

Packaged Courses (3 Credits, 3 Semesters) (Students are required to complete all levels)	
Karate	**Taekwondo**
WSC108/1	WSC115/1
WSC208/1	WSC215/1
WSC308/1	WSC315/1

Non Packaged Courses (1 Credit)	
WSC105/1 –Volley Ball	WSC 125/1- Futsal
WSC106/1 - Golf	WSC 126/1 - Netball
WSC110/1 - Archery	WSC127/1 - Event Management 1
WSC111/1 - Table Tennis	WSC227/1 - Event Management 2
WSC112/1 - Swimming	WSC128/1 - Petanque
WSC113/1 - Aerobics	WSC130/1 - Orienteering
WSC114/1 - Squash	WSC131/1 - Woodball
WSC116/1 - Tennis	WSC124/1 - Sepak Takraw
WSC119/1 - Badminton	

For more information, please refer to the Centre for Co-Curricular Programme website.

(iii) Core of Culture (1 – 6 credits)

The courses offered are as follows:

Packaged Courses (6 Credits, 3 Academic Sessions) (Students are required to complete all levels)	
Jazz Band	**Seni Silat Cekak Malaysia**
WCC108/2	WCC123/2
WCC208/2	WCC223/2
WCC308/2	WCC323/2
Non Packaged Courses (1 Credit)	
WCC105/1 - Gamelan	WCC117/1 - Modern Theatre
WCC107/1 - Guitar	WCC118/1 - Malay Shadow Play
WCC109/1 - Choir	WCC119/1 - Qigong Exercises
WCC115/1 - Modern Dance	WCC124/1 - Musical Kompang
WCC116/1 - Traditional Dance	WCC129/1 - Latin Dance

For more information, please refer to the Centre for Co-Curricular Programme website.

(iv) Core of Innovation and Initiative (1 - 2 credits)

The courses offered are as follows:

Non Packaged Courses (1 Credit)	
WCC103/1 – Painting	WCC128/1 - Embroidery and Beads Sequin Art
WCC110/1 - Handcrafting	WCC130/1 - Digital SLR Photography Art
WCC120/1 - Canting Batik	WCC 131/1 - Editing Digital Photography Art
WCC121/1 - Calligraphic Art	WCC132/1 - The Art of Ceramic
WCC122/1 - Cullinary Arts	WCC133/1 - Decoupage Arts
WCC125/1 - Traditional of Kite Art	
Non Packaged Courses (2 Credits)	
WMU102/2 - Makers@USM Level 1	

For more information, please refer to the Centre for Co-Curricular Programme website.

(v) Core of Community Service (4 credits)

The courses offered are as follows:

Packaged Courses (4 Credits) (Students are required to complete all levels)	
WKM102/2 - Community Service 1	WKM202/2 - Community Service 2
Non Packaged Courses (2 Credits)	
WSK102/2 - Volunteerism Science	

For more information, please refer to the Centre for Co-Curricular Programme website.

(vi) Core of Public Speaking (2 credits)

The courses offered are as follows:

Non Packaged Courses (2 Credits)
WEC102/2 - Public Speaking in Malay Language
WEC103E/2 - Public Speaking in English Language

For more information, please refer to the Centre for Co-Curricular Programme website.

(vii) Core of Sustainability (2 credits)

The courses offered are as follows:

Non Packaged Courses (2 Credits)
WSU101/2 - Sustainability of Issues, Challenges and Prospects

For more information, please refer to the Centre for Co-Curricular Programme website.

3.3 Language Skills

All Bachelor's degree students must take four (4) units from the English Language courses to fulfil the University requirement for graduation.

(a) Entry Requirements for English Language Courses (for students with MUET)

The following table shows the entry requirements for the English language courses offered by the School of Languages, Literacies and Translation.

Number	MUET qualification/ Pre-requisite course	Grade	English Language Course	Course Type
1	MUET **or**; Discretion of the Dean of PPBLT	Bands 2/3	LMT100 (2 units)	Pre-requisite/ Type Z
2	MUET **or**; LMT100 **or**; Discretion of the Dean of PPBLT	Band 4 A - C	LSP300 (2 units)	Compulsory/ Type U
3	MUET **or**; LSP300 **or**; Discretion of the Dean of PPBLT	Band 5 A - C	LSP 401/402/403/404 (2 units)	Compulsory/ Type U
4	MUET **or**; LSP401/402/403/404 **or**; Discretion of the Dean of PPBLT	Band 6 A - C	LHP 451/452/453/454/455/ 456/457/458/459 * all LHP courses are 2 units except for LHP457 which is 4 units	Compulsory/Option / Type U

(b) Entry Requirements for English Language Courses (for students with TOEFL or IELTS)

The following table shows the entry requirements for the English language courses offered by the School of Languages, Literacies and Translation.

TOEFL (Paper Based Test)	TOEFL (Computer Based Test)	TOEFL (Internet Based Test)	IELTS	English Language Course	Course Type
310 - 413	0 - 103	0 - 34	1 – 4.5	LMT 100 (2 units)	Compulsory/ Type U
417 - 497	107 - 170	35 - 60	5.0 – 5.5	LSP 300 (2 units)	Compulsory/ Type U
500 - 650	173 - 277	61 - 114	6.0 – 8.0	LSP 401/402/403/404 (2 units)	Compulsory/ Type U
653 - 677	280 - 300	115 - 120	8.5 – 9.0	LHP Series * all LHP courses are 2 units except for LHP457 which is 4 units	Compulsory/ Option/ Type U

Note:

- Students are required to refer to the list of English language courses required by their respective schools.

- Students may seek advice from the School of Languages, Literacies and Translation if they have a different English language qualification from the above.

- In order to obtain units in English Language courses, students have to pass with a minimum grade 'C'.

- Students with a Score of 260 – 300 (Band 6) in MUET must accumulate the 4 units of English from the courses in the advanced level (LHP451/452/453/454/455/456/457/458/459). They can also take foreign language courses to replace their English language units but they must first obtain written consent from the Dean of the School of Languages, Literacies and Translation. (Please use the form that can be obtained from the School of Languages, Literacies and Translation).

- Students with a score less than 180 (Band 4) in MUET CAN re-sit MUET to improve their score to Band 4 OR take LMT100 course and pass with a minimum grade C before they can register for the LSP300 course.

(c) English Language Course

English courses offered as university courses are as follows:

No	Code/Unit	Course Title	School (If Applicable)
1	LMT100/2	Preparatory English	Students from all schools
2	LSP300/2	Academic English	Students from all schools
3	LSP401/2	General English	School of Language, Literacies and Translation School of Educational Studies (Literature) School of the Arts School of Humanities School of Social Sciences
4	LSP402/2	Scientific and Medical English	School of Biological Sciences School of Physics School of Chemical Science School of Mathematical Sciences School of Industrial Technology School of Educational Studies (Science) School of Medical Sciences School of Health Science and Dentistry School of Pharmaceutical Sciences
5	LSP403/2	Business and Communication English	School of Management School of Communication
6	LSP404/2	Technical and Engineering English	School of Computer Sciences School of Housing, Building and Planning School of Engineering

3.4 Options (1 – 8 credits)

A. Co-curricular course

Students who have enrolled co-curricular courses in excess of two (2) credits under the U4 General Subjects requirement are not required to attend the co-curriculum course under the Option courses. Students only need to register for skill courses or Foreign Language courses subject to the graduation requirements of their respective program of study.

The details of the list of co-curricular courses offered are in the U4 General Subjects section as stated above.

B. Skill / Foreign Language Courses / Courses offered by other schools

Students can choose the following courses as an option:

(i) WSU 101/2 (Sustainability: Issues, Challenges & Prospects)

The following is the synopsis of the course:

This course introduces and exposes the concept of sustainable development to students. The course aims to ensure future generation capabilities to meet their needs in the future are not affected, especially in the era of challenging globalization and the rapid development of information technology at present. Sustainable development models and case studies are also discussed.

For more information, please refer to the Centre for Co-Curricular Programme website.

(ii) HTV201/2 - Thinking Techniques

The following is the synopsis of the course:

This course introduces students to various creative thinking such as styles and thinking tools that can broaden understanding of creativity and improve problem solving skills. Students are trained to select and apply the best techniques to solve specific problems. So this course helps students to learn to think effectively in order to make the most effective decisions in both their studies and daily life.

(iii) Other options / skill courses as recommended or required by the respective schools (if any)

(iv) English language course

The following courses may be taken as a university course to fulfil the compulsory English language requirements (for students with Band 6 in MUET) or as a skill / option course:

No	Code/Unit	Course Title
1.	LHP451/2	Effective Reading
2.	LHP452/2	Business Writing
3.	LHP453/2	Creative Writing

4.	LHP454/2	Academic Writing
5.	LHP455/2	English Pronunciation Skills
6.	LHP456/2	Spoken English
7.	LHP457/4	Public Speaking and Speech Writing
8.	LHP458/2	English for Translation *(Offered during Semester II only)*
9.	LHP459/2	English for Interpretation *(Offered during Semester I only)*

(v) Foreign Language Courses

The foreign language courses offered by the School of Languages, Literacies and Translation can be taken by students as option or compulsory courses to fulfil the number of units required for graduation. Students are not allowed to register for more than one foreign language course per semester. They must complete at least two levels of a foreign language course before they are allowed to register for another foreign language course. However, students are not required to complete all four levels of one particular foreign language course. The foreign language courses offered are as follows:

Arab	**Chinese**	**Japanese**	**German**	**Spanish**
LAA100/2	LAC100/2	LAJ100/2	LAG100/2	LAE100/2
LAA200/2	LAC200/2	LAJ200/2	LAG200/2	LAE200/2
LAA300/2	LAC300/2	LAJ300/2	LAG300/2	LAE300/2
LAA400/2	LAC400/2	LAJ400/2	LAG400/2	LAE400/2

French	**Thai**	**Tamil**	**Korean**
LAP100/2	LAS100/2	LAT100/2	LAK100/2
LAP200/2	LAS200/2	LAT200/2	LAK200/2
LAP300/2	LAS300/2	LAT300/2	LAK300/2
LAP400/2	LAS400/2		

SCHOOL OF PHYSICS

SCHOOL OF PHYSICS
(www.fizik.usm.my)

Introduction

The School of Physics, which occupies Building G06, G06A and G05, was one of the three Schools that was set up when the University was established in the year 1969. The School has since grown and evolved since its inception, and now emerge as one of the leading schools in USM, garnering a national reputation in X-Ray Crystallography and Nano-Optical research, whilst diversifying the thrust through the establishment of research groups, namely, Condensed Matter Physics and X-Ray Crystallography; Applied and Engineering Physics; Energy Studies; Geophysics, Astronomy and Atmospheric Science; Theoretical and Computational Physics; and Medical Physics and Radiation Science.

The School of Physics offers five undergraduate academic programs as follows:

- Pure Physics
- Applied Physics
- Geophysics
- Engineering Physics
- Medical Physics

The main objective of the School of Physics is to produce Physics and Applied Physics graduates who are high achievers, skillful in many areas, both scientific and non-technical and possess excellent knowledge suitable to national needs. Studying physics can help students to develop a range of skills including problem solving, reasoning, numeracy, practical skills, communication, and information and communication technology (ICT).

Vision

Towards global excellence in transdisciplinary research and education in Physics

Mission

To provide academic, research, educational and social programs for development of human capital, knowledge, and technology for a sustainable nation

STAFF AND ADMINISTRATION

DEAN

Prof. Dr. Azlan Abdul Aziz

DEPUTY DEANS

Dr. Norhaslinda Mohamed Tahrin
[Academic, Career and International]

Assoc. Prof. Dr. Lim Hwee San
[Research, Innovation and Industry-Community Engagement]

PROGRAMME CHAIRMAN

Asoc. Prof. Dr. Yoon Tiem Leong
[Pure Physics]

Dr. Mohd Mahadi Halim
[Applied Physics]

Dr. Nusakinah Suardi
[Medical Physics]

Dr. Nordiana Mohd Muztaza
[Geophysics]

Assoc. Prof. Dr. Yam Fong Kwong
[Engineering Physics]

Mr. Madhavan Raman Kutty
[Principal Science Officer]

Ms. Moganeswary A/P Muthusamy
[Senior Assistant Registrar]

Mrs. Naziroh Shafii
[Assistant Registrar]

Administration	**Telephone Extension**	**E-mail**
DEAN		
Prof. Dr. Azlan Abdul Aziz	3200/3814/3663	lan@usm.my
DEPUTY DEAN		
Academic, Career & International Dr. Norhaslinda Mohamed Tahrin	5123/5330	haslinda@usm.my
Research, Innovation & Industry-Community Engagement Assoc. Prof. Dr. Lim Hwee San	5125/3663	hslim@usm.my
PROGRAMME CHAIRMAN		
Pure Physics Assoc. Prof. Dr. Yoon Tiem Leong	6128/5314	tlyoon@usm.my
Applied Physics Dr. Mohd Mahadi Halim	5105/2474	mmhalim@usm.my
Geophysics Dr. Nordiana Mohd Muztaza	5106/5313	mmnordiana@usm.my
Medical Physics Dr. Nursakinah Suardi	5104/3653	nsakinahsuardi@usm,my
Engineering Physics Assoc. Prof. Dr. Yam Fong Kwong	5102/4178	yamfk@usm.my
ADMINISTRATIVE OFFICERS		
Principal Science Officer Mr. Madhavan Raman Kutty	3666	madhavan@usm.my
Senior Assistant Registrar Miss Moganeswary a/p Muthusamy	3204	moganes@usm.my
Assistant Registrar Mrs. Naziroh Shafii	3025	naziroh@usm.my

ACADEMIC STAFF

Professor	**Telephone Extension**	**E-mail**
Dato' Ahmad Shukri Mustapa Kamal, Dr.	3669	ashukri@usm.my
Abdul Razak Ibrahim, Dr.	5306	arazaki@usm.my
Azlan Abdul Aziz, Dr.	3200/3814/5305	lan@usm.my
Haslan Abu Hassan, Dr.	5303/6724	haslan@usm.my
Md. Roslan Hashim, Dr.	3677	roslan@usm.my
Rosli Saad, Dr.	3675	rosli@usm.my
Mohd. Zubir Mat Jafri, Dr.	3651	mjafri@usm.my
Associate Professor		
Abdul Halim Abdul Aziz, Dr.	5329	abdul@usm.my
Azhar Abdul Rahman, Dr.	3655	arazhar@usm.my
Iskandar Shahrim Mustafa, Dr.	6129	iskandarshah@usm.my
Lim Hwee San, Dr.	5125/3663	hslim@usm.my
Lim Siew Choo, Dr.	5322	sclim@usm.my
Nurhayati Abdullah, Dr.	2475	nurhaya@usm.my
Quah Ching Kheng, Dr.	3438	ckquah@usm.my
Shahrom Mahmud, Dr.	3643	shahromx@usm.my
Wong Chow Jeng, Dr.	5308	wongcj@usm.my
Yam Fong Kwong, Dr.	5102/4178	yamfk@usm.my
Yoon Tiem Leong, Dr.	5314/6128	tlyoon@usm.my
Senior Lecturer		
Ahmad Fairuz Omar, Dr.	4111	fairuz_omar@usm.my
Amin Esmail Khalil, Dr.	5315	amin_khalil@usm.my
Andy Anderson Anak Bery, Dr.	5310	andresonbery@usm.my
Beh Khi Poay, Dr.	3673	behkhipoay@usm.my
Ismail Ahmad Abir, Dr.	3679	iahmadabir@usm.my
John Soo Yue Han, Dr.	5326	johnsooyh@usm.my
Loh Wai Ming, Dr.	5327	edmund_waiming@usm.my
Mahayatun Dayana Johan Ooi, Dr.	3049	mahayatun@usm.my
Md. Noordin Abu Bakar, Dr.	5312	mnoordin@usm.my
Mohd Mahadi Halim, Dr.	5105/2474	mmhalim@usm.my
Mohd Marzaini Mohd Rashid, Dr.	3659	marzaini@usm.my
Mohd Zamir Pakhuruddin, Dr.	5318	zamir@usm.my
Naser Mahmoud Ahmed, Dr.	5302	naser@usm.my
Nik Noor Ashikin Nik Abd Razak, Dr.	3674	nnashikin@usm.my
Nordiana Mohd Muztaza, Dr.	5313	mmnordiana@usm.my
Norhaslinda Mohamed Tahrin, Dr.	5123/5330	haslinda@usm.my
Norlaili Ahmad Kabir, Dr.	5317	norlailikabir@usm.my
Nur Azwin Ismail, Dr.	3676	nurazwin@usm.my

Nurhafizah Md Disa, Dr.	5316	mdnurhafizah@usm.my
Nursakinah Suardi, Dr.	5104/3653	nsakinahsuardi@usm.my
Nurul Hashikin Ab. Aziz, Dr.	3670	hashikin@usm.my
Nurul Zahirah Noor Azman, Dr.	3668	nzahirah@usm.my
Ramzun Maizan Ramli, Dr.	5301	ramzun@usm.my
Saiful Najmee Mohamad, Dr.	5304	snajmee@usm.my
Siti Azrah Mohamad Samsuri, Dr.	5325	sitiazrah@usm.my
Subramani Shanmugan, Dr.	3672	shanmugan@usm.my
Suhana Arshad, Dr.	3652	suhanaarshad@usm.my
Teoh Ying Jia, Dr.	5309	tyj@usm.my
Wan Maryam Wan Ahmad Kamil, Dr.	5328	wanmaryam@usm.my
Wan Mohamad Husni Wan Mokhtar, Dr.	2176	wanhusni@usm.my
Wong Khai Ming, Dr.	3678	kmwong@usm.my

Non Academic

Research Officer

Ben Kamarrudin Merican, Mr.	5320	benkamar@usm.my
Siti Khadijah Mohd Bakhori, Dr.	5307/3599	skmb@usm.my
Yushamdan Yusof, Mr.	3206/3599	yushamdan@usm.my
Mohd Mustaqim Rosli, Mr.	5324/3690	mustaqim@usm.my

Science Officer

Hajjaj Juharullah Jaafar, Mr.	3599/2130	hajjaj@usm.my
Nor Izzati Hashim, Ms.	5003	norizzati@usm.my
Nur Awanis Sirat, Ms.	2471	nurawanis@usm.my

Industry and Community Advisory Panel (ICAP)

School of Physics has established an Industry and Community Advisory Panel (ICAP) for the purpose of strengthening the relationship and communication with industries as a win-win strategy for moving toward sustainability. The key role of ICAP is to

- provide guidance and advice on programme curricular as well as the establishment of new courses to produce graduates that meet the industry's needs
- explore the potential collaboration opportunities for promoting synergy in research and industry based projects
- constantly update fresh perspectives on issues of new and emerging technology, changing needs of the industry and employment of graduate

Industry and Community Advisory Panel	Position/Organization	Contact
Pure Physics Mr. Mohamad Nasir Osman	Director Manufacturing *Oryx Advanced Material Sdn. Bhd.*	Plot 69 (d) & (e), Lintang Bayan Lepas 6, Bayan Lepas Industrial Zone Phase 4, 11900 Bayan Lepas, Pulau Pinang Email: nasir.osman@oryxadv.com Tel: 604-6402348 ext 108 (O) Fax: 04-6421357
Pure Physics Mr. Tan Chun Aun	Speciallist Engineer *Vitrox Corporation Bhd.*	47, Lorong Prestij 4, Taman Prestij III, 11000 Balik Pulau. Email: chunaun@gmail.com Tel. H/P: 012-6510683
Geophysics Encik Khairool Anwar Laksamana	Senior Geophysicist *INTEGRATED GGRE ASIA*	8.01 Level 8, Menara Binjai, No. 2 Jalan Binjai, 50450 Kuala Lumpur Email: khairoolanwar@ggreasia Tel H/P: 019-8798897
Engineering Physics Mr. David Lacey	R & D Director *Osram Opto Semiconductors*	2, Denai Bayu 22, Seri Tanjung Pinang 10470 Tanjung Tokong, Pulau Pinang Email: david@lacey.me.uk/ www.lacey.me.uk Tel: 04 – 890 4406 (O) Tel. H/P: 012-4307003
Engineering Physics Mr. John Ong	General Manager *Genetron Company*	11 Sunbird Avenue, 487335 Singapore Email: johnong@genetron.com.my Tel H/P: 019-3885491
Medical Physics Mr. Ng Bong Seng	Chief Medical Physicist (Radiotherapy and X-ray) *Hospital Pantai Pulau Pinang*	82, Jalan Tengah, Bayan Baru 11900 Bayan Lepas,Pulau Pinang Email : bsng@pantaipg.com.my/ gbongseng@gmail.com Tel. H/P: 012- 474 5179; Tel: 04-6433888 (O); Fax: 04-6432888
Applied Physics Mr. Philip Beow Yew Tan	Device Modeling MTS (Manager) *Silterra Malaysia Sdn. Bhd.*	Lot 8, Phase II Kulim Hi-Tech Park 09000 Kulim, Kedah Darul Aman Email: philiptanbeowyew@gmail.com Tel. H/P: 012-4377288

PROGRAMME STRUCTURE FOR THE DEGREE OF BACHELOR OF APPLIED SCIENCE WITH HONOURS – APPLIED PHYSICS, GEOPHYSICS, ENGINEERING PHYSICS AND MEDICAL PHYSICS

Major-Elective or Major-Minor Applied Physics / Geophysics / Engineering Physics / Medical Physics Programme

A student must attain a minimum of 2.0 CGPA ('C' average) for the whole programme and combined basic and core components.

If a student fails one or two core courses, he/she is allowed to replace a maximum of 8 units with core courses of at least similar level offered in other Programmes of study in Physics.

PROGRAM STRUCTURE

TYPE	CODE	CREDIT UNITS
Core	T	72
Elective	E	30/14/10
Minor	M	0/16/20
University	U	18
Total		120

BACHELOR OF SCIENCE WITH HONOURS – APPLIED PHYSICS

PROGRAMME OBJECTIVES

The objectives of the programme are:

1. to develop skilled human resource in various aspects of applied physics fields.
2. to produce knowledgeable and skilled graduates in this field required by the industries including electronic industries, research and higher education institutions to fulfill the market demands and needs.
3. to provide human capital who are able to use logical and critical considerations in their decision making and capable to gain, develop and administer sources of knowledge.
4. to produce graduates who appreciate various culture and able to contribute and lead effectively.

PROGRAMME LEARNING OUTCOMES

At the end of the course, students are able to:

1. understand and assimilate the fundamental concepts and theories of physics,
2. apply analytical skills and be competent in a variety of physics techniques to solve problems,
3. identify, formulate, analyze and solve applied and industrial problems,
4. present and defend applied physics ideas effectively in written and oral form,
5. work collaboratively as part of a team,
6. pursue independent study and continuous personal and professional development,
7. be a skilled and innovative leader,
8. become professional, responsible and ethical in work and in dealing with others, and
9. value culture and cultural diversity.

Programme Stucture for Bachelor of Applied Science with Honours Degree Programme – Applied Physics

Core Courses

ZCA 101/4	Physics I (Mechanics)
ZCA 102/4	Physics II (Electricity and Magnetism)
ZCT 103/3	Physics III (Vibrations, Waves and Optics)
ZCT 104/3	Physics IV (Modern Physics)
ZCT 106/3	Electronics I
*ZCA 110/4	Calculus
ZCT 112/3	Linear Algebra and Vector Analysis
ZCT 191/2	Physics Practical I

ZCT 192/2	Physics Practical II
ZCT 205/3	Quantum Mechanics
ZCT 206/3	Electronics II
ZCT 210/4	Complex Analysis and Differential Equations
ZCT 215/3	Optics
ZAT 281/4	Introduction to Microprocessors
ZAT 283/3	Instrumentation
ZCT 293/2	Physics Practical III
ZCT 307/3	Solid State Physics I
ZAT 386/4	Physics of Semiconductor Devices
ZAT 394/8	Applied Physics Project and Seminar (two semesters)
ZAT 487/4	Semiconductor Fabrication Processes
ZAT 489/3	Low Dimensional Semiconductor Structures

Total: 72 units (21 courses)

*The course content of ZCA 110/4 overlaps with Mathematics course MAA 101/4 Calculus for Science Student I. Students can only register either ZCA 110/4 or ….MAA 101/4.

Elective Courses

Students must select 30 units; at least 26 units from the group of courses below and the remaining units may be selected from other Science or Applied Science programmes, not from School of Physics.

ZCE 111/4	Computational Approach in Physics Learning
ZCT 214/3	Thermodynamics
ZKT 224/4	Electronic and Photonic Materials I
ZCE 275/4	Introduction to Astronomy
ZGE 277/4	Structure of the Universe
ZAE 282/3	Materials Science
ZCT 314/3	Statistical Mechanics
ZKE 327/3	Solid State Lighting I
ZCE 341/4	Energy Studies
ZAE 376/4	Astronomy Principles and Practices
ZKE 378/4	Introduction to Radio Astronomy
ZKE 427/3	Solid State Lighting II
ZCE 451/3	X-Ray Analysis
ZAE 484/4	Laser and Its Applications
ZAE 485/4	Applied Spectroscopy
ZAE 488/4	Non-Destructive Testing
ZCE 499/9	Industrial Training

Suggested Progress Schedule for Course Registration of Bachelor of Applied Science with Honours Degree Programme – Applied Physics (Single Major)

Year	Sem	Courses						Units
1	I	ZCA 101/4	ZCT 103/3	ZCA 110/4		ZCT 191/2	U/4	17
	II	ZCA 102/4	ZCT 104/3	ZCT 106/3	ZCT 112/3	ZCT 192/2	U/2	17
2	I	ZCT 206/3	ZCT 210/4	ZCT 215/3	…/3*	ZCT 293/2	U/2	17
	II	ZCT 205/3	ZAT 281/4	ZAT 283/3	.../3*		U/2	15
3	I	ZCT 307/3	…/3*	…/4*	*ZAT 394/8***		U/2	16
	II	ZAT 386/4	…/4*		*ZAT 394/8***		U/2	14
4	I	ZAT 487/4	ZAT 489/3	.../4*			U/4	15
	II	ZCE 499/9						9
							Total	120

Note: * Elective Courses (according to choice)
** Course conducted over two semesters

BACHELOR OF APPLIED SCIENCE WITH HONOURS – GEOPHYSICS

PROGRAMME OBJECTIVES

The objectives of the programme are:

1. to produce trained manpower in various aspects in the field of geophysics.
2. to produce skillful and knowledgeable graduates in the industrial fields, including oil and gas industries as well as higher institutions to fulfill the needs of the country.
3. to provide human resources that are able to apply logical, critical and analytical concepts/ideas/thinking to exploit, develop and manage the knowledge-based resources.
4. to produce graduates who can appreciate cultural diversity, professionalism and are able to contribute and lead effectively.

PROGRAMME LEARNING OUTCOMES

At the end of the course, students are able to:

1. be competent in the basic concepts and theories of geophysical methods,
2. identify and solve various geophysical problems, carrying out experiment, analysis and interpret data,
3. value culture and cultural diversity,
4. carry out tasks professionally,
5. contribute and lead effectively as a team member to achieve maximum results,
6. make important decisions by logical considerations and critical thinking,
7. study independently with the ability to find, access and use resources,
8. develop and administer knowledge to achieve specific work, and
9. work in a team.

Programme Stucture for Bachelor of Applied Science with Honours Degree Programme – Geophysics

Core Courses

ZCA 101/4	Physics I (Mechanics)
ZCA 102/4	Physics II (Electricity and Magnetism)
ZCT 103/3	Physics III (Vibrations, Waves and Optics)
ZCT 104/3	Physics IV (Modern Physics)
*ZCA 110/4	Calculus
ZCT 112/3	Linear Algebra and Vector Analysis
ZGT 161/3	Geology I
ZGT 162/3	Geology II
ZGT 190/2	Geology Practical

ZCT 191/2	Physics Practical I
ZCT 210/4	Complex Analysis and Differential Equations
ZGT 271/3	Geophysical Data Analysis
ZGT 265/3	Meteorology I
ZGT 266/3	Solid Earth Geophysics I
ZGT 267/3	Solid Earth Geophysics II
ZGT 268/3	Exploration Geophysics I
ZGT 269/3	Exploration Geophysics II
ZGT 295/4	Geophysics Practical (two semesters)
ZGT 372/3	Introduction to Oceanography
ZGT 374/4	Remote Sensing
ZGT 395/8	Geophysics Project (two semesters)

Total: 72 units (21 courses)

*The course content of ZCA 110/4 overlaps with Mathematics course MAA 101/4 Calculus for Student Science I. Students can only register either ZCA 110/4 or MAA 101/4.

Elective Courses

Students must select 30 units; at least 26 units from the group of courses below and the remaining units may be selected from other Science or Applied Science programmes, not from School of Physics.

ZCE 111/4	Computational Approach in Physics Learning
ZCE 275/4	Introduction to Astronomy
ZGE 277/4	Structure of the Universe
ZCE 341/4	Energy Studies
ZGE 364/3	Tropical Meteorology and Forecasting
ZGE 370/3	Meteorology II
ZAE 376/4	Astronomy Principles and Practices
ZKE 378/4	Introduction to Radio Astronomy
ZGE 460/3	Synoptic Meteorology
ZGE 461/3	Advanced Geology
ZGE 471/3	Potential Field Interpretation
ZGE 473/4	Seismic Data Processing
ZGE 475/3	Engineering and Environmental Geophysics
ZGE 477/3	Physics Oceanography
ZGE 479/3	Geological Oceanography
ZCE 499/9	Industrial Training

Suggested Progress Schedule for Course Registration of Bachelor of Applied Science with Honours Degree Programme – Geophysics (Single Major)

Year	Sem	Courses						Units
1	I	ZCA 101/4	ZCT 103/3	ZCA 110/4	ZGT 161/3	ZCT 191/2	U/2	18
	II	ZCA 102/4	ZCT 104/3	ZCT 112/3	ZGT 162/3	ZGT 190/2	U/2	17
2	I	ZCT 210/4	ZGT 265/3	ZGT 266/3	ZGT 268/3	*ZGT 295/4***	U/2	17
	II	ZGT 271/3	ZGT 267/3	ZGT 269/3		*ZGT 295/4***	U/4	15
3	I	ZGT 372/3	ZGT 374/4		*ZGT 395/8***		U/4	15
	II	…/3*	.../3*		*ZGT 395/8***		U/4	14
4	I	…/3*	…/3*	…/3*	…/3*	…/3*		15
	II	ZCE 499/9						9
							Total	120

Note: * Elective Courses (according to choice)
** Course conducted over two semesters

BACHELOR OF APPLIED SCIENCE WITH HONOURS – ENGINEERING PHYSICS

PROGRAMME OBJECTIVES

The objectives of the programme are:

1. to develop skilled human resource in various aspects of engineering physics fields.
2. to produce knowledgeable and skilled graduates in this field required by the industries including electronic industries, research and higher education institutions to fulfill the market demands and needs.
3. to provide human capital who are able to use logical and critical considerations in their decision making and capable to gain, develop and administer sources of knowledge.
4. to produce graduates who appreciate various culture and able to contribute and lead effectively.

PROGRAMME LEARNING OUTCOMES

At the end of the course, students are able to:

1. be competent in the basic concepts and theories of engineering physics,
2. identify and solve various problems related to engineering physics,
3. communicate ideas in engineering physics clearly and effectively,
4. work in a team,
5. conduct independent study,
6. be a skilled and innovative leader,
7. be resourceful, dynamic and innovative,
8. be professional, responsible and ethical, and
9. value culture and cultural diversity.

Programme Stucture for Bachelor of Applied Science with Honours Degree Programme – Engineering Physics

Core Courses

ZCA 101/4	Physics I (Mechanics)
ZCA 102/4	Physics II (Electricity and Magnetism)
ZCT 103/3	Physics III (Vibrations, Waves and Optics)
ZCT 104/3	Physics IV (Modern Physics)
ZCT 106/3	Electronics I
*ZCA 110/4	Calculus
ZCT 112/3	Linear Algebra and Vector Analysis
ZCT 191/2	Physics Practical I

ZCT 192/2	Physics Practical Il
ZCT 205/3	Quantum Mechanics
ZCT 206/3	Electronics II
ZCT 210/4	Complex Analysis and Differential Equations
ZCT 215/3	Optics
ZKT 223/3	Engineering Design
ZKT 224/4	Electronic and Photonic Materials I
ZCT 293/2	Physics Practical III
ZKT 296/2	Photonics Laboratory
ZKT 297/3	Practical Training
ZCT 304/3	Electricity and Magnetism
ZCT 307/3	Solid State Physics I
ZKT 321/3	The Engineer in Society
ZKT 396/8	Engineering Physics Project (two semesters)

Total : 72 units (22 courses)

*The course content of ZCA 110/4 overlaps with Mathematics course MAA 101/4 Calculus for Student Science I. Students can only register either ZCA 110/4 or MAA 101/4.

Elective Courses

Students must select 30 units; at least 26 units from the group of courses below and the remaining units may be selected from other Science or Applied Science programmes, not from School of Physics.

ZCE 111/4	Computational Approach in Physics Learning
ZCT 214/3	Thermodynamics
ZCT 219/4	Mathematical Methods
ZCE 275/4	Introduction to Astronomy
ZGE 277/4	Structure of the Universe
ZCT 314/3	Statistical Mechanics
ZKE 322/3	Electronic and Photonic Materials II
ZKE 323/3	Electronic and Photonic Devices and Systems
ZKE 326/4	Signal and Image Processing
ZKE 327/3	Solid State Lighting I
ZAE 376/4	Astronomy Principles and Practices
ZKE 378/4	Introduction to Radio Astronomy
ZKE 427/3	Solid State Lighting II
ZAE 484/4	Laser and Its Applications
ZAE 488/4	Non-destructive Testing
ZCE 499/9	Industrial Training

Suggested Progress Schedule for Course Registration of Bachelor of Applied Science with Honours Degree Programme – Engineering Physics (Single Major)

Year	Sem	Courses						Units
1	I	ZCA 101/4	ZCT 103/3	ZCA 110/4		ZCT 191/2	U/4	17
	II	ZCA 102/4	ZCT 104/3	ZCT 106/3	ZCT 112/3	ZCT 192/2	U/2	17
2	I	ZCT 206/3	ZCT 210/4	ZCT 215/3	ZKT 297/3	ZCT 293/2		15
	II	ZCT 205/3	ZKT 223/3	ZKT 224/4	ZKT 296/2	…/3*	U/2	17
3	I	ZCT 307/3	ZKT 321/3	…/4*	*ZKT 396/8***		U/2	16
	II	ZCT 304/3	.../4*		*ZKT 396/8***		U/4	15
4	I	…/4*	…/3*	…/3*			U/4	14
	II	ZCE 499/9						9
							Total	120

Note: * Elective Courses (according to choice)
** Course conducted over two semesters

BACHELOR OF APPLIED SCIENCE WITH HONOURS – MEDICAL PHYSICS

PROGRAMME OBJECTIVES

The objectives of the programme are:

1. to train adequate human capital in the medical physics area and to increase the utilization of high technology medical equipments.
2. to expose and increase students' knowledge in radiation physics, dosimetry, medical instrumentation and diagnostic imaging (including radiotherapy, nuclear medicine, magnetic resonance and ultrasound).
3. to train medical physics students to have good analytical skills and able to understand and solve problems related to their field.
4. to produce graduates who are versatile to serve in different fields of applied physics other than medical physics.

PROGRAMME LEARNING OUTCOMES

At the end of the course, students are able to:

1. understand fundamental and broad principles of physics, in particular on radiation physics and dosimetry, medical instrumentations and diagnostic imaging modalities, including nuclear medicine, magnetic resonance and ultrasound,
2. perform experiments, acquire and construe data,
3. acquire diversified skills related to technological literacy, critical thinking, problem solving, communicative, and social responsibilities,
4. adhere to professionalism, values, ethics and observe accountability in execution of tasks,
5. attain communication, leadership, team working and other related skills,
6. apply logical reasoning and critical thinking in scientific matters and issues,
7. keep track, understand physical principles and updating information know-how of latest medical imaging modalities,
8. be self-reliant and able to manage and guide effectively in matters related to scientific tasks, and
9. become a skillful and innovative leader.

Programme Stucture for Bachelor of Applied Science with Honours Degree Programme – Medical Physics

Core Courses

ZCA 101/4	Physics I (Mechanics)
ZCA 102/4	Physics II (Electricity and Magnetism)
ZCT 103/3	Physics III (Vibrations, Waves and Optics)

ZCT 104/3	Physics IV (Modern Physics)
ZCT 106/3	Electronics I
*ZCA 110/4	Calculus
ZCT 191/2	Physics Practical I
ZCT 192/2	Physics Practical II
ZCT 205/3	Quantum Mechanics
ZCT 210/4	Complex Analysis and Differential Equations
ZCT 214/3	Thermodynamics
ZCT 215/3	Optics
ZMT 231/4	Human Anatomy and Physiology
ZCT 293/2	Physics Practical III
ZMT 298/2	Medical Physics Practical
ZCT 307/3	Solid State Physics I
ZCT 314/3	Statistical Mechanics
ZMT 334/4	Physics of Diagnostic Radiology
ZMT 335/4	Physics of Radiotherapy and Nuclear Medicine
ZMT 397/8	Medical Physics Project (two semseters)
ZCE 431/4	Radiation Biophysics

Total: 72 units (21 courses)

*The course content of ZCA 110/4 overlaps with Mathematics course MAA 101/4 Calculus for Student Science I. Students can only register either ZCA 110/4 or MAA 101/4.

Electives Courses

Students must select 30 units; at least 26 units from the group of courses below and the remaining units may be selected from other Science or Applied Science programmes, not from School of Physics.

ZCE 111/4	Computational Approach in Physics Learning
ZCT 112/3	Linear Algebra and Vector Analysis
ZCE 275/4	Introduction to Astronomy
ZGE 277/4	Structure of the Universe
ZCE 305/3	Atomic and Nuclear Physics
ZME 336/4	Medical Instrumentation
ZCE 341/4	Energy Studies
ZAE 376/4	Astronomy Principles and Practices
ZKE 378/4	Introduction to Radio Astronomy
ZAT 386/4	Semiconductor Physics Devices
ZME 432/4	Medical Lasers
ZME 438/4	Physics of Medical Imaging
ZCE 451/3	X-Ray Analysis
ZAE 484/4	Laser and Its Applications
ZAE 488/4	Non-Destructive Testing
ZCE 499/9	Industrial Testing

Suggeated Progress Schedule for Course Registration of Bachelor of Applied Science with Honours Degree Programme – Medical Physics (Single Major)

Year	Sem	Courses						Units
1	I	ZCA 101/4	ZCT 103/3	ZCA 110/4		ZCT 191/2	U/4	17
	II	ZCA 102/4	ZCT 104/3	ZCT 106/3	…/3*	ZCT 192/2	U/2	17
2	I	ZCT 210/4	ZCT 214/3	ZCT 215/3		ZCT 293/2	U/4	16
	II	ZCT 205/3	ZMT 231/4	…/3*		ZMT 298/2	U/4	16
3	I	ZCT 307/3	ZCT 314/3	…/4*	*ZMT 397/8***		U/2	16
	II	ZMT 334/4	ZMT 335/4	.../3*	*ZMT 397/8***			15
4	I	ZCE 431/4	…/4*	…/4*			U/2	14
	II	ZCE 499/9						9
							Total	120

Note: * Elective Courses (according to choice)
** Course conducted over two semesters

MINOR AREA OF SPECIALISATION

Some Minor areas of specialization (not limited to these areas) are as follows:

1. Astronomy
2. Chemistry
3. Mathematics
4. Computer Science
5. Management
6. Islamic Studies
7. English Language

Students are required to pass 16 or 20 units of courses taken under the Minor area of specialisation and the remainder (14 or 10 units) from the elective courses listed in this program. Please refer to the School concerned for further information on the courses offered.

COURSES FOR STUDENTS WHO DO NOT MAJOR IN PHYSICS

Courses offered by the School of Physics can be registered as Basic, Core, Elective, Option and Audit courses by students who do not major in Physics if they have fulfilled the prerequisite of the courses selected.

CONTENT-OVERLAP COURSES

The list of content-overlap courses will be announced whenever neccessary. However, your academic advisor should be referred to for advice.

PRIZES AND DEAN'S LIST

There are five awards in the field of Physics that can be won by students in each academic session:

- **Honourable Dato' Professor Chatar Singh Gold Medal** is awarded to the best graduate in the field of Physics.
- **Ranjeet Singh Memorial Gold Medal** is awarded to the best graduate in the field of Geophysics.
- **Tan Kok Hin Book Prize** is awarded to the best graduate in the field of Applied Physics.
- **Universiti Sains Malaysia Gold Medal** is awarded to the best graduate in the field of Engineering Physics sponsored by Prof. Emeritus Lim Koon Ong.
- **Universiti Sains Malaysia Gold Medal** is awarded to the best graduate in the field of Medical Physics sponsored by the Staff of School of Physics.

Other than the awards stated above, the following are awards given by the university;

- **University Sains Malaysia Gold Medal** is awarded to the best graduate of the Degree of Bachelor of Science with Honours.
- **Universiti Sains Malaysia Gold Medal (Ladies Association)** is awarded to a female graduate who is the best in all fields (academic and co-curriculum activities).
- **The Educational Award (Gold Medal, Certificate, RM1000) given by the Council of Rulers** is awarded to a Malay graduate and a Non-Malay graduate who is the best in all fields in each University.
- **The Chancellor's Gold Medal for the Universiti Sains Malaysia Best All-Round Student** is awarded to the graduate who has achieved distinction in academic results and possessed a record of active involvement in extra-curricular activities.

The Dean's List is awarded to physics students who have achieved a certain level of excellence in their academic performance. The Dean's List is awarded every semester.

STAFF AND STUDENT COMMITTEE

The Staff and Student Committee is formed in the School to strengthen the relationship between students and staff. The Chairman of this Committee is the Deputy Dean (Academic, Career and International). This Committee meets from time to time and it functions as an open forum to discuss matters concerning academic, welfare and non-academic activities. Physics students elect the student representatives to this Committee at the beginning of each academic session.

INDUSTRIAL TRAINING PROGRAMME

Industrial Training, which is optional, is encouraged. Industrial Training lasts for 18 weeks, done in semester 2 of the 4th year of study. The purpose of Industrial Training is to strengthen the relationship between the University and the private and public sectors and provide exposure to working-life for students nearing their completion of undergraduate study. Students will be directly exposed to the real working environment.

Students in the final year are encouraged to apply to serve as trainees with various employers in industries, hospitals or institutions relevant to their fields of study through the School of Physics. During the period of training, it is hoped that students will observe and participate in the research and management activities in the industry, and implement theories of science learned. Evaluation will be done based on the report from the industrial supervisor/field supervisor, industrial training report including log book and presentation. Students may opt out Industrial Training provided substitute courses are taken with total unit equivalent to 9 of courses at the 400 level.

MENTOR SYSTEM

Mentor system is formed to assist students to overcome problems especially in regard to academic matters. Students will be guided so that they will be able to face academic challenges independently.

SCHEME FOR STUDYING ABROAD

The objective of this scheme is to create students' awareness at the international level by allowing them to register for one semester at a chosen university abroad.

FACILITIES

Teaching laboratories for practical classes, research laboratories, workshop, student centre, computer laboratory, microprocessor laboratory, CAI laboratory, postgraduate rooms, resource centre and seminar/tutorial rooms for physics students are available in Buildings G05, G06, and G06A.

LIST OF COURSES OFFERED FOR THE DEGREE OF BACHELOR OF APPLIED SCIENCE WITH HONOURS PROGRAMME – APPLIED PHYSICS, GEOPHYSICS, ENGINEERING PHYSICS AND MEDICAL PHYSICS

Semester I

Level	Course Code	Title	Prerequisite
100	ZCA 101/4	Physics I (Mechanics)	-
	ZCT 103/3	Physics III (Vibrations, Waves and Optics)	-
	ZCA 110/4	Calculus	-
	ZGT 161/3	Geology I	(C) ZCA101/4
	ZCT 191/2	Physics Practical I	-
200	ZCT 206/3	Electronics II	(S) ZCT 106/3
	ZCT 210/4	Complex Analysis and Differential Equations	(S) ZCA 110/4 or (S) MAA 101/4
	ZCT 214/3	Thermodynamics	(S) ZCA 102/4
	ZCT 215/3	Optics	(P) ZCT 103/3
	ZGT 265/3	Meteorology I	(C) ZGT 266/3
	ZGT 266/3	Solid Earth Geophysics I	(S) ZGT 162/3
	ZGT 268/3	Exploration Geophysics I	(C) ZGT 266/3
	ZCE 275/4	Introduction to Astronomy (minor Astronomy)	-
	ZAE 282/3	Material Science	(C) ZCT 214/3
	ZCT 293/2	Physics Practical III	(S) ZCT 191/2 or (S) ZCT 192/2
	ZGT 295/4	Geophysics Practical (two semesters)	(S) ZGT 190/2
	ZKT 297/3	Practical Training	(S) ZCT 192/2
300	ZCE 305/3	Atomic and Nuclear Physics	(S) ZCT 205/3
	ZCT 307/3	Solid State Physics I	(S) ZCT 205/3
	ZCT 314/3	Statistical Mechanics	(S) ZCT 214/3
	ZKT 321/3	The Engineer in Society	-
	ZKE 322/3	Electronic and Photonic Materials II	(S) ZKT 224/4
	ZKE 323/3	Electronic and Photonic Devices and Systems	(S) ZCT 106/3 and (S) ZCT 215/3
	ZKE 327/3	Solid State Lighting I	(C) ZCT 307/3
	ZME 336/4	Medical Instrumentation	(S) ZCT 106/3

	ZGE 370/3	Meteorology II	(S) ZGT 271/3 and (S) ZGT 265/3
	ZGT 372/3	Introduction to Oceanography	(S) ZCA 101/4 and (S) ZGT 162/3
	ZGT 374/4	Remote Sensing	(S) ZCA 102/4 and (S) ZCT 103/3
	ZAE 376/4	Astronomy Principles and Practices (minor Astronomy)	-
	ZAT 394/8	Applied Physics Project and Seminar (two semesters)	(P) ZCT 293/2
	ZGT 395/8	Geophysics Project (two semesters)	(S) ZGT 295/4
	ZKT 396/8	Engineering Physics Project (two semesters)	(S) ZKT 296/2
	ZMT 397/8	Medical Physics Project (two semesters)	(S) MAT 181/4 or (S) ZCE 111/4 and (S) ZMT 298/2
400	ZCE 431/4	Radiation Biophysics	(S) ZCT 104/3
	ZME 438/4	Physics of Medical Imaging	(S) ZCT 106/3
	ZCE 451/3	X-Ray Analysis	(C) ZCT 307/3
	ZGE 471/3	Potential Field Interpretation	(S) ZGT 269/3
	ZGE 473/4	Seismic Data Processing	(S) ZGT 271/3 and (S) ZGT 268/3
	ZGE 475/3	Engineering and Environmental Geophysics	(S) ZGT 268/3
	ZGE 477/3	Physics Oceanography	(S) ZGT 372/3
	ZAE 485/4	Applied Spectroscopy	(S) ZAT 283/3
	ZAT 487/4	Semiconductor Fabrication Processes	(S) ZAT 386/4
	ZAT 489/3	Low Dimensional Semiconductor Structures	(C) ZCT 307/3

Semester II

Level	**Course Code**	**Title**	**Prerequisite**
100	ZCA 102/4	Physics II (Electricity and Magnetism)	(S) ZCA 101/4
	ZCT 104/3	Physics IV (Modern Physics)	-
	ZCT 106/3	Electronics I	(C) ZCA 102/4

	ZCE 111/4	Computational Approach in Physics Learning	-
	ZCT 112/3	Linear Algebra and Vector Analysis	(S) ZCA110/4 or (S) MAA 101/4
	ZGT 162/3	Geology II	(S) ZGT 161/3
	ZGT 190/2	Geology Practical	(S) ZGT 161/3
	ZCT 192/2	Physics Practical II	-
200	ZCT 205/3	Quantum Mechanics	(S) ZCT 104/3
	ZCE 208/3	Classical Mechanics	(P) ZCA 101/4 and (P) ZCA 110/4 and (S) ZCT 112/3 and (S) ZCT 210/4
	ZCT 219/4	Mathematical Methods	(S) ZCT 112/3 and (S) ZCT 210/4
	ZKT 223/3	Engineering Design	(S) ZKT 297/3
	ZKT 224/4	Electronic and Photonic Materials I	(S) ZCT 106/3 and (S) ZCT 210/4
	ZMT 231/4	Human Anatomy and Physiology	-
	ZGT 267/3	Solid Earth Geophysics II	(S) ZGT 162/3
	ZGT 269/3	Exploration Geophysics II	(C) ZGT 267/3
	ZGT 271/3	Geophysical Data Analysis	(S) ZCT 210/4
	ZGE 277/4	Structure of the Universe (minor Astronomy)	-
	ZAT 281/4	Introduction to Microprocessors	(P) ZCT 206/3
	ZAT 283/3	Instrumentation	(S) ZCT 206/3 and (S) ZCT 293/2
	ZCT 294/2	Physics Practical IV	(S) ZCT 191/2 or (S) ZCT 192/2
	ZGT 295/4	Geophysics Practical (two semesters)	(S) ZGT 190/2
	ZKT 296/2	Photonics Laboratory	(S) ZCT 293/2
	ZMT 298/2	Medical Physics Practical	(S) ZCT 293/2
300	ZCT 304/3	Electricity and Magnetism	(P) ZCA 102/4 and (S) ZCT 112/3 and (S) ZCT 210/4
	ZCT 317/3	Solid State Physics II	(S) ZCT 307/3
	ZKE 326/4	Signal and Image Processing	(S) ZCT 219/4
	ZMT 334/4	Physics of Diagnostic Radiology	(S) ZCT 104/3
	ZMT 335/4	Physics of Radiotherapy and Nuclear	(S) ZCT 104/3

		Medicine	
	ZCE 341/4	Energy Studies	(S) ZCA 101/4 and (S) ZCA 102/4
	ZGE 364/3	Tropical Meteorology and Forecasting	(S) ZGT 265/3
	ZKE 378/4	Introduction to Radio Astronomy (minor Astronomy)	-
	ZAT 386/4	Physics of Semiconductor Devices	(S) ZCT 106/3 and (S) ZCT 307/3
	ZAT 394/8	Applied Physics Project and Seminar (two semesters)	(P) ZCT 293/2
	ZGT 395/8	Geophysics Project (two semesters)	(S) ZGT 295/4
	ZKT 396/8	Engineering Physics Project (two semesters)	(S) ZKT 296/2
	ZMT 397/8	Medical Physics Project (two semesters)	(S) MAT 181/4 or (S) ZCE 111/4 and (S) ZMT 298/2
400	ZKE 427/3	Solid State Lighting II	(S) ZKE 327/3
	ZME 432/4	Medical Laser	(S) ZCT 104/3
	ZGE 460/3	Synoptic Meteorology	(S) ZGT 265/3
	ZGE 461/3	Advanced Geology	(S) ZGT 162/3
	ZGE 479/3	Geological Oceanography	(C) ZGT 372/3
	ZAE 484/4	Laser and Its Applications	(S) ZCT 104/3
	ZAE 488/4	Non – Destructive Testing	(S) ZCT 104/3
	ZCE 499/9	Industrial Training	(S) ZAT 394/8 or (S) ZGT 395/8 or (S) ZKT 396/8 or (S) ZMT 397/8

Note:

P : Pass (Grade C and above) S : Sequential C : Concurrent

SYNOPSES OF CORE COURSES

ZCA 101/4 Physics I (Mechanics)

Unit, dimension. Kinematics in one and two dimensions. Vectors in physics. Newton's Laws and application. Work and energy. Conservation of energy and momentum. Collision in one and two dimension. Simple harmonic motion. Universal gravitation, gravitational force. Motion of planets. Extended systems, moment of inertia. Angular momentum, rotational dynamics, compound pendulum. Rigid body, equilibrium, statics. Elasticity, stress, strain and torsion. Young's modulus, shear and bulk modulus. Bending of beams, bending moment. Compression of fluids, surface tension, hydrostatics, viscosity, viscoelasticity. Hydrodynamics, continuity equation, Bernoulli equation, Poisseuille's equation. Turbulent flow, sedimentation, drag.

Learning Outcomes

Upon completion of this course, students are able to:

1. apply the basic principles of mechanics and fundamental laws of physics.
2. study and solve simple problems related to basic principles of mechanics and fundamental laws of physics.
3. analyze problems and search alternative solution for solving simple problems.

ZCA 102/4 Physics II (Electricity and Magnetism)

Coulomb's Law, electric intensity. Gauss's Law, electric flux. Electric potential and electric intensity of point charges, dipole and charge distributions. Capacitance, dielectrics, stored energy. Electric current, resistance, Ohm's Law, Kirchhoff's Law. Microscopic view of current. D.C. RC circuit. Magnetic fields, Ampere's Law, Biot-Savart Law. Faraday's Law. Lenz's Law. Inductance, stored energy, D.C. LR circuit. A.C. current, electric power, RCL circuit. Force on current and moving charge. Lorentz equation, Hall's effect. Dielectric materials, dipole moment, electric polarization. Material resistivity, temperature effect. Electromagnetic waves, electromagnetic spectrum. Magnetic field and electric field vector. Maxwell displacement current, Maxwell equations.

Learning Outcomes

Upon completion of this course, students are able to:

1. explain the basic fundamental physical laws and principles of electricity and magnetism which govern and give meaning to our universe.
2. demonstrate an understanding of scientific methods and the evolution of scientific thought.
3. explain and solve problems related to electricity and magnetism.
4. display basic physical principles and analyze the procedural knowledge to arrive at a solution for some desired unknown, when presented with problem situations.
5. demonstrate mathematical skills necessary to carry an argument from the "given" to the "to find" alluded in (4) above.

ZCT 103/3 Physics III (Vibrations, Waves and Optics)

Equation of motion for simple harmonic motion, damped oscillator, forced oscillator. Logarithmic decrement, resonance and Q factor. Transverse waves and longitudinal waves. The wave equation and its solutions. Reflection and transmission of waves at boundaries. Stationary waves. Superposition of waves. Dispersion of waves. Electromagnetic wave spectrum. Plane electromagnetic waves in vacuum. Propagation of light waves, amplitude and intensity. Doppler effect. Interference, Young's double slits, Michelson interferometer. Multiple reflections, thin films, Newtons rings and Fabry-Perot interferometer. Diffraction grating. Dispersion, Cauchy formula. Polarization, Brewster angle. Light sources and light detectors.

Learning Outcomes

Upon completion of this course, students are able to:

1. explain the basic principles related to vibrations, waves and optics.
2. explain the basic concepts of simple harmonic motion, forced oscillator, longitudinal and transverse waves, nature of electromagnetic waves, interference of light, diffraction pattern and polarization.
3. analyze and solve problems related to vibrations, waves and optics.

ZCT 104/3 Physics IV (Modern Physics)

Special Relativity: Reference frames, invariance of Newton's dynamics. Galilean transformation, invariance for other laws. Michelson-Morley experiment. Postulates of special relativity. Lorentz transformation. Relativistic kinematics and dynamics. Einstein formula. Introduction to modern ideas in Physics: Blackbody radiation, Planck's law. Photoelectric effect, Compton effect, X-rays, Pair production and Pair annihilation, Photon Absorption. Wave-particle duality, de Broglie waves, Heisenberg uncertainty principle, Introduction to Schroedinger equation. Old atomic models. Alpha-scattering, Rutherford model. Old quantum theory and the Bohr model of the atom. Energy levels of the atom and atomic spectra. Excitation and the Franck-Hertz experiment. Bohr's Correspondence Principle.

Learning Outcomes

Upon completion of this course, students are able to:

1. describe the basic ideas in special theory of relativity and quantum theory.
2. explain the conceptual differences between classical physics and modern physics in framing the law of physics.
3. solve problems related to special theory of relativity and quantum theory.

ZCT 106/3 Electronics I

Analysis of circuits. Alternating current circuits. Thevenin's Theorem and Norton's Theorem. Characteristics of diodes and their uses in circuits, rectifying circuits. Signal processing circuits. Bipolar junction transistors and Field effect transistors, input characteristics and output characteristics. Large signal amplifiers, amplification, distortion and frequency response. Power amplifier. Small signal amplifiers and hybrid parameters. Theory of positive and negative feedback. Operational amplifiers and their applications.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the characteristics and operation of components and devices, principles and theory, and apply them to solve electronic circuits.
2. show the ability to design simple electronic circuits with the basic electronic knowledge to solve an operation or problem.
3. display the mature learning skills to study more advanced courses in electronic plus relating it for application in the industry.

ZCA 110/4 Calculus

Calculus:
Sets, real numbers, rational and complex numbers. Functions and graphs. Sequences and series, convergence tests, function limits and properties of limit, continuity, and the mean value theorem. Differentiation techniques, implicit differentiation, higher order differentiation, minimum and maximum values (theory and application), Rolle's theorem, L' Hopital's rule, applications of derivatives. Integration techniques, improper integrals, fundamental theorem, lengths of curves. Trigonometric functions and their inverses, exponential and logarithmic functions, hyperbolic functions and their inverses.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic concepts in differentiation and integration.
2. analyse and identify suitable differentiation law(s) or techniques of integration to be applied in different situations.
3. explain the basic concepts about series.

ZCT 112/3 Linear Algebra and Vector Analysis

Matrices and Determinants: Matrix algebra, determinant, properties of determinant, inverse of a matrix, systems of linear equations, eigenvalues problem and matrix diagonalization.

Vector algebra; definitions, addition, subtraction of vectors, dot products and cross products of vectors, scalar and vector fields, vector transformation; unit vectors. Vector calculus; scalar differentiation, differentiation with respect to time. Gradient, divergence and curl of a vector. Vector integration; line, surface and volume integrals. Green's Theorem, Stokes' Theorem, Gauss's Theorem. Potential theory: scalar potential, vector potential. Coordinate Systems: Cartesian and curvilinear.

Learning Outcomes

Upon completion of this course, students are able to:

1. explain the basic concepts in linear algebra.
2. reproduce the basic vector concepts and further understand main operations of vector calculus and geometric quantities in curvilinear coordinates and its usage in other subjects related to vector.
3. show a sound knowledge and understanding of differentiation and line, surface and volume integrals, perform calculation using gradient, divergence and curl operator as well as Green's theorem, Stokes's Theorem and Gauss's Theorem.
4. relate the vector framework learned for the understanding and study of the advanced engineering, physics and mathematics.

ZGT 161/3 Geology I

Introduction to geology, basic principles and concepts. Origin of the earth. Internal structure of the earth from seismology. Introduction to principles of isostasy. Crustal and isostatic structure of continental margins, mountain ranges, oceanic ridges, plateau uplifts (hot spots). Introduction to continental drift, plate tectonics, sea-floor spreading, passive margins, subduction zones and active margins, extensional sedimentary basins (McKenzie mechanism). Basic mineralogy: properties, composition and structure of minerals. Rock-forming minerals. Composition, textures, structures, formation and classification of sedimentary, igneous and metamorphic rocks. Forms of igneous bodies. Fossils. Geological time scale. Basic stratigraphy: unconformities, diastema, facies, geological correlation. Rock deformation: folding, faulting, joints.

Learning Outcomes

Upon completion of this course, students are able to:

1. explain origin and internal structure of the earth.
2. describe the theory of continental drift, tectonic plate and rocks deformation.
3. describe the concept, characteristics and type of minerals and rocks.
4. justify the concept of geological time scale and describe the fossil formation.

ZGT 162/3 Geology II

External geological processes: mechanical and chemical weathering; erosion and deposition by streams, sea and wind; soil profile. Geomorphology: landforms, valleys, drainage patterns, peneplain; topography of folded and faulted structures. Hydrology: Darcy's law, aquifers, groundwater, artesian wells. Ore deposits: magmatic

differentiation, hydrothermal, sedimentary, supergene, lateritic, alluvial. Petroleum geology: formation and migration of petroleum; structural and stratigraphic traps. Geology of Malaysia: general, structural and economic geology.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain origin and external structure of the earth.
2. describe the weathering concept and describe the soil formation.
3. describe the concept of geomorphology, hydrology and petroleum geology.
4. justify the general geology of Malaysia.

ZGT 190/2 Geology Practical

Experiments in geology.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe and identify the types and properties of mineral.
2. express and identify the rock type and their features.
3. sketch and justify a geological map.

ZCT 191/2 Physics Practicals I

A selection of experiments which are related to physics subjects namely optics, electronics, heat, mechanics and radioactivity: Error Analysis, Mechanical equivalent of heat, Thermoelectric effect, Planck's constant, Radioactivity, AC resonance, Lee's disc, Excitation and ionization, Interference, Electrical measurement, Dynamic.
Students are required to do 6 out of 11 experiments in Semester I. The 'Error Analysis' experiment is compulsory for all students.

Learning Outcomes
Upon completion of this course, students are able to:
1. use the basic concepts of physics during laboratory session.
2. assemble various equipments in the physics laboratory.
3. discuss the experimental data.
4. write a laboratory formal report based on the proposed format.

ZCT 192/2 Physics Practicals II

A selection of experiments which are related to physics subjects namely optics, electronics, heat, mechanics and radioactivity: Error Analysis, Mechanical equivalent of heat, Thermoelectric effect, Planck's constant, Radioactivity, AC resonance, Lee's disc, Excitation and ionization, Interference, Electrical measurement, Dynamic.
Students are required to do 5 out of 11 experiments in Semester II.

Learning Outcomes
Upon completion of this course, students are able to:
1. use the basic concepts of physics during laboratory session.
2. assemble various equipments in the physics laboratory.
3. discuss the experimental data.
4. write a laboratory formal report based on the proposed format.

ZCT 205/3 Quantum Mechanics

Formulation of quantum mechanic. Schrödinger equation. Probability. Observables. Operators and expectation values. Stationary state. Eigen function and eigenvalue. Particle in a box. Harmonic oscillator. Square barrier potentials. Barrier penetration. Central field problem. Hydrogen atom.

Learning Outcomes
Upon completion of this course, students are able to:
1. show an understanding of the basic concepts of non-relativistic quantum mechanics through wave approach.
2. solve moderate quantum mechanics problems mathematically.
3. demonstrate an understanding of the significance of operators, eigenvalue equation, pure and mixed states in quantum mechanics and how quantum mechanics can be used to describe entity in a box, step potential, barrier penetration, harmonic oscillator and hydrogen atom.

ZCT 206/3 Electronics II

Numbers and code system, arithmetic of binary, hexadecimal, and 2's complement numbers. Basic logic, Boolean algebra, de Morgan theorem, and logic circuit analysis. Design of combinational logic circuits, minimization, Karnaugh map, decoder, multiplexer, encoder, and demiltiplexer. Combinational logic elements: basic flip-flop, flip-flop SR, JK, D, and T. Clocked flip-flops. Sequential logic: different types of registers and counters. Sequential timing, synchronous and asynchronous counters and their applications. Arithmetic's unit: adder and substracter. Design of sequential logic systems: state diagram, truth table, and timing diagram. Extension from exited table, circuit design from truth table and timing diagram. Examples of logic circuit applications: memory system, ROM, RAM, memory decoding, and basic architecture of microprocessor system.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic concepts of fundamental digital electronics.
2. explain and analyze the logic circuit, Karnaugh map, combinational logic functions flip-flop, timer,counter shift register.
3. solve problems related to fundamental digital electronics.

ZCT 210/4 Complex Analysis and Differential Equations

Complex Analysis: Functions of complex variable - complex functions. Differentiation of complex functions; Cauchy-Riemann equations, analytic functions, singular points, power series of analytic functions, Taylor series. Zeroes, Singularities and Residues. Laurent series. Complex Integration: Cauchy Goursat theorem, path deformation theorem, Cauchy integral formula. Residue theorem. Applications of residue theorem.
Differential Equations: Ordinary differential equations of first order and methods of solution. Ordinary linear differential equations of second order – homogeneous and non-homogeneous equations and methods of solution. Series solution - power series and Frobenius methods.

Learning Outcomes
Upon completion of this course, students are able to:
1. perform complex number arithmetic, differential, integration and contour integration.
2. analyze any complex integration in physics problems using suitable techniques discussed in lectures.
3. display the skills of solving any normal first order and linear second order differential equations.

ZCT 214/3 Thermodynamics

Simple thermodynamic systems, equation of state, work, heat, first law, internal energy, results of first law, ideal gas. Carnot cycle and heat engine. Second law of thermodynamics, results from second law, entropy, irreversible process. Combination of first and second laws, T-S diagram and thermodynamic relationships. Maxwell equation, Clausius- Clapeyron equation and Tds equation.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the principles of thermodynamics and show how they apply to an arbitrary system.
2. explain thermodynamics phenomena in proper and clear scientific terms.
3. list the procedural knowledge to arrive at a solution for different problem situations.
4. relate and demonstrate mathematical skills necessary to solve problems as in (3) above.

ZCT 215/3 Optics

Polarization. Plane and circular polarization. Reflection and transmission of electromagnetic waves at boundaries. Optical activity. Kerr effect and Faraday effect. Dispersion theory. Diffraction. Fresnel-Kirchhoff equations. Fraunhofer diffraction of a single slit, square and circular aperture. Diffraction gratings and their characteristics.

Fresnel diffraction for circular aperture. Cornu spiral and Fresnel Integrals. Zone plates. Fresnel diffraction for straight edges and rectangular aperture. Quantum optics: laser, fibre optics and light detection.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic concepts related to wave optics.
2. explain the principles of polarization, optical activity, dispersion and diffraction of light.
3. solve problems related to polarized light, optical activity, dispersion and diffraction of light.

ZKT 223/3 Engineering Design

The principal aim of this course is to give students an opportunity to experience the process of carrying out a design project. It will thus enable them to appreciate that design involves synthesizing parameters which will affect the design solution. The topics to be covered include:-
(i) Preparing a design specification.
(ii) Preparing a design report.
(iii) Using computer technology in the design process.

Learning Outcomes
Upon completion of this course, students are able to:
1. carry out a project of design involving synthesising parameters that will affect the design solution.
2. work with other members for solving the design problem and to achieve customer's needs.
3. report the progress of project on design, present and defend the outcome of design.

ZKT 224/4 Electronic and Photonic Materials I

Classes of materials: metals, semiconductors, insulators, single crystals, polycrystals, glasses, ceramics, polymers, bulk materials, thin films, nanostructures. Growth of conducting single crystal material. Thin films growth methods, sputtering, sol-gel, laser ablation, growth of single crystal epitaxial film and multilayers: LPE, VPE, MOCVD, MBE methods. Basic processing of bulk ceramic. Preparation of polymers and glass. Characterization of thin film and bulk material: electrical, diffraction, optical, ion beam microscopy, imaging. Fabrication methods, diffusion, ion implantation, lithography, metallization, dielectric deposition, wet and dry etching. Type of junctions. Materials for light emitting diodes. Materials for lasers. Materials for photodetector and photoconductor. Materials for solar cell. Material for resonant tunneling diode and sensors.

Learning Outcomes
Upon completion of this course, students are able to:
1. define the classification of materials using atomistic and bandgap theories.
2. describe the classification of materials based on their dimensions.
3. explain how the materials are grown, characterized and fabricated.
4. describe the electronic and photonic devices and their corresponding operations.

ZMT 231/4 Human Anatomy and Physiology

This course covers all the levels of structural organization in human body which are chemical level, cell level, tissue level, organ level and system level. The anatomical structure and functions for each level are also discussed.

Learning Outcomes
Upon completion of this course, students are able to:
1. define the terms associated with human anatomy and physiology.
2. explain the levels of structural organization in human body.
3. explain the 10 human systems, its associated organs and the functions of the organs.
4. understand and explain the functions of each system in order to maintain the balancing of the activity in the human body.

ZGT 271/3 Geophysical Data Analysis

Characteristics of geophysical, meteorological and oceanographic data and special requirements for their analysis. Laplace, Hilbert and Hankel transforms. Dirac delta function. Fourier series. Continuous, discrete and fast Fourier transforms. Power spectra, noise. Correlation, convolution and deconvolution. Basic filters. Basic statistical analysis. Sampling. Applications in geophysics, meteorology and oceanography.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe the basic concepts related to mathematical operators used in geophysical data analysis.
2. select a suitable operator for each application.
3. solve problems related to the application of these operators in signal analysis.

ZGT 265/3 Meteorology I

Introduction: Structure, composition, layering, pressure, density and temperature-height profile of the atmosphere. Atmospheric thermodynamics: dry adiabatic lapse rate, thermodynamic laws, hydrostatic balance, geopotential, humidity, hipsometric equation, adiabatic process, tepigram. Parcel method, static energy. Thermal stability. Radiation: radiative transfer, global radiation budget, greenhouse effect, effective temperature. Pressure gradient force, local wind systems. General circulation, single and three cell

models. Clouds: Development of cloud droplets, growth of raindrops by condensation, collision, coalescence. Cloud dynamics, rain and snow. Local storms.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic concepts of meteorology.
2. apply and identify the meteorology phenomena such as air temperature and seasons.
3. explain and analyse weather data and the weather maps.

ZGT 266/3 Solid Earth Geophysics I

Earthquakes, what and where. Properties of elastic wave propagation. Knott's and Zoeppritz's equations. Seismic waves at distances of 0-10^{o}, 10-103^{o}, > 103^{o}. Travel time tables and the IASPEI 91 velocity model. Recording systems, instrument frequency properties and seismometry. Strong motion analysis. Structure and composition of the crust, mantle and core: crust, Mohorovicic discontinuity, mantle, transition zone and core. Earth rheology: effect of stress, mantle viscosity, shock wave experiments. Thermal history of the earth: submarine and terrestrial heat flow, temperature distribution. Geochronology: radioactivity, age determination methods such as the Rb-Sr, K-Ar, U, Th-Pb, Pb and Carbon-14 methods.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic concepts of earthquakes and structure of earth interior.
2. explain the principles of elastic wave propagation and seismic wave.
3. analyse the models related to the plate tectonic movements.

ZGT 267/3 Solid Earth Geophysics II

The earth and the solar system, Kepler's laws, sunspots, solar flares, prominences, photosphere, chromosphere, corona. Fundamentals of potential field theory. Rotation, gravity field and shape of the earth. Principles of isostasy. Earth tides. Geomagnetism, secular and diurnal variations, dynamo theory, paleomagnetism, rock magnetism.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic theory related to the earth and the solar system.
2. explain the theory of potential field.
3. classify the principles of isostasy and geomagnetism of the earth.

ZGT 268/3 Exploration Geophysics I

Introduction to seismic methods: seismic waves, reflection, refraction, diffraction. Geophones, hydrophones, energy sources, recording equipment. Position-fixing methods. Seismic reflection method: data acquisition on land and offshore, data reduction, processing, velocity determination, interpretation, applications. Seismic refraction method: data acquisition, reduction, processing, interpretation, applications.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe the basic theory related to the seismic methods in exploration geophysics.
2. describe and explain the theory and practices of seismic methods.
3. classify the field procedure and interpretation techniques in seismic methods.

ZGT 269/3 Exploration Geophysics II

Theory and practice of potential field methods for geophysical exploration, including the gravity method, the magnetic method and electrical methods. For each method details covered include a description of equipment used, field procedures, nature of data acquired, methods of data processing and interpretation and applications.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe basic theory related to the potential field methods in exploration geophysics.
2. describe and explain the theory and practices of potential field methods.
3. classify field procedure and interpretation techniques in potential field methods.

ZAT 281/4 Introduction to Microprocessors

Design of microcomputer systems: history and development, architecture, sequential design, and organization. Design of microprocessor systems: internal bus structure, instruction and machine cycles, and instructions flow in CPU. Functions of CPU: ALU, decoder, program counter, instructions register, address data and control registers. Data transfer and timing diagrams. Microprocessor instructions, and assembly language programming. Assemblers and cross assemblers. Interrupts: software and hardware. Interface: memory, input and output port ADC, DAC. Series and parallel ports: RS232, UART/DUART, PIT, buffer, and other peripheral devices. Introduction to current microprocessor systems.
Laboratory: Data Input and output, delay subroutine, ADC, DAC. Seven segments or LCD display interface. Controller: DC motor, IR sensor, motor speed, and temperature sensor. Signal generation and transmittance via optical fibres.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain and interpret the architecture of microprocessor system
2. explore and manipulate the 68000 microprocessor system
3. write and interpret assembly language programming
4. correlate the 68000 microprocessor system with other systems

ZAT 283/3 Instrumentation

This course introduces the students to the concept of instrumentation process control and the engineering of related devices such as sensors, transducers, operational amplifiers and actuators.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe the key elements of instrumentation control process system that include measurement, comparison, control and actuation
2. explain the design and operation of various types of transducers, operational amplifiers and actuators, and select the best device for a certain function relating to control process system
3. solve accuracy problems related to transducer calibration and discuss the advantages and disadvantages of various types of transducer

ZCT 293/2 Physics Practicals III

A selection of experiments related to physics subjects namely optics, electronics, mechanics and Modern Physics: Spectrometer Grating, Statistical Analysis for Radioactive Measurement, Micro Wave, Variable Pendulum, Single-Slit and Double Slit Diffraction, Back Scattering Of Beta Ray, Laser Interferometer, Stefan Constant, Vacuum Technique, Tin Lead Phase Diagram, Computerized Spectrometer Grating, Interference Microwaves, DC

Power Pack, Franck Hertz, Class A Amplifier, Pulse Circuit, Quinke Method, Tensile Test, Measuring Velocity of Lights, Thermal Expansion, Hall Effect, Beta Ray Absorption, Transistor, Poisson Ratio for Glass.

Learning Outcomes
Upon completion of this course, students are able to:
1. demonstrate experimental and analytical skills.
2. explain the data and discuss the result.
3. initiate new ideas through independent learning.

ZGT 295/4 Geophysics Practical (two semesters)

Experiments in geophysics and Geophysical Field Camp.

Learning Outcomes
Upon completion of this course, students are able to:
1. measure and study subsurface properties of the earth using various geophysical equipments.
2. organize geophysical field survey.
3. Study, analyse and identify advantages and limitations of each geophysical method.
4. elaborate and solve problems related to application of geophysical methods.

ZKT 296/6 Photonics Laboratory

Selected experiments in basic photonics application such as reflection, refraction and optical waveguiding experiments to more complex experiment such as erbium doped fibre amplifiers and opticla network analysis experiements.

Learning Outcomes
Upon completion of this course, students are able to:
1. perform the photonics experiments in fundamental and complex fibre optic communications.
2. perform good practices in experimentation including keeping a lab book and maintaining the cleanliness the experiment station.
3. report experimental results with manuscript quality.

ZKT 297/3 Practical Training

Students will be introduced to the various basic processes commonly found in machine and electronic workshops. They will be allowed to work on some of these processes. Elements of safety will be emphasized. Students will also be introduced to the basics of technical drawing and they will be given opportunities to practice independent design and analysis. As such students will be required to design and build simple physical models/products based on sound engineering principles and design criteria discussed in previous courses.

Learning Outcomes
Upon completion of this course, students are able to:
1. perform the operation of the machine following all precautionary measures security.
2. using the equipment at the electronics workshops follow all security measures.
3. using knowledge is learned to implement project projects in machine and electronics workshops.

ZMT 298/2 Medical Physics Practical

The principal aim of this course is to expose students to some medical physics experiments. This course also helps student to plan and perform the experiment, acquire and analyze data, and writing report.

Learning Outcomes
Upon completion of this course, students are able to:
1. follow the instructions of the experiment and perform the experiment.
2. analyze the acquired data.
3. report the experimental result.

ZCT 304 /3 Electricity and Magnetism

Revision of vector analysis, vector calculus, basic theorems, curvilinear coordinates, and Dirac-delta function. The Coulomb Law. Electric fields, E. Divergence of E. The Gauss's Law. Curl of E. Gradient of E and electrical potential, V. Electrical dipoles. The Poisson's and Laplace's equations. Electrostatics field in dielectric medium. The Gauss's law for dielectric. Displacement vectors. Polarization. Electric susceptibility and dielectric constant. Electrical boundary conditions. Electrical potential energy for dielectric medium. Magnetic fields. The Biot-Savart's law. Divergence of B. Magnetic potential vector, A. Curl of B. The Ampere's circuit law. Magnetic dipoles. Electromagnetic induction. The Faraday's induction laws. Magnetic materials. The Maxwell's equations. Polarization of electric fields. The Poynting theorem. Electromagnetic boundary conditions. Propagation of electromagnetic waves in free space. Propagation of electromagnetic waves in material medium.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic concepts involving electricity and magnetism.
2. identify suitable mathematical methods for different configurations.
3. analyze and solve advanced problems related to electricity and magnetism.

ZCT 307/3 Solid State Physics I

Crystal structure, classification of interatomic binding in crystals. Diffraction, reciprocal lattice, Brillouin zone, lattice vibration, dispersion curve, specific heat-models of Einstein and Debye. Free electron theory for metals, electrical conductivity, electron gas heat capacity. Band theory of solids, Kronig-Penney model, holes, effective mass. Semiconductor - intrinsic and extrinsic. Carrier density. Conductivity of impurities, Hall effect. Optical properties: absorption processes, exciton, photoconductivity.

Learning Outcomes
Upon completion of this course, students are able to:

1. differentiate the crystal structures of various solids.
2. display an understanding how the properties of a crystal are related to its structure.
3. explain problems that are related to crystals.

ZCT 314/3 Statistical Mechanics

Characteristics of macroscopic and microscopic systems. Probability concepts and counting of states. Postulate of equal a priori probabilities. Microcanonical Ensemble. Definition of absolute temperature and entropy. Canonical Ensemble. Statistics of ideal quantum gases. Maxwell-Boltzmann statistics. Bose-Einstein statistics. Fermi-Dirac statistics. Applications of quantum statistics: specific heat of solids, black body radiation, conducting electrons in solids.

Learning Outcomes
Upon completion of this course, students are able to:
1. demonstrate the understanding of basic statistical physics methodology in describing the behaviour of macroscopic physical systems.
2. explain macroscopic thermodynamical phenomena in proper and clear statistical mechanics terms.
3. list the procedural knowledge to arrive at a solution for different simple systems.
4. demonstrate mathematical know-how necessary to solve problems as in (3) above.

ZKT 321/3 The Engineer in Society

Engineering profession – duties, responsibilities, work culture, professionalism. Impact of technology on society and environment – responsibility of engineers to develop useful, safe and economical products for the society. Code of ethics and professionalism of the engineer – themes of ethics, views of ethical conduct, meaning of responsibility, ethical dilemma, code of ethics, corporate social responsibility.
Basic skills in management and law – globalization impact, organizations, types of managers, management processes and approaches, behavioral management.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe the engineering discipline and identify the good qualities of an engineer.
2. explain the ethical issues of engineering profession and justify the decisions to solve ethical problems.
3. explain the basics of management and industrial laws.
4. demonstrate results of critical thinking in problem-based projects and practice leadership roles.

ZMT 334/3 Physics of Diagnostic Radiology

This course covers the aspects that relate to the X-ray. It included X-ray production (X-ray tube and generator), interaction of X-ray in human body, X-ray imaging modalities

such as fluoroscopy, tomography and mammography.Beside that, radiation hazards associated with diagnostic radiology and quality control & testing of radiographic X-ray machine are also discussed.

Learning Outcomes
Upon completion of this course, students are able to:
1. understand and distinguish the basic concepts between conventional and digital radiography
2. explain the work operation of fluoroscopy, tomography and mammography
3. explain the radiation hazards associated with diagnostic radiology
4. explain the current technology in diagnostic radiology
5. understand and explain the factors and parameters associated with film image quality as well as quality control and testing of radiographic X-ray machine

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ZMT 335/3 Physics of Radiotherapy and Nuclear Medicine

This course provide identification to radiotherapy and nuclear medicine. This can prepared student from physics fundamental in radiotherapy and nuclear medicine. At the same time this course will allocate the profesionalism, value, behaviour and ethic when dealing with radiotherapy and nuclear medicine sourses.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic concepts related to radiotherapy and nuclear medicine.
2. classify the radiotherapy and nuclear medicine equipments.
3. explain the dose distribution and analyze the scattered radiation in radiotherapy.
4. classify the radionuclide properties used in nuclear medicine.
5. perform safety aspect related to radiotherapy and nuclear medicine sources.

ZGT 372/3 Introduction to Oceanography

Shape of ocean basins, continental margins, morphology of the ocean floor. Temperature, salinity and density distributions in oceans. Light and sound in sea water. Composition of sea water, chemical and biological reactions in sea water. Air-sea interaction, heat and water cycles. Causes of instability in oceans. Ocean circulation, current measurement. Causes of currents; pressure gradient, Coriolis forces, geostrophic flow, wind-driven circulation. Waves and tides. Marine biology.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe basic principles of ocean structure and movement.
2. describe and differentiate the fundamental laws governing the ocean.
3. explain several basic ocean phenomena.

ZGT 374/4 Remote Sensing

Fundamental theory of remote sensing: units of measurement, electromagnetic energy, electromagnetic spectrum, image characteristics, vision, sources of remote sensing information. Aerial photography: interactions between light and matter, film technology, characteristics of aerial photographs, black-and-white photography, colour science, infra-red colour photography, spectral reflectance, multispectral photography and imagery, sources of aerial photographs. Sensors for environmental monitoring, sensor platforms, sensor packages and satellite data distribution. Radar, LANDSAT, thermal infra-red and remote sensing applications in meteorology: weather analysis and forecasting, remote sensing of the atmosphere. Satellite data applications in meteorology, global climatology, atmospheric moisture distribution, synoptic climatology of weather systems, water in the environment, hydrometeorology, surface hydrology, hydrogeology and oceanography. Remote sensing of soils and landforms by photography. Applications in geological mapping, resource exploration, hydrology, water pollution, etc.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain basic concepts used in remote sensing related to spectral regions and data acquisition techniques.
2. apply remote sensing techniques to retrieve information from remotely sensed data
3. analyze remote sensing images using basic image processing analysis.

ZAT 386/4 Physics of Semiconductor Devices

Energy band, density of states, intrinsic semiconductor, electron and holes conduction, extrinsic semiconductor, impurities, impurity level, Fermi level, carrier concentration; Hall effect, impurity motion, minority carrier lifetime, recombination process, diffusion length, semiconductor surface, semiconductor-metal contact, semiconductor insulator contact; Ge, Si and III-IV compounds; p-n junction devices inclusive of Zener diode, tunnel diode, varactor, variator; single junction transistor, field-effect transistors inclusive of junction FET and metal oxide semiconductor FET (MOSFET), silicon controlled switch (SCS), Schotky diode and phototransistor, solar cell and semiconductor laser.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain, differentiate and relate the theory and properties of semiconductor.
2. identify, explain, track and understand the design and integration of semiconductor devices.
3. explain, discuss and evaluate the characteristics of semiconductor devices.

ZAT 394/8 Applied Physics Project and Seminar (two semesters)

This course combines the basic knowledge and continuous learning and realized in the form of a scientific project. The success of the student is evaluated in term of the ability to conduct and accomplish the project well through a final year report. The report will explain the quality of the work and the objectives achieved. At the end of the course the student will present the output of the project before the supervisor and an examiner and this will instill the confidence in the student. The seminar component consists of visits to industrial factories and colloquium given by the experts in related fields will widen the horizon in the student's mind in order to see the expectations from outside world before completing the studies.

Learning Outcomes
Upon completion of this course, students are able to:
1. utilise theories for practical work.
2. report research results through scientific writing.
3. participate and report knowledge derived from scientific seminars and industrial visits.
4. present and defend project findings.

ZGT 395/8 Geophysics Project (two semesters)

Project in geophysics or related fields.

Learning Outcomes
Upon completion of this course, students are able to:
1. analyse and measure basic parameters related to geophysical investigation.
2. justify geophysical anomaly from the acquired data set.
3. organize, elaborate and conclude the findings of the study.
4. solve problems related to geophysical investigation.

ZKT 396/8 Engineering Physics Projects (two semesters)

Project/experiment of related areas of thrust in Engineering Physics programme.

Learning Outcomes
Upon completion of this course, students are able to:
1. form an effective coordination with the project partner and conduct a physics project successfully.
2. perform project activities including independent work, critical thinking and literature review.
3. write project thesis that includes methodology, results, analyses and conclusions from the project.
4. present the outcome of the project successfully.

ZMT 397/6 Medical Physics Project (two semesters)

This course covers the involvement of students in planing and perform a project which related to radiation biophysics, radiology, radiotherapy and nuclear medicine field.

Learning Outcomes
Upon completion of this course, students are able to:
1. study the literature review.
2. write the project report.
3. present the work in a seminar and viva-voce.

ZCE 431/4 Radiation Biophysics

Interaction of radiation with matter. Interaction mechanism of photons and electrons with matter. Interaction of neutrons, alpha particles, heavy nuclei and nuclear fission fragments with matter. Detection and measurement of radiation. Radiation dosimetry. Production of radionuclides and its use in tracer techniques. Biological effects of radiation.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the interaction mechanism of ionizing radiation with matter.
2. explain the concepts of the detection and measurement of radiation.
3. explain the process of production of the radionuclides and its use.
4. explain the biological effects of radiation.

ZAT 487/4 Semiconductor Fabrication Processes

Growth of semiconductor ingot, preparation and characterization of wafer, oxidation and lithography process. Diffusion of dopant and creation of junction. Metallization. Characterization of junction,example junction depth, etc. Thin film techniques, integrated circuit development, bonding and packaging.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe and relate all processes used in semiconductor wafer and device fabrication to the physics concepts of these processes.
2. fabricate a device and explain its parameters, starting from bare silicon wafers, all processing steps from beginning to end and wafer characterization during the process.
3. demonstrate the completed devices and create a report based on results obtained.
4. understand and participate in the role rotation as group leader and group member in laboratory work.

ZAT 489/3 Low Dimensional Semiconductor Structures

The course starts with basic exposure on the structural and electronic properties of thin films that formed the heterostructure. Characteristics of energy gaps at the interfaces of the semiconducting layers are then studied and discussed for AlGaAs semiconductors. These include discussion on the formation of wells and barriers. Optical absorptions in the wells are discussed and compared between classical treatment and quantum calculations using Fermi's Golden Rule. Electron transitions between energy levels are identified for special cases).

Learning Outcomes

Upon completion of this course, students are able to:

1. explain, differentiate and relate the properties of semiconductor heterostructures and their related low dimensional systems.
2. solve and identify simple quantum well problems and conclude the results for different wells.
3. appreciate the role of electron trapping in creating electrons with two dimensional behavior.
4. use Fermi's Golden Rule to explain optical absorption for quantum wells of various shapes.
5. explain optical properties of quantum wells related to different optical devices.

SYNOPSES OF ELECTIVE COURSES

ZCE 111/4 Computational Approach in Physics Learning

Introduction to programming package, importing and exporting of files, data manipulation and visualization, interpolation, extrapolation and fitting of data points, numerical root-finding, solving first and second order differential equations numerically, numerical integration, visualization of geometry in two and three dimensions, simulation of motion in classical physics, simulation of wave propagation, simulation of electrostatic and magnetostatic fields.

Learning Outcomes

Upon completion of this course, students are able to:

1. Identify and understand basic concepts of software applications in the development of simple algoritams.
2. Explore and apply techniques and strategies of programming to solve problems in physics learning.
3. Show potential in computer software package applications for visualization, manipulation and processing of data.

ZCT 219/4 Mathematical Method

Integral transforms: general properties. Laplace transform: general properties, applications in physical problems. Fourier transform: general properties, applications in physical problems. Special functions/equations: Gamma, Bessel, Legendre and Associated Legendre. Fourier Analysis: expansion of functions in terms of sine and cosine, properties, physical examples. Partial differential equations: Sturm – Liouville boundary value problems. Wave equation, Heat equation, Laplace equation - solution by separation of variables technique.

Learning Outcomes

Upon completion of this course, students are able to:

1. show the understanding of the two integral transforms i.e. Fourier and Laplace transforms.
2. identify the Bessel, Legendre and associated Legendre functions as the solutions of the Bessel, Legendre and associated Legendre equations, respectively.
3. determine Fourier series representation for a cyclic function.
4. solve heat, wave and Laplace equations (finite case only) using the separation of variables technique, including expressing the solution in terms of Fourier series.

ZCE 275/4 Introduction to Astronomy

Celestial mechanic. Measurement of time. The Sun and solar system. Structure of the Universe. Astronomical Instrumentation. Other astronomy. Practical.
Celestial sphere, celestial coordinate system, celestial mechanic, ephemeredes, star charts. Time and its measurements, calendrical system. Optical telescopes, mounting, tracking telescope. The Sun and its associated motion, structure of the Sun, its influence on the Earth. The solar system, eclipses. Structure of the universe, stars stellar evolution, H-R diagram, white dwarfs, pulsars, black holes. Galaxy, the Milky Way, evolution, active galaxies, cosmology. Other astronomy – radio, IR, UV, x-ray and gamma ray astronomy.
Understand, handle and observe through optical telescopes. Recognizing stars and constellations. Observe and record celestial objects. Solar observation using filters. Build a simple telescope. Young crescent moon observation. Astrophotography, Image processing. Sky simulation and calculate locations of celestial objects and others.

Learning Outcomes
Upon completion of this course, students are able to:
1. define, interpret, explore and explain the basic foundations of astronomy.
2. recognize, assemble and manipulate astronomical instruments.
3. recognize and elaborate on the physical objects in the universe and relate them with physical theories.

ZGE 277/4 Structure of the Universe

Size & content of the Universe. Electromagnetic waves as carriers of information; The Solar System (Earth, Moon, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune & Solar System debris); Exoplanets; The Sun & stars; The interstellar medium; Stellar formation, evolution and explosions; Neutron stars & black holes; The Milky Way Galaxy; Galaxies & Dark Matter; Cosmology & the early Universe; Life in the Universe.

Learning Outcomes
Upon completion of this course, students are able to:
1. understand, evaluate and appreciate the structure and beauty of the universe;
2. relate the components that make up the universe;
3. trace and determine the physical processes operating within it.

ZAE 282/3 Materials Science

Introduction. Structure: Crystal structure and imperfections, phase diagrams, phase transformations, diffusion, deformation of materials, strengthening mechanisms and microstructures, corrosion and oxidation. Materials: Iron, steel and ferrous alloys, non-ferrous metals and alloys, polymers, ceramics, composites.

Learning Outcomes
Upon completion of this course, students are able to:
1. define the properties, structures and uses of engineering materials and also evaluate the impact of material selection, material performance of a structure or mechanism due to the relationship between macroscopic properties and microscopic causes.
2. draw unit cells for crystal structures, describe crystalline planes using Miller indices and compute density.
3. describe types of point defects and dislocation defects in crystalline solids and able to distinguish between steady state and non-steady state diffusion in solids and apply Fick's laws to solve simple diffusion problems.
4. define engineering stress and strain, and interpret a stress-strain diagram.

ZCE 305/3 Atomic and Nuclear Physics

Atomic structure: Hydrogen atom. States in hydrogen atom. Angular momentum. Many electron atom. Electron spin. Pauli exclusion principle. Symmetric and Antisymmetric wave functions. Spin orbit coupling. LS and JJ coupling. Atomic spectra. Selection rules. One valence electron-atom. Zeeman effect, Normal and Anomalous. Nuclear structure: General properties of nuclear - composition, size, form, mass and atomic nuclear charge. Nuclear force and deuteron problem. Radioactivity, alpha decay, gama decay, electron capture. Internal conversion. Nuclear reactions. Nuclear models and magic numbers.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the origin, the general procedure and feature of atomic quantum theory.
2. explain the spectra of hydrogen, alkali metals, helium and other many electron atoms.
3. differentiate the mechanisms of radioactive decay and other nuclear reactions.
4. distinguish the principles of fission, fusion and nuclear power.

ZKE 322/3 Electronic and Photonic Materials II (Special Topics)

Ferroelectrics:
Basic ideas. Displacive ferroelectrics. Relaxor ferroelectrics. Landau theory of displacive transitions. Susceptibility divergence. Materials design of perovskite ceramics for specific applications. Properties of PZT family. Applications of bulk type ferroelectrics; capacitors, pyroelectric detectors, strain sensors and actuators, nonlinear optic crystals. Applications of ferroelectrics thin film; capacitors, DRAM elements in ICs.
Processing routes and integration with IC technology.
Liquid crystals:
Basic definitions. Nematic ordering, definition of direction. Alignment of direction by electric and magnetic fields and by pinning at surfaces. Free energy in direction of divergence and curl. Electric field alignment and Frederiks transitions. Optical anisotropy. Rotation of optical polarization in pure twist cell. Chiral molecules and

cholesteric ordering. Pitch of cholesteric spiral and variation with temperature. Smectic ordering. SmA, SmC and SmC*. Simple applications in display devices. Twisted nematic display cell and operation. Dipole switching of SmC* cells and possible applications. Definations of B, H, M. Hysteresis loops of ferromagnets, materials, domain walls. Ferromagnetic thin film. Microwave applications and ferrite devices.

Learning Outcomes

Upon completion of this course, students are able to:

1. define ferroelectrics materials and properties; Piezoelectric and pyroelectric materials, devices and applications.
2. sketch the structure of ferroelectric and ferromagnetic materials and the structure of liquid crystals display.
3. describe types of ferroelectric, ferromagnetic and liquid crystals.
4. define the advantages and disadvantages of different applications and integration with technology.

ZKE 323/3 Electronic and Photonic Devices and Systems

Electronic Devices: Zener Diode, Tunnel Diode, FET, MOSFET, UJT, SCR. LASCR, Programmable Logic Controller (PLC). Source and Detectors: Lamps, LEDs, lasers, PMT, Photodiodes, Phototransistors, Infrared and Microwave Sources and Detectors. Electro-optic Devices: Magneto-optic and acousto-optic modulators, optical switches, liquid crystal display and TV, CCD, integrated optics. Optical Instruments: Microscopes, Interferometer, Radiometer.

Learning Outcomes

Upon completion of this course, students are able to:

1. explain the principles of operation of several electronic, photonic, electro-optic and acousto-optic devices.
2. explain the concept of devices application in electronic and photonic systems.
3. demonstrate the importance of certain parameters in the design of system based on electronic and photonic devices.
4. perform calculations that involve electronic and photonic devices and systems performance.

ZKE 326/4 Signal and Image Processing

Digital image and signal processing system; processors, digitizer, digital computer, storage, display, scanner.

Sampling and quantization; image geometry, frequency domain, image and signal transformations: Fourier transform, discrete Fourier transform, 2-D Fourier transform,

Laplace transform, convolution, fast Fourier transform, Walsh transform, discrete cosine transform, Hotelly transform and Hough transform.

Signal detection in frequency domain, power spectrum, filters. Encoding, different pulse code modulation.

Image enhancement, histogramming, smoothing, sharpening, thresholding, edge detection, spatial mask, linking. Image representation and description.
Industrial vision system; automated visual inspection, process control and assembly application. Holography.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain all basic principles in digital signal and image processing and display including acquisition, processing and enhancement.
2. explain image and signal transformation.
3. relate the knowledge with the industrial applications.
4. explain all basic principles of digital signal and image processing including acquisition, processing and enhancement.
5. describe image and signal transformation.
6. Correlate knowledge with industrial applications.

ZKE 327/3 Solid State Lighting I

Solid State Lighting I will cover a brief introduction to semiconductor material systems and growth techniques used for producing light emitting diodes (LEDs). The basic of structures, properties and operation as well as other applications of LEDs will be taught.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the basic structures, properties and operation as well as other applications of light emitting diodes.
2. understand and explain the fabrication of LEDs, from the aspects of growth until metallization process.
3. know and differentiate the characterization techniques for LEDs.

ZME 336/4 Medical Instrumentation

The course will expose the students to the various modern diagnostic instrumentations; in particular X-rays, magnetic resonance imaging, ultrasound, medical lasers, microscopy and computers in medicine. The course will helps student to be capable of intelligent self-supervision of such equipments.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the X-ray tube structure, describe the fundamentals of X-ray generator and discuss about X-ray production and detection.
2. explain gamma camera components, MRI instrumentations, ultasound, medical lasers, optical and electron microscope.
3. discuss the hazards and aplications of lasers in medicine.
4. discuss various computer applications in medicine.

ZCE 341/4 Energy Studies

Brief history of energy use. Energy situation in Malaysia. Introduction to renewable energy, Types of renewable energy: solar thermal, solar photovoltaic, biomass, hydro, wind, geothermal. Sunlight and spectrum distribution of sunlight. Solar thermal and solar photovoltaic collectors. Solar cell technology. Biomass and bio-energy. Biomass energy conversion process: direct combustion, pyrolysis, gasification, fermentation and anaerobic digestion. Hydro power. Wind power. Geothermal.

Learning Outcomes
Upon completion of this course, students are able to:
1. identify the alternative sources of renewable energy and explain the need for renewable energy.
2. explain the main processes for power generation and be able to use relevant and clear scientific terms.
3. explain and discuss about energy efficiency from renewable energy. Analyse and solve problems related to renewable energy.

ZGE 364/3 Tropical Meteorology and Forecasting

Introduction; radiation processes in the tropics (the input and energy received at the earth's surface). Circulation in the tropics, the ITCZ, trade-wind inversion, cumulus convection. Tropical disturbances, their structures and theories according to different regions: the tropical cyclone, warm low pressure, squalls, tornado, Hadley circulation, the easterly waves. Equatorial atmospheric features: equatorial waves, Kelvin waves, mixed Rossby-gravity waves. Analysis of synoptic charts in the tropics (streamlines, isotach and satellite images).Tropical scalar analysis (continuity equation). Theory: barotropic instability, barotropic-baroclinic instability, instability of the first, second kinds, CISK, parcel and slice methods. The flow features, structure of the monsoon waves. Interaction and variability of the monsoon and its relationship with the higher latitudes (north and south). Disturbances over peninsular Malaysia. Short and long range forecasting (statistics and numerical modelling).

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the concepts of tropical circulations.
2. analyse and identify the equatorial atmospheric features.
3. exhibit, justify and select the model used for the short and long range forecasting.

ZGE 370/3 Meteorology II

Air motion: Coriolis force, gravity effect, pressure gradient, friction, equations of motion, scale analysis. Horizontal flow: geostrophic, thermal, gradient winds, continuity equation. Weather and climate, weather modification, boundary layer. Air pollution meteorology, ozone layer, air-sea interaction. Introduction to numerical modelling. Lightning and biometeorology. Meteorological instrumentation and data acquisition techniques. Weather systems, climatological variability due to winds.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain advanced concepts related to the meteorology phenomena.
2. analyse and identify meteorological phenomena such as air masses, tornadoes and hurricanes.
3. analyse weather forecasting models.

ZAE 376/4 Astronomy Principles and Practices

The universe at a glance. Spherical trigonometry. Celestial sphere. Celestial coordinate system. Reckoning time. Calendrical systems. Positional astronomy python programming. Astrometry. Radiation laws. Observation and measurement system.

Learning Outcomes
Upon completion of this course, students are able to:
1. know and understand principles of measurements in astronomy.
2. use, detail and illustrate a few main astronomical instruments.
3. understand how astronomical measurements are made and able to perform simple astronomical calculations.

ZKE 378/4 Introduction to Radio Astronomy

History of radio astronomy. The radio universe. Cosmic microwave background (CMB). Radio telescopes. Radio interferometry. Image systhesis. Active radio stars. Active radio galaxies.

Learning Outcomes
Upon completion of this course, students are able to:
1. understand and affirm the principles of radio astronomy.
2. recognize and elaborate receiving and data processing instruments.
2. recognize and appreciate the contributions of radio astronomy to knowledge.
4. relate radio data with physical processes in the region.

ZKE 427/3 Solid State Lighting II

This course will cover introduction to light emitting diode (LED), LED electrical and optical properties, as well as visible-spectrum LED made from III-V semiconductors. It will introduce areas such as human vision, packaging, photometry, calorimetry, color mixing and also thermal analysis including junction and carrier temperatures that affects the device performance.

Learning Outcomes

Upon completion of this course, students are able to:

1. identify light emitter diode and understanding the detail characteristics of electricity and light emitter diode optics.
2. explain the basis and the characteristic of material which have spectrum visible light and ultra purple and also capable to design and simulate the DBR reflector for light extraction.
3. calculate and analyse thermal resistance network in various junction temperature of the heat flow of one dimension and explain calorimetry principle, photometry measurement and rendering colour in light emitting diode.

ZME 432/4 Medical Lasers

The course will expose the students to the interactions of lasers with tissues, medical laser optical fibre, types of medical lasers and their clinical applications. The course will help student to understand laser classifications and radiation hazards as well as laser safety and management of laser equipments. Topic on regulatory aspect of non-ionising radiation (NIR) safety will aslo be highlighted.

Learning Outcomes

Upon completion of this course, students are able to:

1. explain tissue response to laser exposure.
2. explain safety aspects of laser usage.
3. discuss laser hazard and its application in medical field.

ZME 438/4 Physics of Medical Imaging

Photography process, solid state detector and CCD. Signal/noise and sensitivity. Calibration, horizontal field and splitting technique. Digitizer and plate scanner. Hardware for image processing, software techniques, histogram, convolution, fringe upgrading, Fourier techniques and slit synthesis. Discrete, 2-D, and fast. Fourier transforer. Laplace, Hough, Walsh and Hotelly transforms and their applications.

Information acquired from imaging such as data acquired in CT, MRI, angiography, infrared and ultrasound imagings.

Physical factors that may be considered in each technique to enhance imaging information.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain all basic principles of digital image processing.
2. analyse digital images.
3. explain the process of image acquisition, enhancement, storage, format, and display.
4. discuss the principles of image processing and its applications in medical imaging equipments systems.

ZCE 451/3 X-ray Analysis

X-ray production using Coolidge tube and the synchrotron methods with definition of crystal and its symmetries. Point groups, Laue groups and space groups from triclinic, monoclinic and orthrhombic systems. Miller indices, zon axis, Weiss zone laws. Derivation of the structure factor equation and proof of Friedel's law. Limiting conditions for various translational symmetries and Bravais lattices. The Bragg's law in equation form as well as in the Ewald sphere construct. Electron map diagrams. X-ray fluoroscence, instrumentation and execution. Wavelength dispersive and energy dispersive methods. Qualitative and quantitative methods. The power method with specific application for cubic crystals. The cell parameter using actual experimental data.

Learning Outcomes
Upon completion of this course, students are able to:
1. relate how the structure of a molecule is derived through the x-ray crystallography method.
2. apply and analyse the X-ray fluoroscence and the powder methods.
3. sketch, label and elaborate X-ray analysis instruments.
4. explain and justify the role of each X-ray analysis method.

ZGE 460/3 Synoptic Meteorology

Introduction to surface weather charts, the plotting meteorological codes. Air mass: features, classification, modification. Features of the frontal system, its structure and theory (classical Bergeron theory and current theory). Horizontal advection theory and the continuity equation. Non-frontal low pressure systems e.g. typhoons and tornadoes. General features of the anticyclone: warm and cold anticyclones. Development of the cyclonic system, shearing and curvature for cyclonic and anticyclonic flow. Divergence, convergence and vertical motion. Relative vorticity, potential vorticity and absolute vorticity and their relation to divergence and convergence. Features of long waves: structure and theory. Observations and analysis at the surface and upper levels. Weather forecasting: numerical modeling.

Learning Outcomes
Upon completion of this course, students are able to:

1. explain the concepts related to a large-scale weather system.
2. analyse and identify a large-scale weather system.
3. justify and analyse a model used for weather forecasting.

ZGE 461/3 Advanced Geology

Depositional environments; sedimentary facies. Facies models: alluvial fan, fluvial plain, sandy desert, lake, coast, delta, glacier, terrigenous shelf, carbonate shelf, continental slope, continental rise, basin plain, sub ducting plate margin, oceanic ridge and oceanic basin. Stratigraphic framework and structural styles in petroleum exploration. Basin analysis.

Learning Outcomes
Upon completion of this course, students are able to:
1. generalize the depositional environments, sedimentary facies and facies models.
2. explain the reservoir rocks and sedimentary basin.
3. describe the rock porosity, permeability, diagenesis and stratigraphy.
4. justify aspects related to hydrocarbon production and development.

ZGE 471/3 Potential Field Interpretation

Interpretation of gravity and magnetic data: 2-dimensional and 3-dimensional models. Kernel function in resistivity sounding; modelling, inversion and interpretation. Introduction to non- linear optimization methods, linear inversion, generalized inverse method.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain basic theory related to the potential field methods.
2. explain interpretation techniques of potential field methods using two and three dimension model.
3. calibrate and classify the nonlinear optimization methods in the interpretation techniques of potential field methods.
4. solve problems involving application of nonlinear optimization methods.

ZGE 473/4 Seismic Data Processing

Basic mathematics for Fourier Transform. Aliasing and phase considerations. Operations in the time domain and frequency domain. Preprocessing. Main processing sequence. Velocity analysis. Factors that influence velocity. NMO. Dipping cases. DMO. Velocity spectrum.
Deconvolution. Convolution model. Inverse filtering. Minimum phase. Optimum-Wiener filters. Predictive deconvolution. Migration in space and time: Kirchhoff, finite-difference and frequency-wavenumber. Introduction to partial migration before stack.

Land and sea acquisition geometry. 3-D seismic data processing. Random transform and tau-p processing. Hilbert transform and complex trace analysis. AVO.

Learning Outcomes
Upon completion of this course, students are able to:
1. understand the full seismic data processing.
2. explain the importance of seismic data processing
3. analyze various steps e.g. common signal processing operations, velocity analysis, deconvolution, migration etc.
4. measure few advanced techniques used in seismic data processing.
5. solve problems regarding seismic data processing.

ZGE 475/3 Engineering and Environmental Geophysics

Introduction to environmental and engineering problems as well as geophysical technique. Relevant physical properties of rocks and soil, seismic reflection: Optimum window and optimum offset techniques. Field procedure, techniques and instrumentation. Data correction and interpretation. Seismic refraction: Interpretation techniques such as GRM and others. Electrical Images: 2D Resistivity Modelling. Finite difference method. 2D electrical imaging exploration and multi electrodes. Data collection and interpretation. Introduction to 3D electrical imaging. Relevant topics such as GPR and others. Field examples for environmental, engineering and hydrogeology.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the geophysics theory and concept related to the engineering and environment, including their ethics.
2. Measure and explain problems in engineering and environment using geophysical techniques.
3. classify the geophysical field procedure and interpretation techniques related to the engineering and environment.

ZGE 477/3 Physics Oceanography

Physical setting and fundamental role of the oceans in shaping the Earth. Oceanic phenomena such as Ekman transport, Langmuir circulation, planetary waves, boundary current's tides, tsunamis and surface waves.

Learning Outcomes
Upon completion of this course, students are able to:
1. identify physical conditions and processes of sea water.
2. describe and differentiate ocean cycle, Coriolis effect and properties of flow kinematic.
3. sketch and explain strong variations such as tides, tsunami and surface waves.

ZGE 479/3 Geological Oceanography

Sources of sediments, grain size, grain size analysis and environmental interpretation of grain size. Properties of fluid flow, sediment movement, sediment transport rate. Bedforms and internal structures. Origin and morphology of ocean basins and margins. Beach, salt marsh and estuarine sedimentation. Sources, composition and types of deep-sea sediments. Patterns of deep-sea sedimentation. Effects of sea-level changes. Nature of hydrothermal circulation. Resources from the ocean floor.

Learning Outcomes
Upon completion of this course, students are able to:
1. identify and classify the source of sediment and the fundamentals of fluid flow
2. describe the pattern of sediment transport and depositional environment
3. explain patterns of deep-sea sediment and resources from the ocean floor

ZAE 484/4 Laser and Its Applications

This course will focus on the introduction to properties of lasers. Basic principle of laser. Stimulated emission. Laser pumping. Oscillator. Laser output. Modifying laser output. Laser expositions. Holography and applications. Optical communications. Laser induced fluorescence. LIDAR and pollution control. Industrial uses of lasers. Medical applications. Laser classifications and safety.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the properties of laser beam and its uses for different applications and infer the impact of laser selection and laser performance due to the quality and design of the resonator.
2. draw the structure of optical cavity and the laser action processing.
3. describe the types of lasers according to the active medium and appreciate the requirements for safety.
4. explain the nature of light, mechanism of emission, population density as well as the quantum of laser emission.

ZAE 485/4 Applied Spectroscopy

Introduction. Several common units in spectroscopy. General instrumentation: Electromagnetic spectrum, general equipments for an absorption experiment, equipments for scattering experiment, components for absorption experiment. Interaction of electromagnetic radiation with atoms and molecules: Electromagnetic radiation, absorption, emission and bandwidth. Symmetry of molecules: point symmetry, dipole moment and dielectric moment Rotational spectroscopy: linear, symmetry of rotor, spherical rotor, nonsymmetric rotor molecules, infrared rotation, millimeter waves and microwave spectra, Raman rotational spectroscopy, determination of structural from rotational constant. Electronic spectroscopy, atomic spectroscopy, diatomic and polyatomic molecules spectroscopy. Photoelectron spectroscopy: experimental methods,

interpretation of spectra, X-ray photoelectron for a gas, X-ray photoelectron for a solid. Auger electron spectroscopy, X-ray fluoresence spectroscopy.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain, differentiate and relate the theories of spectroscopy.
2. identify, relate and solve simple spectral patterns.
3. appreciate, differentiate and evaluate different spectra.

ZAE 488/4 Non-Destructive Testing

Introduction. Visual inspection. Stress and leakage testing. Liquid penetrant inspection. Thermal methods. Industrial radiography, (eg x-ray radiography). Ultrasonic. Dynamic testing. Electromagnetic methods, (eg, magnetic particle method, particle-electric and eddy currents). Thickness measurement. Other techniques: for example spot test, chemical
spectral analysis, activation analysis, EDX, electrographic printing, sulfur printing, spark testing, surface analysis, electron probe.

Learning Outcomes
Upon completion of this course, students are able to:
1. present detailed information about NDT methods and be able to decide, select, use and interpret NDT methods for inspection and evaluation of engineering materials.
2. define the calibration standards, explain scope and limitation of NDT methods and select appropriate equipment for a given problem specifications.
3. solve problems related to x-ray, ultrasonics, Eddy current methods of NDT, and interpret and report the results obtained (transformer analysis).

ZCE 499/9 Industrial Training

Industrial training will be carried out and last for 18 months in the 4th year, semester 2. Students will be assigned at the industrial, hospital or institution which is identified by the school or the student himself/herself. Students will be directly exposed to the real working environment. Evaluation for this training will be done based on the report from the industrial supervisor/field supervisor, industrial training report or log book and seminar presentation.

Learning Outcomes
Upon completion of this course, students are able to:
1. relate what you learned during lecture with real working environment.
2. organize and explain findings from training.
3. practice knowledge, skill and ability.

Index

Elective Courses

SCHOOL OF MATHEMATICAL SCIENCES

SCHOOL OF MATHEMATICAL SCIENCES

(math.usm.my)

INTRODUCTION

The Bachelor of Applied Science degree program in this School was introduced in the 1987/88 Academic Session. The program emphasizes the applications of mathematics and gives emphasis to computing in the study of mathematical sciences. This is to produce graduates who are capable of carrying out research and development work in industries as well as in public and private agencies.

The School offers four areas of specialization:

(i) Applied Statistics
(ii) Operations Research
(iii) Mathematical Modelling
(iv) Mathematics and Economics

The above specializations were created in an effort to produce trained graduates in areas of applied mathematical sciences to support the nation's manpower need. The courses have been structured to provide a specialized and solid applied mathematical sciences education. The skills acquired provides a solid foundation for further development of mathematical skills.

VISION

To be a recognised department of mathematics that can attract excellent students and produce quality mathematicians nationally and internationally.

MISSION

To lead and innovate in achieving excellence in Mathematical Sciences at the international level through advancing and disseminating knowledge and truth; instilling qualities that stress academic excellence and professionalism; developing holistic individuals; and providing a strong commitment towards the aspiration of society; the country's vision and universal aspirations.

BACHELOR OF APPLIED SCIENCE (APPLIED STATISTICS)

Programme Objectives

Graduates of Bachelor of Applied Science (Applied Statistics) will

1. have a specialized and solid applied statistics education.
2. have a solid foundation for further development of mathematical skills.
3. possess professional attitudes, good ethics and leadership qualities.
4. have an educational experience that motivates them to pursue life-long learning.
5. have a solid foundation to be enrolled in a university graduate programme or employed.

Programme Learning Outcomes

At the end of the program, the student is

1. competent in the fundamental concepts, theories and results of statistics and able to apply skills in statistical reasoning.
2. competent in a variety of statistical techniques to solve problems.
3. able to identify, formulate, analyze and solve applied and industrial problems through the integration of statistical techniques with other disciplines.
4. able to convey ideas and statistical knowledge clearly and effectively in both written and oral form.
5. able to work collaboratively as part of a team.
6. able to pursue independent study and continuous personal and professional development.
7. able to be a skilled and innovative leader.
8. professional, responsible and ethical.
9. able to identify business and entrepreneurship opportunities.

BACHELOR OF APPLIED SCIENCE (OPERATIONS RESEARCH)

Programme Objectives

Graduates of Bachelor of Applied Science (Operations Research) will

1. have a specialized and solid operations research education.
2. have a solid foundation for further development of mathematical skills.
3. possess professional attitudes, good ethics and leadership qualities.
4. have an educational experience that motivates them to pursue life-long learning.
5. have a solid foundation to be enrolled in a university graduate programme or employed.

Programme Learning Outcomes

At the end of the program, the student is

1. competent in the fundamental concepts and theories of operations research.
2. able to apply analytical skills and is competent in a variety of operations research techniques to solve problems.
3. able to identify, formulate, analyze and solve applied and industrial problems through the integration of operations research techniques with other disciplines.
4. able to convey ideas and operations research knowledge clearly and effectively in both written and oral form.
5. able to work collaboratively as part of a team.
6. able to pursue independent study and continuous personal and professional development.
7. able to be a skilled and innovative leader.
8. professional, responsible and ethical.

BACHELOR OF APPLIED SCIENCE (MATHEMATICAL MODELLING)

Programme Objectives

Graduates of Bachelor of Applied Science (Mathematical Modelling) will

1. have a specialised and solid mathematical modelling education.
2. have a solid foundation for further development of mathematical skills.
3. possess professional attitudes, good ethics and leadership qualities.
4. have an educational experience that motivates them to pursue life-long learning.
5. have a solid foundation to be enrolled in a university graduate programme or employed.

Programme Learning Outcomes

At the end of the program, the student is

1. knowledgeable in the fundamentals of mathematical sciences and competent in the application of mathematical modelling to science and engineering.
2. capable of identifying, formulating, analysing and solving problems in science and engineering, skilled in computer programming, computational techniques and ICT.
3. a team player who is accountable and responsible.
4. professional, responsible and ethical.
5. an effective and confident communicator.
6. a critical thinker who adopts a scientific approach towards solving problems.
7. capable of improving his or her mathematical knowledge as part of a life long learning process.
8. a skilled and innovative leader and manager of resources.
9. able to identify business and entrepreneurship opportunities.

BACHELOR OF APPLIED SCIENCE (MATHEMATICS AND ECONOMICS)

Programme Objectives

Graduates of Bachelor of Applied Science (Mathematics and Economics) will

1. have a specialized and solid mathematics and economics education.
2. have a solid foundation for further development of mathematical and economics skills.
3. possess professional attitudes, good ethics and leadership qualities.
4. have an educational experience that motivates them to pursue life-long learning.
5. have a solid foundation to be enrolled in a university graduate programme or employed.

Programme Learning Outcomes

At the end of the program, the student

1. understands how mathematical concepts and processes can be used to develop economics and financial knowledge.
2. is competent in a variety of mathematical techniques to solve problems.
3. is able to identify, formulate, analyze and solve economic problems through the integration of mathematical techniques .
4. is able to communicate ideas and knowledge in mathematics and economics clearly and effectively in both written and oral form.
5. is able to work collaboratively as part of a team.
6. is able to pursue independent study and continuous personal and professional development.
7. is able to be a skilled and innovative leader.
8. is professional, responsible and ethical.
9. is able to identify business and entrepreneurship opportunities.

STAFF AND ADMINISTRATION

DEAN

Professor Dr. Hailiza Kamarulhaili

DEPUTY DEANS

Dr. Nuzlinda Abdul Rahman
(Academic, Career & International)

Associate Professor Dr. Farah Aini Abdullah
(Research, Innovation & Industry-Community Engagement)

PROGRAMME CHAIRPERSONS

Assoc. Prof. Dr. Lee See Keong
Science (Mathematics)

Dr. Ahmad Lutfi Amri Ramli
Applied Science (Mathematical Modelling)

Dr. Norhashidah Awang
Applied Science (Mathematics and Economics)

Dr. Fam Pei Shan
Applied Science (Applied Statistics/ Operations Research)

Dr. Yazariah Mohd. Yatim
Facility & Teaching Development Co-ordinator

ASSISTANT REGISTRARS

Mr. Muhamad Tarmizi Rahim
Principal Assistant Registrar

Mr. Ahmad Wafi Sahedan
Assistant Registrar

ADMINISTRATION

	E-mail
DEAN	
Prof. Dr. Hailiza Kamarulhaili	dean_mat@usm.my
DEPUTY DEAN (ACADEMIC, CAREER & INTERNATIONAL)	
Dr. Nuzlinda Abdul Rahman	ddsa_mat@usm.my
DEPUTY DEAN (RESEARCH, INNOVATION & INDUSTRY-COMMUNITY ENGAGEMENT)	
Assoc. Prof. Dr. Farah Aini Abdullah	ddpg_mat@usm.my

PROGRAMME CHAIRPERSONS

SCIENCE (MATHEMATICS)	
Assoc. Prof. Dr. Lee See Keong	sklee@usm.my
APPLIED SCIENCES (MATHEMATICS AND ECONOMICS)	
Dr. Norhashidah Awang	shidah@usm.my
APPLIED SCIENCES (APPLIED STATISTICS/OPERATIONS RESEARCH)	
Dr. Fam Pei Shan	fpeishan@usm.my
APPLIED SCIENCE (MATHEMATICAL MODELLING)	
Dr. Ahmad Lutfi Amri Ramli	alaramli@usm.my
FACILITY & TEACHING DEVEVELOPMENT CO-ORDINATOR	
Dr. Yazariah Mohd. Yatim	yazariahmy@usm.my
PRINCIPAL ASSISTANT REGISTRAR	
Mr. Muhamad Tarmizi Rahim	tarmizi_rahim@usm.my
ASSISTANT REGISTRAR	
Mr. Ahmad Wafi Sahedan	wafi@usm.my

ACADEMIC STAFF

PROFESSOR	**TELEPHONE EXTENSION**	**E-MAIL**
Rosihan M. Ali, Dato' Indera Dr	3966	rosihan@usm.my
Ahmad Izani Md. Ismail, Dr	3657	ahmad_izani@usm.my
Hailiza Kamarulhaili, Dr	3648	hailiza@usm.my
Low Heng Chin, Dr	3641	hclow@usm.my
Michael Khoo Boon Chong, Dr	3941	mkbc@usm.my
Norhashidah Hj. Mohd. Ali, Dr	3960	shidah_ali@usm.my
Zarita Zainuddin, Dr	3940	zarita@usm.my
ASSOCIATE PROFESSOR		
Adam Baharum, Mr	3942	adam@usm.my
Andrew Rajah, Dr	4780	andy@usm.my
Ang Miin Huey, Dr	4772	mathamh@usm.my
Farah Aini Abdullah,Dr	4765	farahaini@usm.my
Lee See Keong, Dr	2070	sklee@usm.my
Mohd. Tahir Ismail, Dr	2071	m.tahir@usm.my
Noor Atinah Ahmad, Dr	4767	nooratinah@usm.my
Saratha A/P Sathasivam, Dr	2428	saratha@usm.my
Sek Siok Kun, Dr	5338	sksek@usm.my
Teh Su Yean, Dr	4770	syteh@usm.my
SENIOR LECTURER		
Ahmad Lutfi Amri Ramli, Dr	2065	alaramli@usm.my
Amirah Azmi, Dr	2671	amirahazmi@usm.my
Azhana Ahmad, Dr	4771	azhana@usm.my
Fam Pei Shan, Dr	3968	fpeishan@usm.my
Hajar Sulaiman, Dr	4779	hajars@usm.my
Husna Hasan, Dr	4773	husnahasan@usm.my
Kong Voon Pang, Dr	3943	kongvp@usm.my
Maisarah Haji Mohd, Dr	4488	maisarah_hjmohd@usm.my
Md Yushalify Misro, Dr	3658	yushalify@usm.my
Mohd Hafiz Mohd, Dr	5059	mohdhafizmohd@usm.my
Ng Zhen Chuan, Dr	5337	zhenchuanng@usm.my
Noor Saifurina Nana Khurizan, Dr	4989	saifurina@usm.my
Norazrizal Aswad Abdul Rahman, Dr	3944	aswad.rahman@usm.my
Norhashidah Awang, Dr	4774	shidah@usm.my
Norlida Mohd. Noor, Mrs	3958	norlida@usm.my
Norshafira Ramli, Dr	4764	norshafiraramli@usm.my
Nur Nadiah Abd Hamid, Dr	2356	nurnadiah@usm.my
Nuzlinda Abdul Rahman, Dr	4781	nuzlinda@usm.my

Ong Wen Eng, Dr	4776	weneng@usm.my
Rosmanjawati Abdul Rahman, Dr	4778	rosmanjawati@usm.my
Shamani A/P Supramaniam, Dr	3384	shamani@usm.my
Shamsul Rijal Muhammad Sabri, Dr	3964	rijal@usm.my
Shareduwan Mohd Kasihmuddin, Dr	4769	shareduwan@usm.my
Siti Amirah Abd Rahman, Dr	2355	amirahr@usm.my
Syakila Ahmad, Dr	3945	syakilaahmad@usm.my
Teh Wen Chean, Dr	4777	dasmenteh@usm.my
Yazariah Mohd Yatim, Dr	4783	yazariahmy@usm.my
Zainudin Arsad, Dr	2069	zainudin.arsad@usm.my
Zalila Ali, Mrs	4775	zalila_ali@usm.my

SUPPORT / TECHNICAL STAFF

Siti Salmah Harun	Office Secretary
Nur Atiqah Jamaluddin	Office Secretary
Fazril Ezwan Shafii	Administrative Assistant (Clerical/Operation)
Hartini Ahmad	Information Technology Assistant Officer
Hasliza Razali	Chief Clerk
Mohd Zaidul Khair Mansor	Administrative Assistant (Clerical/Operation)
Noraidah Zamaludin	Administrative Assistant (Clerical/Operation)
Nor ‘Izzati Zaidi	Administrative Assistant (Clerical/Operation)
Nor Rafidah Abd Majid	Administrative Assistant (Clerical/Operation)
Yusnita Yusop	Administrative Assistant (Clerical/Operation)
Syed Mohamed Hussain Syed Osman	Engineering Assistant Officer
Arzahar Ismail	Operational Assistant

REQUIREMENT OF THE PROGRAM

(a) Specialization in Applied Statistics, Operations Research and Mathematical Modelling

Type of Courses	Classification	Units
Core	T	75
Minor / Elective	M / E	32*
University	U	20
	Total Number of Units	127

* A student who chooses to do a minor needs to accumulate 20 units from one of the minor programs.

* Students taking electives to replace minor are required to take courses offered by the school which have not been taken as compulsory core and compulsory elective courses. Students can take other courses with permission from the Dean.

(b) Specialization in Mathematics and Economics

Type of Courses	Classification	Units
Core	T	75 (Mathematics : 51) (Economics : 24)
Elective	E	32
University	U	20
	Total Number of Units	127

COMPULSORY CORE AND ELECTIVE COURSES

Students in the specialization areas of Applied Statistics, Operations Research, Mathematical Modelling and Mathematics and Economics must accumulate **75 units.**

APPLIED STATISTICS SPECIALIZATION

Compulsory Core (75 units)

MAT100/3	:	Mathematical Foundations
MAT101/4	:	Calculus
MAT111/4	:	Linear Algebra
MAT161/4	:	Elementary Statistics
MSG162/4	:	Applied Statistical Methods
MAT181/4	:	Programming for Scientific Applications
MAT201/4	:	Advanced Calculus
MAT223/4	:	Differential Equations I
MAT263/4	:	Probability Theory
MAT264/4	:	Non-Parametric Statistics
MSG265/4	:	Design and Analysis of Experiments
MSG287/3	:	Statistical Laboratory
MAT363/4	:	Statistical Inference
MSG368/4	:	Sample Survey and Sampling Technique
MSG460/3	:	Survival Analysis
MSG466/4	:	Multivariate Analysis
MSG467/4	:	Time Series Analysis
MSG469/4	:	Regression Analysis
MSG491/6	:	Project

Compulsory Elective

Choose 3 from 5 listed courses

MAT251/4	:	Introduction to Operations Research
MSG355/4	:	Inventory Control
MSG362/4	:	Quality Control
MSG370/4	:	Mathematics of Finance
MSG453/4	:	Queuing System and Simulation

No.	Code & Title of Courses	Prerequisite	Semester Offered
1.	MAT100/3 : Mathematical Foundations	-	1
2.	MAT101/4 : Calculus	-	2
3.	MAT111/4 Linear Algebra	-	2
4.	MAT161/4 : Elementary Statistics	-	1, 2
5.	MSG162/4 : Applied Statistical Methods	MAT161 (S)	2
6.	MAT181/4 : Programming for Scientific Applications	-	1, 2
7.	MAT201/4 : Advanced Calculus	MAT101 (S)	1
8.	MAT223/4 : Differential Equations I	MAT101 (S) and MAT111 (S)	1
9.	MAT251/4 : Introduction to Operations Research	MAT111 (S) and MAT161 (S)	2
10.	MAT263/4 : Probability Theory	MAT161 (S) and MAT201 (S)	2
11.	MAT264/4 : Non-Parametric Statistics	MAT101 (S) MSG162 (S)	1
12.	MSG265/4 : Design and Analysis of Experiments	MSG162 (S)	2
13.	MSG287/3 : Statistical Laboratory	MSG162 (S)	2
14.	MSG352/4 : Linear and Integer Programming	MAT251 (S)	1
15.	MSG354/4 : Network Flows	MAT251 (S)	2
16.	MSG355/4 : Inventory Control	MAT251 (S)	2
17.	MSG362/4 : Quality Control	MSG162 (S)	2
18.	MAT363/4 : Statistical Inference	MAT263 (S)	1
19.	MSG368/4 : Sample Survey and Sampling Technique	MSG162 (S)	1
20.	MSG370/4 : Mathematics of Finance	MAT201(S)	1
21.	MSG386/3 : Operations Research Laboratory	MAT251 (S)	1
22.	MSG453/4 : Queueing System and Simulation	MAT263 (S) and MAT181 (S)	1
23.	MSG455/4 : Game Theory	MAT251 (S)	1
24.	MSG456/4 : Mathematical Programming	MAT251 (S)	1
25.	MSG460/3 : Survival Analysis	-	1

26.	MSG466/4 : Multivariate Analysis	MSG162 (S) and MSG287 (S)	2
27.	MSG467/4 : Time Series Analysis	MSG287 (S)	1
28.	MSG469/4 : Regression Analysis	MSG162 (S) MSG287 (S)	2
29.	MSG491/6 : Project	Applied Statistics : MAT263 (S) and MSG287 (S) Operations Research : MSG386 (S)	2

Sequential prerequisite (S) means if course A is a sequential prerequisite (S) to course B, then course A must be taken and assessed before course B is taken.

Core And Compulsory Elective Courses Registration Guide

Year of Study	Semester 1	Units	Semester 2	Units
1	MAT100	3	MAT101	4
	MAT161	4	MAT111	4
	MAT181	4	MSG162	4
2	MAT201	4	MAT263	4
	MAT223	4	MSG265	4
	MAT264	4	MSG287	3
3	MAT363	4	*MSG362	4
	MSG368	4	MSG466	4
	*MSG370	4	MSG469	4
4	MSG467	4	*MSG355	4
	MSG460	3	*MAT251	4
	*MSG453	4	MSG491	6

* Elective Courses : Choose 3 from the 5 listed courses.

OPERATIONS RESEARCH SPECIALIZATION

Compulsory Core (75 units)

MAT100/3	:	Mathematical Foundations
MAT101/4	:	Calculus
MAT111/4	:	Linear Algebra
MAT161/4	:	Elementary Statistics
MSG162/4	:	Applied Statistical Methods
MAT181/4	:	Programming for Scientific Applications
MAT201/4	:	Advanced Calculus
MAT223/4	:	Differential Equations I
MAT251/4	:	Introduction to Operations Research
MAT263/4	:	Probability Theory
MSG287/3	:	Statistical Laboratory
MSG352/4	:	Linear and Integer Programming
MSG354/4	:	Network Flows
MSG355/4	:	Inventory Control
MAT363/4	:	Statistical Inference
MSG386/3	:	Operations Research Laboratory
MSG453/4	:	Queueing System and Simulation
MSG456/4	:	Mathematical Programming
MSG491/6	:	Project

Compulsory Elective

Choose 3 from 5 listed courses

MSG265/4	:	Design and Analysis of Experiments
MSG370/4	:	Mathematics of Finance
MSG455/4	:	Game Theory
MSG467/4	:	Time Series Analysis
MSG469/4	:	Regression Analysis

No.	Code & Title of Courses	Prerequisite	Semester Offered
1.	MAT100/3 : Mathematical Foundations	-	1
2.	MAT101/4 : Calculus	-	2
3.	MAT111/4 Linear Algebra	-	2
4.	MAT161/4 : Elementary Statistics	-	1, 2
5.	MSG162/4 : Applied Statistical Methods	MAT161 (S)	2
6.	MAT181/4 : Programming for Scientific Applications	-	1, 2
7.	MAT201/4 : Advanced Calculus	MAT101 (S)	1
8.	MAT223/4 : Differential Equations I	MAT101 (S) and MAT111 (S)	1
9.	MAT251/4 : Introduction to Operations Research	MAT111 (S) and MAT161 (S)	2
10.	MAT263/4 : Probability Theory	MAT161 (S) and MAT201 (S)	2
11.	MAT264/4 : Non-Parametric Statistics	MAT101 (S) MSG162 (S)	1
12.	MSG265/4 : Design and Analysis of Experiments	MSG162 (S)	2
13.	MSG287/3 : Statistical Laboratory	MSG162 (S)	2
14.	MSG352/4 : Linear and Integer Programming	MAT251 (S)	1
15.	MSG354/4 : Network Flows	MAT251 (S)	2
16.	MSG355/4 : Inventory Control	MAT251 (S)	2
17.	MSG362/4 : Quality Control	MSG162 (S)	2
18.	MAT363/4 : Statistical Inference	MAT263 (S)	1
19.	MSG368/4 : Sample Survey and Sampling Technique	MSG162 (S)	1
20.	MSG370/4 : Mathematics of Finance	MAT201(S)	1
21.	MSG386/3 : Operations Research Laboratory	MAT251 (S)	1
22.	MSG453/4 : Queueing System and Simulation	MAT263 (S) and MAT181 (S)	1
23.	MSG455/4 : Game Theory	MAT251 (S)	1
24.	MSG456/4 : Mathematical Programming	MAT251 (S)	1
25.	MSG460/3 : Survival Analysis	-	1

26.	MSG466/4	: Multivariate Analysis	MSG162 (S) and MSG287 (S)	2
27.	MSG467/4	: Time Series Analysis	MSG287 (S)	1
28.	MSG469/4	: Regression Analysis	MSG162 (S) MSG287 (S)	2
29.	MSG491/6	: Project	Applied Statistics : MAT263 (S) and MSG287 (S) Operations Research : MSG386 (S)	2

Sequential prerequisite (S) means if course A is a sequential prerequisite (S) to course B, then course A must be taken and assessed before course B is taken.

Core And Compulsory Elective Courses Registration Guide

Year of Study	Semester 1	Units	Semester 2	Units
1	MAT100 MAT161 MAT181	3 4 4	MAT101 MAT111 MSG162	4 4 4
2	MAT201 MAT223	4 4	MAT251 MAT263 MSG287	4 4 3
3	MSG386 MAT363 *MSG370 MSG352	3 4 4 4	MSG354 MSG355	4 4
4	MSG453 MSG456 *MSG455 *MSG467	4 4 4 4	MSG491 *MSG265 *MSG469	6 4 4

* Elective Courses : Choose 3 from the 5 listed courses.

MATHEMATICAL MODELLING SPECIALIZATION

Compulsory Core (75 units)

MAT100/3	:	Mathematical Foundations
MAT101/4	:	Calculus
MAT111/4	:	Linear Algebra
MAT161/4	:	Elementary Statistics
MAT181/4	:	Programming for Scientific Applications
MAT201/4	:	Advanced Calculus
MAT202/4	:	Introduction to Analysis
MAT203/4	:	Vector Calculus
MSS212/4	:	Further Linear Algebra
MAT223/4	:	Differential Equations I
MAT263/4	:	Probability Theory
MAT323/4	:	Differential Equations II
MSG328/4	:	Introduction to Modelling
MSG381/3	:	Modelling Laboratory I
MAT382/4	:	Introductory Numerical Methods
MSG382/3	:	Modelling Laboratory II
MSG384/4	:	Introduction to Geometric Modelling
MSG489/4	:	Numerical Methods for Differential Equations
MSG491/6	:	Project

Compulsory Elective

Choose 3 from 4 listed courses

MSG422/4	:	Fluid Mechanics
MSG427/4	:	Environmental Modelling
MSG485/4	:	Finite Element Methods
MSG488/4	:	Mathematical Algorithms for Computer Graphics

No.	Code & Title of Courses			Prerequisite	Semester Offered
1.	MAT100/3	:	Mathematical Foundations		1
2.	MAT101/4	:	Calculus	-	2
3.	MAT111/4		Linear Algebra	-	2
4.	MAT161/4	:	Elementary Statistics	-	1, 2
5.	MAT181/4	:	Programming for Scientific Applications	-	1, 2
6.	MAT201/4	:	Advanced Calculus	MAT101 (S)	1
7.	MAT202/4	:	Introductions to Analysis	MAT201 (S)	2
8.	MAT203/4	:	Vector Calculus	MAT201 (S)	2
9.	MSS212/4	:	Further Linear Algebra	MAT111 (S)	1
10.	MAT223/4	:	Differential Equations I	MAT101 (S) and MAT111 (S)	1
11.	MAT263/4	:	Probability Theory	MAT161 (S) and MAT201 (S)	2
12.	MAT323/4	:	Differential Equations II	MAT223 (S)	1
13.	MSG328/4	:	Introduction to Modelling	MAT223 (S)	2
14.	MSG381/3	:	Modelling Laboratory I	MAT181 (S)	1
15.	MAT382/4	:	Introductory Numerical Methods	MAT181 (S)	1
16.	MSG382/3	:	Modelling Laboratory II	MSG381 (S)	2
17.	MSG384/4	:	Introduction to Geometric Modelling	MAT181 (S) and MAT201 (S)	2
18.	MSG422/4	:	Fluid Mechanics	MAT223 (S)	2
19.	MSG427/4	:	Environmental Modelling	MSG328 (S)	1
20.	MSG485/4	:	Finite Element Methods	MAT223 (S)	2
21.	MSG488/4	:	Mathematical Algorithms for Computer Graphics	MSG384 (S)	1
22.	MSG489/4	:	Numerical Methods for Differential Equations	MAT382 (S)	2
23.	MSG491/6	:	Project	Mathematical Modelling: MSG328 (S) Geometric Modelling : MSG384 (S)	2

Sequential prerequisite (S) means if course A is a sequential prerequisite (S) to course B, then course A must be taken and assessed before course B is taken.

Core And Compulsory Elective Courses Registration Guide

Year of Study	Semester 1	Units	Semester 2	Units
1	MAT100 MAT181	3 4	MAT101 MAT111 MAT161	4 4 4
2	MAT201 MSS212 MAT223	4 4 4	MAT202 MAT263 MAT203	4 4 4
3	MAT382 MAT323 MSG381	4 4 3	MSG384 MSG328 MSG382	4 4 3
4	MSG489 *MSG427 *MSG488	4 4 4	MSG491 *MSG422 *MSG485	6 4 4

∗ Elective Courses : Choose 3 of 4 listed courses

MATHEMATICS AND ECONOMICS SPECIALIZATION

Compulsory Core Mathematics Courses (51 units)

MAT100/3	:	Mathematical Foundations
MAT101/4	:	Calculus
MAT111/4	:	Linear Algebra
MAT161/4	:	Elementary Statistics
MSG162/4	:	Applied Statistical Methods
MAT201/4	:	Advanced Calculus
MAT223/4	:	Differential Equations I
MAT251/4	:	Introduction to Operations Research
MAT263/4	:	Probability Theory
MSG287/3	:	Statistical Laboratory
MAT363/4	:	Statistical Inference
MSG386/3	:	Operations Research Laboratory
MSG491/6	:	Project

Compulsory Core Economics Courses (24 units)

SKW109/3	:	Introduction of Economic Issues
SEW101/3	:	Microeconomics
SEW103/3	:	Macroeconomics
SEW202/3	:	Intermediate Microeconomics
SEW204/3	:	Intermediate Macroeconomics
SEW303/3	:	History of Economics
SEP206/3	:	Malaysian Economy
SEP304/3	:	Basic Econometrics

Compulsory Elective Courses (32 units)

Choose at least 2 from 4 of the following courses:

SEU224/3	:	Economics of Agricultural Marketing and Cooperatives
SEU227/3	:	Development Economics
SEU230/3	:	Labour Economics
SEU231/3	:	Islamic Economics

Choose at least 2 from 5 of the following courses:

SEU332/3	:	Behavioral Economics
SEU334/3	:	Money, Banking and Financial Markets
SEU335E/3	:	Public Sector Economics I
SEU336E/3	:	Environmental and Natural Resources Economics
SEU339E/3	:	Economic Planning and Project Analysis

Choose at least 2 from 5 of the following courses:

SEU411E/3 : International Trade
SEU413E/3 : Monetary Economics
SEU416E/3 : Public Sector Economics II
SEU421E/3 : International Finance
SEU422E/3 : Applied Economics

Choose at least 2 from the following courses:

MSG370/4 : Mathematics of Finance
MSG455/4 : Game Theory
MSG456/4 : Mathematical Programming
MSG467/4 : Time Series Analysis

The offering and prerequisites of courses for the mathematics component of **Mathematics and Economics specialization** are the same as for those in Applied Statistics specialization. The prerequisites of courses for the Economics component are as follows:

No.	Code & Title of Courses			Prerequisite
1.	SKW109/3	:	Introduction to Economic Issues	-
2.	SEW101/3	:	Microeconomics	SKW109 (S)
3.	SEW103/3	:	Macroeconomics	SKW109 (S)
4.	SEW202/3	:	Intermediate Microeconomics	SEW101 (S)
5.	SEW204/3	:	Intermediate Macroeconomics	SEW103 (S)
6.	SEW303/3	:	Economics History	
7.	SEP206/3	:	Malaysian Economics	SKW109 (S)
8.	SEP304/3	:	Basic Econometrics	SEW101 (S), SEW103 (S)
9.	SEU224/3	:	Agricultural Marketing and Cooperative Economics	SKW109 (S)
10.	SEU227/3	:	Development Economics	SKW109 (S)
11.	SEU230/3	:	Labour Economics	SKW109 (S)
12.	SEU231/3	:	Islamic Economics	SKW109 (S)
13.	SEU332/3	:	Behavioral Economics	SEW101 (S)
14.	SEU334/3	:	Money, Banking and Financial Market	
15.	SEU335E/3	:	Public Sector Economics I	SEW202 (S)
16.	SEU336E/3	:	Environment Economics and Natural Resource	SEW101 (S)
17.	SEU339E/3	:	Economic Planning and Project Analysis	SEW101 (S), SEW103 (S)
18.	SEU411E/3	:	International Trade	SEW101 (S)
19.	SEU413E/3	:	Monetary Economics	SEW103 (S)
20.	SEU416E/3	:	Public Sector Economics II	SEW202 (S),SEU335E (S)
21.	SEU421E/3	:	International Finance	SEW103 (S)
22.	SEU422E/3	:	Applied Economics	SEW202 (S), SEW204 (S)

Sequential prerequisite (S) means if course A is a sequential prerequisite (S) to course B, then course A must be taken and assessed before course B is taken.

Core And Compulsory Elective Courses Registration Guide

Students are required to check the list of courses offered at the beginning of each academic session.

Year of Study	Semester 1	Units	Semester 2	Units
1	MAT100 SKW109 MAT161	3 3 4	MAT101 MAT111 MSG162 SEP206 SEU224[b] SEU227[b]	4 4 4 3 3 3
2	MAT201 MAT223 SEW101 SEW103	4 4 3 3	MAT251 MAT263 MSG287 SEW202 SEW204	4 4 3 3 3
3	MSG386 MAT363 SEW303 SEU230[b] SEU231[b] SEU339E[c] SEU332[c] SEU334[c] SEU335E[c]	3 4 3 3 3 3 3 3 3	SEP304 SEU336E[c]	3 3
4	SEU411E[d] SEU413E[d] *MSG370 *MSG455 *MSG456 *MSG467	3 3 4 4 4 4	MSG491 SEU416E[d] SEU421E[d] SEU422E[d]	6 3 3 3

Optional Courses
- [b] Choose at least 2 from these courses.
- [c] Choose at least 2 from these courses.
- [d] Choose at least 2 from these courses
- *Choose 2 from these courses

SKILL / OPTIONAL COURSES

In order to fulfill this requirement, students of the School of Mathematical Sciences are allowed to take any course outside the Schools of Mathematical Sciences, Chemical Sciences, Biological Sciences and Physics. Students are encouraged to take English language [LHP code], foreign languages, thinking techniques, history and philosophy of science courses.

COURSE PREREQUISITE AND SEMESTER OF OFFERING

The prerequisites and semester of offering of the core and compulsory elective courses are as follows:

MATHEMATICS MINOR PROGRAM

1.	MAA101/4	:	Calculus for Science Students I
2.	MAA102/4	:	Calculus for Science Students II
3.	MAA111/4	:	Algebra for Science Students
4.	MAA161/4	:	Statistics for Science Students
5.	MSG162/4	:	Applied Statistical Methods
6.	MAT181/4	:	Programming for Scientific Applications
7.	MAT203/4	:	Vector Calculus
8.	MAT223/4	:	Differential Equations I
9.	MAT263/4	:	Probability Theory
10.	MSS311/4	:	Modern Algebra
11.	MAT323/4	:	Differential Equations II
12.	MSG362/4	:	Quality Control
13.	MSS391/4	:	Special Topic Survey

Mathematics minor students have to accumulate 20 units and it is compulsory for them to take both MAA101/4 and MAA111/4 either as core or minor courses. Courses which they have taken to fulfill the core requirements must be replaced by the above listed courses. Please refer to the minor program guide book for further details.

SCHOOL'S FACILITIES

The School of Mathematical Sciences has 3 undergraduate computer laboratories, a postgraduate computer laboratory and a research and development laboratory. These laboratories are equipped with MS Windows based computer facilities, net worked and laser printers.

Awards

Besides awards from the University, there are 3 other specific awards for mathematics students:

1. Tan Sri Dato' Professor Sir Alexander Oppenheim Book Prize for the best first year student.
2. Dato' Abdul Razak Yusof Gold Medal Award to the best final year student in the field of Mathematical Sciences.
3. Telesol Sdn. Bhd. Gold Medal Award to the best final year student in the field of Applied Sciences (Mathematics).

The Dean Lists certificates are awarded every semester to each academically excellent student who has obtained a GPA of at least 3.5 and accumulated at least 14 units.

The Dean's Award will be conferred to a student who has excelled both academically and in co-curriculum activities. Only one award is available for each year of study from each program. A student of a CGPA of 3.7 and above in an academic session is qualified to be considered for this award.

Mathematical Sciences Society

This society organizes various activities in order to promote mathematics amongst USM and secondary school students. Students of School of Mathematical Sciences are encouraged to join this society.

Graduate Program

The School also offers the following graduate programs:

- Master of Science (Mathematics) by research
- Master of Science (Statistics) by research
- Master of Science (Mathematics) by mixed-mode
- Master of Science (Statistics) by mixed-mode
- Master of Science (Teaching of Mathematics) by course-work
- Doctor of Philosophy by research

Industry Community Advisory Panel (ICAP) for School of Mathematical Sciences

1. Mr. Amir Hamzah Mohd. Nawawi
   Senior Quality Manager
   Sanmina-SCI Systems (M) Sdn. Bhd.
   202, Industrial Park, 13600, Jalan Perusahaan Maju 9
   Bukit Tengah, 13600 Perai, Pulau Pinang, Malaysia

2. Dr. Lee Wen Jau
   Senior Staff Engineer / Technical Manager
   Intel Technology Sdn. Bhd.
   (Company No. 36420-H)
   Bayan Lepas Free Industrial Zone
   Phase 3, Halaman Kampung Jawa
   11900 Penang

3. Encik Tan Soon Keong
   Director and Head of Technology Product Engineering
   Infineon Technologies (Kulim) Sdn Bhd
   Lot 10 & 11, Jalan Hi-Tech 7
   Industrial Zone II, Kulim Hi-Tech Park
   09000 Kulim, Kedah

4. Encik Ahmad Shukor b. Hj. Md Salleh
   Head of Trade Marketing
   Celcom Axiata Berhad - Northern Region
   No. 291-G Jalan Dato' Kramat
   10150 Georgetown, Pulau Pinang

5. Dr. Mohd. Azizi b. Chik
   Senior Manager
   Silterra (M) Sdn. Bhd.
   Lot 8, Phase II, Kulim Hi-Tech Park
   09000 Kulim, Kedah Darul Aman

SYNOPSIS OF COURSES

MAT100/3 Mathematical Foundations

This course is designed to bridge the gap of basic mathematical knowledge in sets, functions, graphs, real numbers, integers and complex numbers among first year mathematics students besides exposing them with mathematical proving. These topics consist of basic knowledge in supporting all branches of mathematical studies. Since terms and results in these topics have been exposed (without proof) to students in their pre-university study, these topics serves as a very efficient medium to introduce and strengthen various mathematical proving techniques among students. Among other things, proving techniques cover direct, contra-positive, by cases, by counter example, contradiction and induction proving.

Learning Outcomes

Upon completion of this course, students are able to:
1. solve problems and prove mathematical statements related to sets and matrices
2. solve problems and prove mathematical statements related to the real and complex number systems
3. verify elementary mathematical results related to number theory
4. practice problem solving techniques related to functions and graphs

MAT101/4 Calculus

This course discusses the concepts and applications of calculus and exposes the students to basic concepts in analysis. It describes the concept and theory of limits, continuity, differentiation and integration of functions of one variable up to the fundamental theorem of calculus. The applications of differentiation and integration will be discussed as well.

Learning Outcomes

Upon completion of this course, students are able to:
1. define and determine a function, limits of functions and their properties
2. determine the derivative of a function by using definition and various differentiation methods
3. evaluate the integration of a function using various methods and properties
4. perform the calculus methods of differentiation and integration in solving problems in life sciences and physical sciences

MAA101/4 Calculus for Science Students I

This is a course on basic concepts of differential and integral calculus. Some of the concepts being discussed are limit, continuity, derivative and integral. Techniques of differentiation and integration will also be taught. Some of the applications of

differentiation and integration, like finding the maximum and minimum, the area and volume of revolution, are covered.

Learning Outcomes

Upon completion of this course, students are able to:
1. know about functions and limits, and their connection with differentiation and integration
2. find the derivative of functions using various rules of differentiation
3. evaluate integral of functions using various quadrature methods
4. apply method in differential and integral calculus to problems in life and physical sciences

MAA102/4 Calculus for Science Students II

This course discusses further the basics of calculus and introduces first order differential equations. Topics: sequences and series of numbers, power series, improper integral, partial derivatives, double integrals, methods for solving first order differential equation and its applications.

Learning Outcomes

Upon completion of this course, students are able to :
1. determine the convergence of a sequence, series, power series and improper integrals
2. select and use an appropriate test to determine the convergence of the series
3. find the partial derivatives using chain rule, directional derivatives and their applications
4. evaluate a double integral in cartesian and polar coordinates apply the methods in first order differential equation to problems in life and physical sciences
5. apply the methods in first order differential equation to problems in life and physical sciences

MAT111/4 Linear Algebra

This course introduces the basic concepts of linear algebra such as matrices, real vector spaces, linear transformations from R^n to R^m, inner product in R^n and diagonalization problems in real eigen value. The relationship between linear transformations and matrices is emphasized.

Learning Outcomes

Upon completion of this course, students are able to :
1. display a detailed solution to a system of linear equations
2. apply the concepts of the vector space R^n on the general vector space
3. perform the Gram-Schmidt proses to find the orthonormal basis
4. produce the orthogonal complement for a subspace of an inner product space
5. perform a complete diagonalization of a matrix

MAA111/4 Algebra for Science Students

This course introduces fundamental concepts of linear algebra. Topics covered include matrix operations, methods for solving linear systems, determinants, vector space in Υ^n and matrix diagonalisation.

Learning Outcomes

Upon completion of this course, students are able to:

1. use the Gauss-Jordan method to solve problems involving systems of linear equations and matrices
2. compute the determinant of a matrix and apply properties of determinant in the computation
3. explain concepts of vectors spaces and how to find bases and dimensions of subspaces
   apply the theory on eigenvalue and eigenvector to determine the diagonalizability and diagonalization of a matrix

MAT161/4 Elementary Statistics

This is an introductory course in descriptive statistics, probability theory and inferential statistics which provide the basic statistical concepts and techniques for data analysis. Descriptive statistics provides the techniques for organizing, summarizing and displaying data. Inferential statistics uses sample data to make estimations, decisions and draw conclusions about the population. Probability theory is used to evaluate the uncertainty involved in making inferences. Parametric and nonparametric procedures are used in making inferences for a single population and in comparing two populations. Statistical methods of analyzing qualitative data are used for data that are classified into two or more categories and into two categorical factors.

Learning Outcomes

Upon completion of this course, students are able to:

1. identify different types of data and describe the data graphically, numerically and interpret their meanings in general
2. compute probability and apply its concepts and rules to construct theoretical models of populations
3. differentiate between situations that are suitable for the application of parametric methods and non-parametric methods in statistical inferences.
4. identify the appropriate statistical methods to be used in making inferences about one and two populations
5. perform data analysis appropriately and make decisions and conclusions in solving problems

MAA161/4 Statistics for Science Students

An introduction to the science of collecting, organizing, analyzing and interpreting data. The focus is on data presentation and statistical reasoning based on the analysis of data sets.

Learning Outcomes

Upon completion of this course, students are able to :
1. have a clear understanding of the basic concepts of statistics such as probability and random variables
2. differentiate between discrete and continuous random variables and use them appropriately
3. make statistical inferences for population parameters based on sample statistics
4. identify the appropriate parametric and non-parametric methods in making statistical inferences

MSG162/4 Applied Statistical Methods

This course introduces the statistical methods appropriate for a single factor study, a two-factor study and a simple regression analysis. The basic principles of experimental design are introduced in the applications of a single factor study and a two-factor study. The statistical design for experiments are concerned with systematic scientific techniques in the process of collecting appropriate data. Analysis of variance is a statistical tool used in the analysis of a single factor and a two-factor study. Correlation and simple linear regression analysis provides statistical techniques for studying the relationship between a dependent variable and an independent variable. Nonparametric methods for a single factor study and correlation are used when certain model assumptions are violated. A wide range of applications are illustrated using these techniques.

Learning Outcomes

Upon completion of this course, students are able to:
1. identify the different models for a single factor and two-factor study
2. apply the appropriate statistical techniques for the models of a single factor and a two-factor study
3. differentiate between problems that are suitable for the application of parametric and non-parametric methods
4. apply the appropriate statistical analysis for a simple linear regression model
5. perform data analysis, make interpretations and conclusions in solving problems

MAT181/4 Programming for Scientific Applications

This course introduces basic computer concepts, algorithm development, problem solving methods and programming techniques using the C++ language. Topics covered include

types of data, variables, input/output and file manipulation, computation and arithmetic expression, control structure, modular program design, arrays, pointers, structure and file processing. Application problems will be discussed.

Learning Outcomes

Upon completion of this course, students are able to:
1. understand fundamental computer programming concepts and algorithm development in problem solving
2. apply appropriate programming techniques/structures and strategies in transforming the description of a problem into executable computer codes
3. develop programs using advanced programming structures (modular programming, files manipulation, pointers) which add values to the computer programs
4. solve problems in mathematics and scientific applications using a computer programming language

MAT201/4 Advanced Calculus

This course discusses further the basics of calculus. It describes the concept and theory of limits, continuity, differentiation and integration of functions of several variables. Sequences and series of numbers, power series and improper integrals are also discussed.

Learning Outcomes

Upon completion of this course, students are able to :
1. differentiate between sequence and series of number, and their relationship
2. use the series representation for some basic functions
3. recognize the improper integral for several types of function and determine their convergence
4. show understanding about functions of several variables and the concept of limit, continuity, differentiation and integration of such functions

MAT202/4 Introduction to Analysis

This course introduces basic concepts of analysis: real numbers ¡ sequences and series, functions and continuity, and topology on ¡ . The real numbers and their properties are discussed axiomatically, with the least upper bound and the greatest lower bound receiving special attention. Focus will also be given to sequences and their types; and topology on ¡ . The course also reviews some important notations in topology such as type of points in ¡ closed and open sets, compact sets and connected sets. Continuity and sequences and series of functions are also discussed. This course develops students' abilities to work in an abstract setting with precise definition, logical and complete proof.

Learning Outcomes

Upon completion of this course, students are able to :
1. have a firm understanding of the real number system and its topological properties
2. state mathematical definitions precisely, illustrate them with examples, and use them in writing proofs
3. relate topics from calculus such as limit and continuity from a more advanced view point
4. construct mathematical proof using mathematical logic

MAT203/4 Vector Calculus

This course covers of vector aspect and its application in geometry and differential geometry of space curves. The scalar valued functions with emphasis in two and three variables will be introduced where the concept of derivative of a function in a single variable is extended to two and three variables with applications such as finding the equation of tangent plane to the surface, linear approximation, types of critical points, and extremum value of a function with and without constraints. Vector-valued functions and vector field with applications such as curl and divergence will also be introduced. The concept of integration in a single variable calculus is extended to 2 and 3 variables with applications in computing the areas in a region, the volume of a solid bounded by surfaces included parametric surfaces. The Green's theorem is introduced together with the line integral. Stoke's Theorem and Divergence Theorem is introduced together with the surface integrals. The last topic covered will be on application of vector calculus, such as in electromagnetism and fluid and gas flow.

Learning Outcomes

Upon completion of this course, students are able to:
1. evaluate scalar, vector and triple products and their uses in the description of lines and planes
2. evaluate the differential geometry of 2 and 3-dimension
3. evaluate the gradient, divergence and curl of scalar and vector fields in terms of cartesian, cylindrical and spherical coordinates
4. evaluate line, surface and volume integrals
5. state and use Green's theorem in the plane, divergence theorem and Stokes' theorem

MAT223/4 Differential Equations I

This course introduces the student to basic concepts, theories and methodologies of ordinary differential equations. Standard methods of first and second order differential equations will be discussed. Focus will also be given to numerical solution techniques and error analysis as well as power series solutions. In addition, emphasis will be given to formal solution methods of linear systems of differential equations. The course concludes with discussions and examples of mathematical modelling of real world phenomena.

Learning Outcomes

Upon completion of this course, students are able to :
1. understand fundamental concepts and theory of differential equations (DE) and able to apply DE procedures in routine and non-routine concepts
2. select and use appropriate DE strategies and techniques
3. demonstrate an understanding of the appropriate use of DE modeling
4. gain computational skills needed in understanding applied problems
5. have quantitative reasoning skills, conceptual understanding and are able to effectively communicate in mathematics

MAT251/4 Introduction to Operations Research

The course introduces the field of operations research. It starts with the art of mathematical modeling of a simplified practical real world problem. Various classes of problem will be modeled and formulated, including transportation, assignment and project scheduling. Students will learn how best to formulate a problem and select the best solution from interpretation of the sensitivity analysis. This is a practical course in optimization, which could be applied, in many industrial and organizational settings.

Learning Outcomes

Upon completion of this course, students are able to:
1. interprete the economic interpretation of the optimal solution
2. execute sensitivity analysis
3. choose and use a suitable method to solve a problem
4. formulate problem into a linear programming model

MAT263/4 Probability Theory

This course introduces basic concepts and techniques in probability theory. This includes probability, random variables, discrete and continuous distributions, moment generating functions, conditional distributions and expectations, functions of random variables, basic concepts of convergence, limiting distributions and sampling distributions.

Learning Outcomes

Upon completion of this course, students are able to :
1. find the probability density function (p.d.f.) and distribution function (d.f.) of any random variables (r.v.) and hence, obtain the mean, variance, moment generating function and the kth. moment from this p.d.f. or d.f.
2. define probability and prove basic theorems in probability
3. adapt daily problem that can be solved in terms of r.v. and determine the properties of its distribution
4. identify the distributions of sample mean and variance from a normal distribution and distribution of functions of two or more r.v's

5. study problems of joint and conditional p.d.f.'s and d.f's and their moments and determine the dependence between two r.v's

MAT264/4 Non-parametric Statistics

This course explores the fundamental principles and methods of nonparametric statistics. Methods for a wide variety of applied problems will be explored. This course emphasizes the conceptual understanding and application as well as calculations of nonparametric statistics.

Learning Outcomes

Upon completion of this course, students are able to:
1. identify the different types of tests in non-parametric statistical methods
2. apply the appropriate non-parametric procedures in problem solving
3. interpret results of non-parametric statistics

MSG265/4 Design and Analysis of Experiments

This course starts with the introduction to factorial design, the general factorial design up to three-factor design and the 2^k design. The statistical analysis of the fixed effect model, random effect model and mixed model are discussed. There is also detailed discussion on the two-level factorial and fractional factorial This course starts with the introduction to factorial design, the general factorial design up to three-factor design and the 2^k design. The statistical analysis of the fixed effect model, random effect model and mixed model are discussed. There is also detailed discussion on the two-level factorial and fractional factorial designs, which includes blocking and confounding in the 2^k design. To conclude the course, an overview of the nested and split-plot designs is given and also an introduction to the response surface methodology. This course will include either an industrial visit or an industrial talk that focuses on real-world applications of design and analysis of experiments.

Learning Outcomes

Upon completion of this course, students are able to:

1. explain the procedures of designing those experiments
2. interpret the results for the different designs and write conclusions for the different designs
3. identify the design for the data given
4. perform the analysis of variance for the data obtained from different designs using statistical softwares.

MSG287/3 Statistical Laboratory

In this course students will be introduced to the fundamentals of statistical packages commonly used by statisticians. Independent learning is encouraged as much as possible to diversify students' approach in using the software.

Learning Outcomes

Upon completion of this course, students are able to:
1. apply statistical packages to the data set
2. relate the statistical reasoning from the results obtained
3. perform analysis for simple case study
4. interpret and discuss results of case study given

MSS212/4 Further Linear Algebra

This course covers the classical theory of determinant that involves permutations, the theory on diagonalization of matrices that involves complex eigenvalues, Jordan canonical form and powers of matrices problem, and lastly the inner product space that leads to the application of Spectral Theorem. The focus will be on the close relationship between linear transformations and matrices through vector space isomorphisms

Learning Outcomes

Upon completion of this course, students are able to
1. comprehends the theory behind matrix determinant
2. use isomorphism of vector spaces to find a matrix representation of a linear transformation with respect to the given bases
3. solve power of matrices problems for matrices using Jordan canonical form of matrices
4. use Spectral theorem to determine whether a matrix is diagonalizable

MAT323/4 Differential Equations II

The course consists of three important topics in differential equations. First, basic ideas of modern ordinary differential equations in the form of autonomous system and phase space are introduced. Next, boundary value problems in the context of Sturm-Liouville eigenvalue problems are discussed. Lastly, techniques to analytically solved second order partial differential equations are elaborated and applied.

Learning Outcomes

Upon completion of this course, students are able to:
1. analyze the local stability of plane autonomous systems
2. solve the regular Sturm-Liouville eigenvalue problem
3. performs analysis of solutions to Euler and Euler-Cauchy equations for Dirichlet, Neumann and Robin boundary conditions

4. solve partial differential equations through method of characteristics and d'Alembert
5. solve partial differential equations using separation of variables method

MSG328/4 Introduction to Modelling

This course describes the ideas and techniques (using case studies) in mathematical modeling. Mathematical software is used to obtain the solutions of the case studies and the generated results are interpreted based on the fundamental ideas of modeling.

Learning Outcomes

Upon completion of this course, students are able to:
1. interpret the model and its solution, and conclude the findings
2. describe the understanding and skill on the method applied in various models
3. construct model from an oral description or data
4. construct model based on physical laws and etc

MSG352/4 Linear and Integer Programming

This course exposes students to techniques in solving linear and integer programming problems. The methods covered in linear programming are such as the revised simplex and dual simplex. The theory behind the methods used will also be stressed. The methods for integer programming are the cutting plane, branch-and-bound and implicit enumeration.

Learning Outcomes

Upon completion of this course, students are able to:

1. use duality theory for every Linear Programming problem
2. use any techniques taught to solve Linear Programming and Integer or Mixed Programming
3. detect the similarity and differences between the simplex and the revised simplex methods
4. formulate Goal Programming problem and get the solution using appropriate techniques

MSG354/4 Network Flows

This course covers the theories, algorithms and applications of network flow problems. Topics that are discussed include minimum spanning tree, shortest route, maximum flow, minimum cost flow, chinese postman and traveling salesman problems.

Learning Outcomes

Upon completion of this course, students are able to:
1. explain the underlying theorems for network flow problems
2. choose and use appropriate algorithms to solve network flow problems
3. formulate/translate real life problems as a network flow problem
4. perform economic interpretation of the network flow solutions

MSG355/4 Inventory Control

This course starts with some basic concepts of inventory, the systems and models available. The inventory models are divided into two parts: deterministic and probabilistic. Students will be taught how to model and analyse the appropriate inventory system. They will also be introduced to other inventory control or production techniques, such as the materials requirement planning (MRP) and the just-in-time (JIT) model. This course will include either an industrial visit or an industrial talk that focuses on the real-world applications of inventory control.

Learning Outcomes

Upon completion of this course, students are able to:
1. understand clearly the basic concept and issues in inventory management
2. identify a suitable model for a given inventory problem
3. apply a suitable method for finding the optimum solution to a given inventory problem.
4. explain the solution obtained from a given inventory problem

MSG362/4 Quality Control

This course introduces the concepts of quality, total quality management (TQM) and quality control (QC). The seven QC tools are discussed in detail and used in problem solving. The concept of process is illustrated by an industrial visit where a walk on the shop floor speaks for itself. Statistical Process Control (SPC) is shown using real life case studies. Effective implementation of SPC is discussed and illustrated. Various statistical and QC software (SPSS, Minitab, JMP, and SPC Expert) are used as tools to solve quality problems. Process capability and acceptance sampling plans are also taught. Brainstorming, teamwork, communication and presentation skills are encouraged and practised throughout this course. This course will include either an industrial visit or an industrial talk that focuses on the real-world applications of quality control.

Learning Outcomes

Upon completion of this course, students are able to:
1. define and describe the concepts of quality, total quality management(TQM) and quality control (QC)
2. analyze, interpret and solve quality-related problems

3. adapt both graphics and quantitative quality measurement and quality analysis tools
4. present orally and in written form pertaining to quality
5. work as a team to solve quality related issues

MAT363/4 Statistical Inference

This course will initially revise the basic concepts and techniques on probability theory. Students will then be introduced to the main focus of statistical inference. Emphasis should be given to the topics covered in this phase, namely, point estimation, interval estimation and tests of hypotheses.

Learning Outcomes

Upon completion of this course, students are able to :
1. explain and solve problems on probability theory and statistical inference
2. find the distributions and joint distributions of random variables and random vectors
3. find point estimators, construct confidence intervals and conduct testing of hypotheses to verify claims

MSG368/4 Sample Survey and Sampling Techniques

This course is to introduce various methods of collecting the sample data. Using the sample data, estimation on certain population parameters and the bounds of error of estimation will be discussed. Some of the design will be introduced such as simple random sampling, stratified random sampling, cluster sampling and systematic sampling.

Learning Outcomes

Upon completion of this course, students are able to :
1. identify the design of sample survey
2. deduce about a population from the information contained in a sample.
3. follow the sampling procedures for selecting the sample from the population
4. differentiate methods for estimating population parameters and the bounds on the error of estimations

MSG370/4 Mathematics of Finance

This course initially defines interest rates and their computations, mathematically. Then, it exposes the applications of interest rates in the basic finance models such as saving, loan or financing, and bond. At the end of the course, it offers the methods of designing dynamic finance models related closely to the interest rates.
This course introduces :
a. Effective interest and discount rates, simple and compound interest, force of interest, present and future values, and nominal interest and discount rates
b. Annuity-due and annuity-immediate, perpetuity, discrete and continuous annuities.

c. Loan balance, ammortization schedule and sinking fund.
d. Security, bond, callable bond, mortgage and option.

Learning Outcomes

Upon completion of this course, students are able to:
1. explain and solve problems on interest theory and related annuities
2. find the yield rates of the financial models such as annuities of loan, saving and bond
3. find the present value, future value and current value of financial models

MSG381/3 Modelling Laboratory I

The course provides fundamental knowledge in mathematical softwares and practical abilities required to effectively utilize it in technical numerical computations and visualization.

Learning Outcomes

Upon completion of this course, students are able to:
1. use mathematical software for interactive computation
2. generate and export plots for use in reports and presentations
3. demonstrate the ability to use appropriate technology for research in mathematics
4. formulate ways of using technology effectively in investigating and developing understanding of mathematical ideas
5. practice the use of technological methods and tools in the following courses

MAT382/4 Introductory Numerical Methods

The goal of this course is to give introduction into fundamental concepts, ideas and methods of numerical analysis. Both theoretical and algorithmic aspects of numerical methods will be covered. The students will become familiar with an array of basic numerical methods. They will understand the methods scope, limitations and principles of implementation.

Learning Outcomes

Upon completion of this course, students are able to:
1. use basic numerical methods to solve calculus and algebra problems
2. analyze errors of basic numerical methods
3. generate polynomial interpolation to a given data set

MSG382/3 Modelling Laboratory II

This course introduces the fundamental concepts and workflows for creating 2D and 3D models with CAD software. Students explore how to create and modify both 2D, 3D, solid and surface models. Students learn how to present their designs while they are still

being created, using visualization tools such as visual styles, model walk and fly through, materials, and lighting. The course will also introduce basic techniques for generating picture in a computer through a C++ programming language using OpenGL as an application programming interface. Independent learning is encouraged as much as possible to diversify students' approaches using the software.

Learning Outcomes

Upon completion of this course, students are able to:

1. interpret the general structures and syntax of the CAD softwares in 2D and 3D drawing. (AutoCAD and 3ds Max)
2. construct C++ programs in procedural and functional-based styles to perform desirable tasks using OpenGL
3. perform analysis for case studies

MSG384/4 Introduction to Geometric Modelling

This course introduces students to the basic concepts of geometric modelling, especially in the field of Computer Aided Geometric Design. Emphasis is given on both mathematical and computational aspects in the process of designing curves and surfaces.

Learning Outcomes

Upon completion of this course, students are able to:

1. gain the knowledge of geometric modelling and able to practice them
2. analyse and interpret the geometric properties of curves and surfaces in mathematical representations
3. build and manipulate curves and surfaces with the assistance of computer

MSG386/3 Operations Research Laboratory

This course introduces operations research software packages like Excel Solver, LINDO, LINGO, etc to solve real-world problems. Students will be taught to formulate problems and interpret solutions using the software packages. The focus will be to train the students to possess the ability to model real-world problems and solve them via operations research software packages.

Learning Outcomes

Upon completion of this course, students are able to:

1. model real-world decision problems
2. develop a model for the problem using a combination of techniques
3. differentiate between multi-attribute and multi-objective decision making problems
4. apply the programming skills into solving the mathematical models

MSG422/4 Fluid Mechanics

This course describes the general equations, both integral and differential, that result from the conservation of mass principle, Newton's second law and the first law of thermodynamics. These general equations will be considered and applied to new and different situations.

Learning Outcomes

Upon completion of this course, students are able to:
1. classify the properties of fluid related concept such as viscosity, compressibility, laminar or turbulent flows
2. construct the governing equations of fluid mechanics using a finite control volume and an infinitesimally small fluid element model
3. compute quantities of interest based on different types of flow

MSG427/4 Environmental Modelling

In this course, techniques introduced in prerequisites courses are used to analyze models of environmental problems. These models are developed from first principles and the ramifications are analyzed using mathematical and numerical analysis.

Learning Outcomes

Upon completion of this course, students are able to:
1. formulate and solve simple real life problems by ODE using analytical and numerical methods
2. implement codes to solve real life problem
3. interpret and explain the results of mathematical models

MSG453/4 Queueing System and Simulation

The course provides a good understanding of the modelling of queues, using both queueing theory and using computer simulation. The queueing theory part of the course covers the used of mathematical techniques. It starts with the introduction of some basics terminologies and proceeds to discuss the characteristics of exponential distribution, the birth-and-death process, queueing models based on the birth-and-death process, queueing models involving non-exponential distributions and queueing network. The simulation part of the course, on the other hand, provides a good understanding of the theory of simulation and the skills needed in its practical application. The emphasis is on the discrete event simulation. There will be several computer laboratory sessions during the course. Students will gain experience and skills in using a well- known simulation software package.

Learning Outcomes

Upon completion of this course, students are able to:
1. derive the performance measurement formulae of various queueing models
2. master the usage of the simulation package
3. solve queueing system using analytical methods and simulation

MSG455/4 Game Theory

This course considers the interaction among a group of decision makers, where a person's decision is directly tied to another. As such, the theory of games and its applications in negotiation, strategic management, and economics would be covered. Students will be exposed to mechanism design for learning, reputation building, commitment, trust, as well as games involving imperfect information and bargaining. Some of the topics covered would be zero sum games, mixed strategies, maxmin strategies, Nash equilibria in mixed strategies, and multistage bargaining will be discussed.

Learning Outcomes

Upon completion of this course, students are able to:
1. think forward and reason backwards with the strategies provided
2. formulate and translate real life problems into decision models for problem solving
3. use mathematical programs for decision making and negotiation

MSG456/4 Mathematical Programming

This course introduces students to some techniques and algorithms used in solving unconstrained and constrained non-linear programming problems (NLPs). Students will be exposed to some case studies involving NLPs and there will be a computer laboratory session during the course.

Learning Outcomes

Upon completion of this course, students are able to:
1. recognize the differences between linear programming (LPs) and the non-linear programming (NLPs) problems
2. use software packages to solve NLPs and interpret the software output
3. select appropriate techniques to solve NLPs and able to interpret the solutions
4. formulate the real problems to NLPs

MSG460/3 Survival Analysis

This course introduces students to fundamental concepts in survival analysis. Parametric and non-parametric methods will be explored. The emphasis is on statistical methods, point estimation and tests of hypothesis.

Learning Outcomes

Upon completion of this course, students are able to:
1. explain the concepts of survival functions and censoring mechanisms
2. understand and apply the survival models
3. estimate the parameters in the models for survival data

MSG466/4 Multivariate Analysis

This course introduces students to the general ideas and techniques in multivariate analysis. This includes the techniques for examining and summarizing multivariate data. Statistical inferences on multivariate data are discussed and illustrated. Popular multivariate techniques and their applications are introduced, followed by the discussion on how to choose the appropriate technique and then the interpretation of the results from the analysis.

Learning Outcomes

Upon completion of this course, students are able to:
1. define and describe the ideas of multivariate data and techniques
2. analyze and interpret multivariate problems
3. display both graphics and quantitative multivariate techniques to data analysis
4. present orally and in written form pertaining to multivariate analysis
5. work as a team to solve multivariate problems

MSG467/4 Time Series Analysis

This course exposes students to the theory and application of time series modelling. Among the important areas covered are the fundamental concepts of time series models, Box-Jenkins ARIMA model, model identification, parameter estimation, diagnostic checking, model selection and forecasting. The course also introduces students to seasonal time series model as well as time-varying volatility GARCH model. The course also exposes students to computer software for time series analysis such as Minitab, SPSS and E-Views.

Learning Outcomes

Upon completion of this course, students are able to:
1. explain the fundamental concepts and terminologies of time series
2. differentiate time series elements such as non-stationary, seasonal and heteroscedasticity

3. identify, estimate and diagnose appropriate models for the given time series using statistical software
4. produce forecasts from the estimated model
5. produce a well-organized report which includes concise explanation of the steps taken and interpreting results of time series analysis

MSG469/4 Regression Analysis

This course introduces regression methods for the modeling of relationship between two or more variables. The course provides the knowledge for estimation, inferences, model building and diagnostics of the regression model. Model building involves several variable selection and best model selection techniques. Diagnostic tools are used to examine assumptions and adequacy of the model. Regression model for data with binary qualitative response variable will also be introduced.

Learning Outcomes

Upon completion of this course, students are able to:
1. define and describe linear regression model and its basic assumptions
2. build a regression model by using various variable selection techniques
3. examine adequacy of the fitted regression model
4. apply remedial measure to the violations of assumptions of the regression model
5. interpret results of regression analysis and produce well-organized report

MSG485/4 Finite Element Methods

The course gives a general introduction to finite element method as a common numerical analysis tool. It covers the fundamental theoretical approach. The implementation of finite element is taught through writing basic and then through the modification of example codes (written in C++, Matlab or Mathematica). Students are then introduced to an industrial strength finite element system. The course also gives students an understanding of finite element analysis as applied to stress analysis and heat transfer. Basic eigen-problem approaches are also covered.

Learning Outcomes

Upon completion of this course, students are able to:
1. describe basic theoretical principles of finite element
2. use this method to linear differential equations
3. efficiently implement this method in solving particular problem

MSG488/4 Mathematical Algorithms for Computer Graphics

This course discusses the algorithms of generating curves and surfaces in Computer Aided Geometric Design with an emphasis on the Bézier and B-spline representations. This course also introduces the methods of manipulating geometric objects using computer software.

Learning Outcomes

Upon completion of this course, students are able to:
1. analyse process of mathematical algorithms in computer graphics
2. use mathematical and computational methods to describe and design curves and surfaces
3. simulate and represent an object geometrically under computer control

MSG489/4 Numerical Methods for Differential Equations

The course introduces numerical methods for solving ordinary and partial differential equations encountered in various fields of sciences. It covers initial value and boundary value problems. The finite difference method and its implementation is emphasized.

Learning Outcomes

Upon completion of this course, students are able to:
1. identify appropriate numerical methods for solving differential equations
2. interpret numerical solutions of differential equations
3. solve scientific problems involving differential equations using numerical methods

MSG491/6 Project

The aims of this course are to give an opportunity for students to work on a particular topic relevant to their program; to give students an introduction to the methods and experience of research, and to make them better prepared to start a research degree or work in a research and development environment; to develop students' ability to organize their work in a substantial project; and to develop students' ability to present their work in both written and oral form.

Learning Outcomes

Upon completion of this course, students are able to:
1. conduct research projects
2. conduct a meaningful discussion related to all aspects of the project
3. write reports and report research findings

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SCHOOL OF BIOLOGICAL SCIENCES

SCHOOL OF BIOLOGICAL SCIENCES

(www.bio.usm.my)

Introduction

Excellence in research and teaching is our aspiration, which is driven by research-active staff from diverse academic and research backgrounds. We offer exciting opportunities to students over a wide variety of topics related to Biological Sciences. Students are exposed to essential fundamental knowledge on ecosystem, biodiversity, plants, animals and microbial and cellular processes in the first year. Towards the end of second year, students can choose to specialise in either Agrobiology, Aquatic Biology, Entomology and Parasitology, Biotechnology or Environmental Biology leading to a degree in Bachelor of Applied Science (Honours) in four years. In addition, students are also encouraged to register for an optional internship programme (Elective Course) during the semester break at the end of the 3rd year (Semester 2). The 2 months internship programme will provide students with valuable industry and corporate exposures.

Students graduating from the School of Biological Sciences will be equipped with the following knowledge:

a. The diversity of life forms and the reasons for this.
b. The intricate relationships between life forms and their environments.
c. Role of all life forms in maintaining the delicate balance of our ecosystem.
d. Good Laboratory Practices and usage of common and advanced laboratory equipment.
e. Ability to design and implement scientific experiments.
f. Ability to write reports and make scientific presentations.

The knowledge acquired by the students will enable them to make wise decisions with respect to the current global environmental issues such as pollution, environmental deterioration, biodiversity loss, deforestation, global warming and climate change. In addition, the students also develop innovative skills and are able to generate and test new ideas**.** Students with this essential knowledge will excel in any career path that they choose. The School of Biological Sciences is proud to produce students who can think in a holistic manner to ensure a sustainable tomorrow.

Vision

Centre of excellence for education and research in the field of biological sciences.

Mission

a. To provide quality and innovative teaching and learning for its entire degree programme.
b. To achieve research excellence.
c. To establish and enhance collaboration with industries for education input and research.
d. To serve the society and country by providing the latest knowledge and technology.

Administration	Telephone Extension	Email
DEAN		
Prof. Dr. Amirul Al-Ashraf Abdullah	3181/3815	amirul@usm.my
DEPUTY DEAN		
Academic, Career & International		
Assoc. Prof. Dr. Asyraf Mansor	3503/3905/6153	asyrafm@usm.my
Research, Innovation & Industry-Community Engagement		
Prof. Dr. Latiffah Zakaria	3503/5016/3506	Lfah@usm.my
PROGRAMME MANAGERS		
Agrobiology, Entomology and Parasitology		
Assoc. Prof. Dr. Zary Shariman Yahaya	6155	zary@usm.my
Aquatic and Environmental Biology		
Dr. Mahadi Mohammad	3534	mahadi@usm.my
Biotechnology and Microbiology		
Assoc. Prof. Dr. Rashidah Abdul Rahim	6158	rshidah@usm.my
Plant and Animal Biology		
Assoc. Prof. Dr. Nik Fadzly N Rosely	5489	nfadzly@usm.my
ASSISTANT REGISTRARS		
Deputy Registrar		
Mr. Mokhtar Alfakari Anurbek	3535	alfakari@usm.my
Senior Assistant Registrar		
Mrs. Nor Ezliza Hasim	4035	ezliza@usm.my

STAFF AND ADMINISTRATION

DEAN

Prof. Dr. Amirul Al-Ashraf Abdullah

DEPUTY DEANS

Assoc. Prof. Dr. Asyaraf Mansor
(*Academic, Career & International*)

Assoc. Prof. Dr. Yahya Mat Arip
(*Research, Innovation & Industry – Community Engagement)*

PROGRAMME MANAGERS

Dr. Mahadi Mohammad
(*Aquatic and Environmental Biology*)

Assoc. Prof. Dr. Zary Shariman Yahaya
(*Agrobiology, Entomology and Parasitology*)

Assoc. Prof. Dr. Rashidah Abdul Rahim
(*Biotechnology and Microbiology*)

Assoc. Prof. Dr. Nik Fadzly N. Rosely
(*Plant and Animal Biology*)

DEPUTY REGISTRAR

Mr. Mokhtar Alfakari Anurbek

SENIOR ASSISTANT REGISTRAR

Mrs. Nor Ezliza Hasim

ADMINISTRATIVE ASSISTANT (SECRETARIAL)

Mrs. Mazlinda Mydin Pitchay [Dean]	3181	mazlinda@usm.my
Mrs. Zarina Ibrahim [Deputy Dean]	3503	zarinami@usm.my

CHIEF ADMINISTRATIVE ASSISTANT (CLERICAL/OPERATIONS)

Mrs. Siti Murni Abu Seman	3906	siti_murni@usm.my

ADMINISTRATIVE ASSISTANT (CLERICAL/OPERATIONS)

Mrs.Hasmimi Md Akhir - Human Resources	3961	hasmimi@usm.my
Mr. Nor Azam Samsudin - Academics (Postgraduate)	3961	norazamsamsudin@usm.my
Mrs. Nor Azawati Abd Malek Academics (Undergraduate)	5132	azawati@usm.my
Mrs. Nor Rafida Abdul Karim - Academics (Postgraduate)	5134	norrafida@usm.my
Mrs. Nur Syazwani Mohd Shariff - Academics (Undergraduate)	5134	syazwanie@usm.my
Mrs. Safiyah Mohd Yusoff - Financial (School)	3529	safiyahyusoff@usm.my
Mrs. Shabariah Ahmed - Store (Chemicals)	3536	shabariah@usm.my
Ms. Nur Zahirah Md Ismail - Financial (Grants)	6150	nurzahirah@usm.my

OFFICE ASSISTANT

Mr. Mohd Izad Farid Abd Rahim	5135	izad_farid@usm.my
Mr. Noor Sharizwan Che Anoor	5135	sharizwan@usm.my

General Office Facsimile No. 04-6565125

RESEARCH OFFICER

Ms. Hasni Abu Hassan - *Herbarium section*	6160	hasni@usm.my
Mrs. Rosilawati Abdullah - *Herbarium section*	2713	tie@usm.my
Mrs. Siti Ruzainah Omar	3963	sruzai@usm.my
Mrs. Zarina Mohd. Yassan	4010	zarina@usm.my
Dr. Manorengitha Malar a/p Sivanathan - *Entomology Section*	2717	manorengitha@usm.my
Ms. Nurlina Rosli	6254	nurlina@usm.my

SCIENCE OFFICER

Mr. Adanan Che Rus	4229	adnanrus@usm.my
Mr. Adril Ellmi Mohd Adnan	6255	adril@usm.my
Mrs.Roziana Mat Khairuddin	5879	roziana@usm.my
Ms. Norahizah Abd. Rahim	5490	norarahim@usm.my

TECHNICIAN

Mr. Masrul Mansor	3502	masrul@usm.my
Mr. Mazlan Abdul Halil	3584	ahmazlan@usm.my
Mr. Saadon Zubir	3584	saadonzubir@usm.my

ACADEMIC STAFF

1. AGROBIOLOGY, ENTOMOLOGY AND PARASITOLOGY

Programme Manager

Assoc. Prof. Dr. Zary Shariman Yahaya	6155	zary@usm.my

Lecturer

Prof. Dr. Zairi Bin Jaal	4153	zairi@usm.my
Prof. Dr. Latiffah Binti Zakaria	3506	Lfah@usm.my
Prof. Madya Dr Hamdan Ahmad	3053	hamdana@usm.my
Prof. Madya Dr. Wan Fatma Zuharah Binti Wan Musthapa	6130	wfatma@usm.my
Prof. Madya Dr. Zary Shariman Bin Yahaya	6155	zary@usm.my
Prof. Madya Dr.Abdul Hafiz Ab Majid	4893	abdhafiz@usm.my
Dr.Ahmad Bukhary Bin Ahmad Khair	6664	abukhary@usm.my
Dr. Mohammad Fadhli Mad' Atari	3087	madatari@usm.my
Dr. Nik Ahmad Irwan Izzauddin Bin Nik Him	3505	nikirwan@usm.my
Dr. Nur Faeza Binti Abu Kassim	5138	nurfaeza@usm.my
Dr. Siti Nasuha Binti Hamzah	4061	sitinasuha@usm.my
Dr. Suhaila Binti Ab Hamid	5874	ahsuhaila@usm.my
Dr. Farah Haziqah Binti Meor Termizi	3527	farahhaziqah@usm.my
Dr. Hadura Binti Abu Hasan	3515	hadura@usm.my
Dr. Hafizi Bin Rosli	4954	hafizirosli@usm.my
Dr. Hasber Bin Salim	3011	hasbersalim@usm.my
Dr. Hasnuri Binti Mat Hassan	3962	hasnurimh@usm.my
Dr. Intan Haslina Binti Ishak	5137	intanishak@usm.my
Dr. Masratul Hawa Binti Mohd	4009	masratulhawa@usm.my
Dr. Nik Mohd Izham Bin Mohamed Nor	4002	nikizham@usm.my
Dr. Rosnida Binti Tajuddin	4001	rosnidatajuddin@usm.my

2. AQUATIC AND ENVIRONMENTAL BIOLOGY

Programme Manager

Dr. Mahadi Mohammad	5912	mahadi@usm.my

Lecturer

Prof. Dato' Dr. Tan Shau Hwai	3508	aileen@usm.my
Prof. Dr Chong Shu Chien @ Alexander	5501/4014	alex@usm.my
Prof. Dr. Ng Wing Keong	4052	wkng@usm.my
Prof. Dr. Zulfigar Yasin	3500	zulfigar@usm.my
Profesor Dr. Wan Maznah Binti Wan Omar	3533	wmaznah@usm.my
Dr. Amir Shah Rudin Md Shah	6201	amirshah@usm.my
Dr. Azma Hanim Ismail	6170	azmahanim@usm.my
Dr. Faradina Merican Mohamed Sidik Merican	5878	faradina@usm.my faradeena@gmail.com
Dr. Foong Swee Yeok	3511	foong@usm.my
Dr. Hazzeman Bin Haris	6662	hazzeman@usm.my
Dr. Mahadi Mohammad	3534	mahadi@usm.my
Dr. Noor Khalidah Binti Abdul Hamid	3516	khalidah.hamid@usm.my
Dr. Nurul Salmi Binti Abdul Latip	6151	salmi@usm.my
Dr. Shuhaida Binti Shuib	6296	shuhaidashuib@usm.my

3. BIOTECHNOLOGY AND MICROBIOLOGY

Programme Manager

Assoc. Prof. Dr. Rashidah Abdul Rahim	6158	rshidah@usm.my

Lecturer

Prof. Dr. Amirul Al-Ashraf Abdullah	3815	amirul@usm.my
Prof. Dr. Darah Binti Ibrahim	2926	darah@usm.my
Prof. Dr. Mohd Nazalan Bin Mohd Najimudin	6159	nazalan@usm.my
Prof. Dr. K Sudesh Kumar A/L C Kanapathi Pillai	4367	ksudesh@usm.my
Prof. Madya Dr. Ahmad Ramli Mohd Yahya	6163	armyahya@usm.my
Prof. Madya Dr. Amir Hamzah Ghazali	4008	amirhg@usm.my

Dr. Amira Suriaty Binti Yaakop	6204	amirasuriaty@usm.my
Dr. Kamarul Zaman Bin Zarkasi	6152	kamarul.zarkasi@usm.my
Dr. Nethia A/P Mohana Kumaran	4016	nethiakumaran@usm.my
Dr. Siti Khayriyyah Binti Mohd Hanafiah	3517	kye@usm.my
Dr. Yazmin Binti Bustami	6663	ybustami@usm.my
Dr. Chew Bee Lynn	3521	beelynchew@usm.my
Dr. Mohd Ghows Bin Mohd Azzam	4005	ghows@usm.my
Dr. Nur Asshifa Binti Md Noh	6157	nurasshifa@usm.my

4. PLANT AND ANIMAL BIOLOGY

Programme Manager

Assoc. Prof. Dr. Nik Fadzly Nik Rosely	5489	nfadzly@usm.my

Lecturer

Prof. Dr. Ahmad Sofiman Othman	4019	sofiman@usm.my
Prof. Dr. Shahrul Anuar Bin Mohd Sah	3524	sanuar@usm.my
Prof. Dr. Sreeramanan A/l Subramaniam	3528	sreeramanan@usm.my
Prof. Madya Dr. Asyraf Bin Mansor	6153	asyrafm@usm.my
Prof. Madya Dr. Rahmad Bin Zakaria	6154	rahmadz@usm.my
Dr. Darlina Md. Naim	4056	darlinamdn@usm.my
Dr. Farah Alia Binti Nordin	6161	farahalianordin@usm.my
Dr. Khaironizam Bin Md Zain	3531	khaironizam@usm.my
Dr. Nadine Brigitte Ruppert	3513	n.ruppert@usm.my
Dr. Nurul 'Ain Binti Elias	6661	nurulain.elias@usm.my
Dr. Rosazlina Binti Rusly	6203	rosazlinarusly@usm.my
Dr. Sebastien Lavoue	3522	sebastien@usm.my
Dr. Zarul Hazrin Bin Hashim	6172	zarul@usm.my

GENERAL INFORMATION

1. Career

The School of Biological Sciences is located at the main campus of Universiti Sains Malaysia (USM), Penang. It is one of the three pioneering schools to be set up when USM was established in 1969. Ever since then, it has grown rapidly to become an outstanding research-intensive school, which now boasts the largest number of post-graduate students in the university. Because of the presence of a large population of graduate students, the undergraduates are naturally inspired to continue with postgraduate studies. Every year, a significant number of undergraduates continue to pursue their Masters and Ph.D. Those that choose to pursue their careers elsewhere are usually recruited by pesticide and pest management industries, aquaculture industries, food industries, electronics industries, microbiology and biotechnology industries medical devises industries. In addition, various governmental and semi-governmental organisations and R&D centers also hire a significant number of graduates. These include Forest Research Institute of Malaysia (FRIM), Federal Land Development Authority (FELDA), Malaysian Palm Oil Board (MPOB), Institute for Medical Research (IMR) and many more.

2. Alumni

Our graduates are automatically become members of the growing family of USM's alumni, which to date amounting to some 100,000 members! Its mission is to mobilise resources and advance the USM alumni as an innovative fraternity which nurtures its members and rallies its stakeholders to contribute to the university and society. For further details, please visit www.alo.usm.my.

3. Awards and Dean's Certificate

The graduating students from the School of Biological Sciences are considered for a number of awards at both the university and the school levels. These awards are available to outstanding students:

a. **Chancellor's Gold Medal Award -** awarded to the best final year student in all fields.
b. **Royal Education Award -** awarded to the best student in all fields, by the Majlis Raja-Raja Melayu.
c. **USM Gold Medal Award** - awarded to the best female final year student in all fields, by Persatuan Wanita USM
d. **USM Gold Medal Award** - awarded to the best Bachelor of Applied Science (Honours) degree final year student, by Nestle Products Sdn. Bhd.
e. **USM Gold Medal Award** - awarded in memory of Professor E. Balasingham is to the best final year student in the field of Biology.
f. **USM Gold Medal Award -** awarded to the best final year student in the field of Biology (Major in Environmental and Aquatic Biology) by Professor Mashhor

Mansor.

In addition, at each semester, the students who achieved academic excellence will also be awarded the **Dean's Certificate**.

4. Clubs and Society

Bio Society (BioSoc) is a platform for students to interact with one another, as well as with the academic, administrative and supporting staff. Led by the undergraduates, the society is advised by a faculty member and the Dean. BioSoc regularly organizes academic, non-academic, recreation and student development programmes that are essential in creating versatile students and individuals. As a result of these initiatives, the School of Biological Sciences' Alumni Society was created to gather and reunite as many former students and staff of the school. Bio Society' motto *"Inspire Your Life"* is timely as it is also involved with the community and schools through awareness programmes on the potentials of biology as well as addressing the issues of sustainable development.

5. Graduate Programme (Master and Doctor of Philosophy)

A large number of students from the School of Biological Sciences pursue higher degrees with us. We offer both full and part-time programmes leading to degrees of Master of Science and Doctor of Philosophy by research.

For further details please contact :-
Deputy Dean (Research, Postgraduate and Networking)
School of Biological Sciences
Universiti Sains Malaysia
11800 Minden
Penang, Malaysia

Tel : 604-653 3503/5016

For more information pertaining to postgraduate studies in USM particularly in School of Biological Sciences, please visit bio.usm.my and www.ips.usm.my.

6. Industry and Community Network

The school reaches out to the local and international communities *via* active research and academic collaborations. Locally, the School of Biological Sciences has very close relationships with FRIM, Forest Department, Department of Agriculture, FELDA, Fisheries Department, MACRES and SIRIM. Internationally, the school has student and staff exchange programmes with world-class research institutions such as Universite of Loraine (France), RIKEN (Japan), Purdue University (USA), Mississippi State University (USA), University of Georgia (USA) and Kyoto University (Japan).

Listed below are the members of the Industry and Community Advisory Panels (ICAP) for School of Biological Sciences, USM :-

1) Y. Bhg. Dato' Dr. Dionysius S.K. Sharma – World Wide Fund for Nature.
2) Mr. Shahrem Md Ramli – Ensystex (Malaysia) Sdn. Bhd.
3) Dr. Mohd Aizuddin Kamaruddin – Agilent Technologies LDA Malaysia Sdn. Bhd.
4) Dr. Allen Tan – The Habitat Penang Hill.

7. Facilities

As a research-intensive school driven by research-active staff, the School of Biological Sciences is equipped with various cutting-edge facilities such as the Electron Microscopy. This facility is used heavily by students and researchers from our school as well as from other schools in USM and other universities in Malaysia.

In addition, the Electron Microcopy Unit has also been providing services to the manufacturing industries in this region for the last 20 years particularly for *Failure Analysis, Quality Control, and R & D* investigations. The facilities provided by the unit include Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Energy Dispersive X-Ray Microanalysis (EDX), Light Microscopy (LM) and Image Analysis (IA). The school has recently acquired an EF-TEM (Zeiss-Libra120) with EELS, ESI and electron diffraction accessories.

DEGREE IN BACHELOR OF APPLIED SCIENCE

1. Bachelor of Applied Science Degree Programme

Students undertaking the Bachelor of Applied Science degree under the School of Biological Sciences may elect to specialise in one of the following five (5) areas of specialisation/major listed below :-

a. Agrobiology
b. Aquatic Biology
c. Entomology and Parasitology
d. Biotechnology
e. Environmental Biology

2. Graduation Requirements

Students must fulfill the following requirements to graduate :-

a. Fulfill the minimum residential requirement for the programme which is 8 semesters.
b. Fulfill all the credit requirements of the programme and required units for each component (Core, Elective/Minor and University components).
c. Obtain a minimum CGPA of 2.00 for the Core component/courses.
d. Obtain a minimum CGPA of 2.00 for the overall programme.
e. Obtain a minimum grade C for all of the University courses.

3. Curriculum and Graduation Structure

In order to qualify for the Bachelor of Applied Science degree, students are required to accumulate **122 – 124 units** over a period of **not less than 8 semesters (minimum residential requirement of 8 semesters)**. There are 2 types of study mode under the Bachelor of Applied Science degree for students to choose, Minor structure or Elective structure :-

a. Minor Structure

Course Component		Course Code Type	Minimum No. of Units Required
CORE	Basic • 38 units	**T**	74 – 76
	Compulsory • 36 – 38 units		
ELECTIVE		**E**	14 - 15
MINOR		**M**	16
**** UNIVERSITY**		**U**	18
		TOTAL :	**122 – 124**

b. Elective Structure

Course Component		Course Code Type	Minimum No. of Units Required
CORE	Basic • 38 units	**T**	74 – 76
	Compulsory • 36 – 38 units		
ELECTIVE		**E**	30 - 31
**** UNIVERSITY**		**U**	18
		TOTAL :	**122 – 124**

***** Details of University courses offered (Table 1 and Table 2) (page 15).***

(i). Table 1 : ***For Malaysian students***

No.	Name of Course	No. of Units
1	Bahasa Malaysia IV (Malay Language) - Course code = *LKM400* (2 units)	2
2	a. Academic English (English Language) - Course code = *LSP300* (2 units) b. Scientific And Medical English (English Language) - Course code = *LSP402* (2 units)	4
3	Islamic Civilisation and Asian Civilisations (TITAS) - Course code = *HTU223* (2 units)	2
4	Ethnic Relations - Course code = *SHE101* (2 units)	2
5	Core Entrepreneurship - Course code = *WUS101* (2 units)	2
6	Co-curriculum/ Skills Courses/Option	6
	TOTAL :	**18**

(ii). Table 2 : ***For international students***

No.	Name of Course	No. of Units
1	Bahasa Malaysia I (Malay Language) - Course code = *LKM100* (2 units)	2
2	a. Academic English (English Language) - Course code = *LSP300* (2 units) b. Scientific And Medical English (English Language) - Course code = *LSP402* (2 units)	4
3	Malaysian Studies - Course code = *SEA205E* (4 units)	4
4	Core Entrepreneurship - Course code = *WUS101* (2 units)	2
5	Co-curriculum/ Skills Courses/Option	6
	TOTAL :	**18**

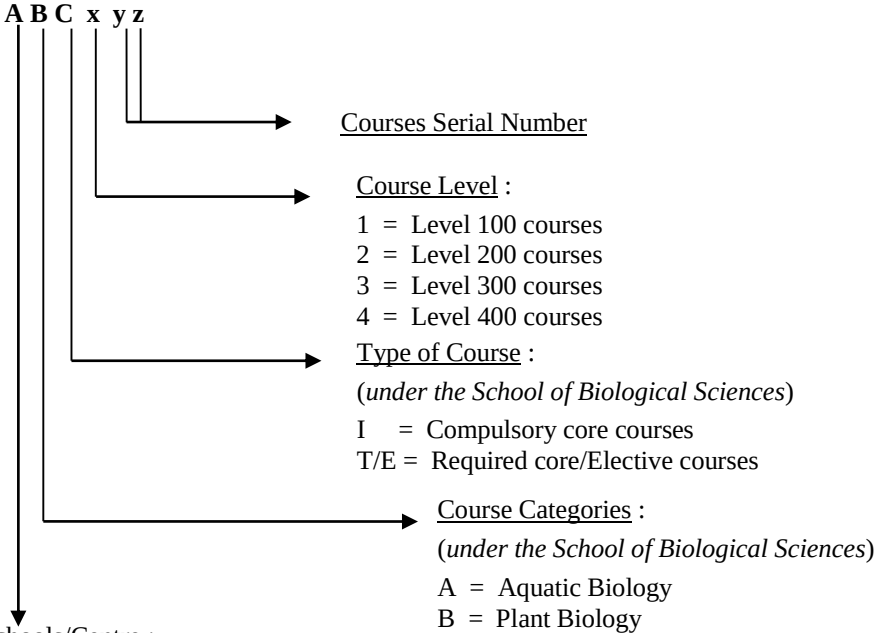
4. Classification of Year Equivalent

Students are classified as being in the first, second, third or fourth year based on the number of credits accumulated as follows:

Degree	Year equivalent based on total units accumulated			
	First	**Second**	**Third**	**Fourth (Final)**
Bachelor of Applied Science	0 - 32	33 - 62	63 – 95	≥ 96

5. Course Code

Each course has a course code which is made up of 3 alphabets and 3 numbers.
Its explanation is as follows :-



6. Course Definition

a. Core Courses (Course code type = **T**)

The Core Courses component is made up of courses of level 100, 200, 300 and 400. It includes the Basic Core courses ('Teras Asas') and the Compulsory Core courses ('Teras Wajib'). Courses in the Basic Core and Compulsory Core groups are compulsory Level 100 courses where students must attain passing grades.

b. Elective (Course code type = **E**)

Elective courses are those that enhance or support a particular specialization or major in a programme of study. These are courses at the 200, 300 and 400 level for specific fields of specialization only.

c. Minor Courses (Course code type = **M**)

Minor courses are a package of courses in one area of specialization or a package of courses reserved for and offered to students of another programme of study.

d. Optional Courses (Co-curriculum/ Skills courses) (Course code type = **U**)

Optional courses are courses chosen by students from among those that are outside their program of study. Optional Course is a substitute course for students who do not take Cocurriculum courses and Skill/Analysis courses.

e. Audit Courses (Course code type = **Y**)

In principle, the university allows students to register for any course on an audit basis for the purpose of enhancing the students knowledge in specific fields during their study. However, the units of any such audit courses will not be taken into consideration for graduation purposes.

7. Prerequisite Courses (Course code type = **Z**)

Student are allowed to register for any course provided they fulfill the prerequisites of the course. There are 3 types of prerequisites.

a. Pass (**P**)

If a Pass in Course A is a prerequisite for Course B, then student must take Course A and obtain the mínimum of a Grade C before he/she is allowed to take Course B.

b. Sequential (**S**)

If Course A is a sequential prerequisite (S) for Course B, then a student must take Course A and sit for the examination before he/she is allowed to take Course B.

c. Concurrent (**C**)

If Course A is a concurrent prerequisite for Course B, then a student must take Course A and sit for the examination at the same time as Course B.

8. Minor package

Offering School/Centre	Title of Minor Package - Choose one (1) Minor package only - Minimum 16 units for any selected package - Refer to the school/centre for the courses offered under each package
School of Social Sciences	• Anthropology And Sociology • Economics • Psychology • Development Planning And Management • Political Science • International Relations • Public Policy And Administration • Southeast Asian Studies
School of Humanities	• English Language • Malay Language • Philosophy And Civilization • Geography • Literature • Islamic Studies • History • Translation And Interpretation
School of Management	Management
School of Communication	Communication Studies
School of Languages, Literacies and Translation	• Japanese Language • Chinese Language • Communicative Arabic • French Language • English For Professionals

School of the Arts	• Fine Arts • Communications Graphics • Acting and Directing • Seni Persembahan dan Pedagogi • Music Technology
School of Industrial Technology	• Bio-Resource, Paper and Coating Technology • Food Technology
School of Computer Sciences	• Computer Science • Information Technology
School of Physics	Astronomy
School of Chemical Sciences	Chemistry
School of Mathematical Sciences	Mathematics
Centre for Global Archaeological Research	Archaeology

CORE COURSES (74 – 76 Units)

The Core Courses component is made up of courses of level 100, 200, 300 and 400. The cources include Basic Core courses ('Teras Asas') and Required Core courses ('Teras Wajib'). Courses in the Basic Core and Required Core groups are compulsory where students must attain passing grades.

(i). BASIC CORE COURSES (38 UNITS)

Basic core courses are offered by various science schools which are School of Biological Sciences, Physics, Chemical Sciences and Mathematical Sciences. All undergraduate students of the School of Biological Sciences must enrol and attain passing grades for these courses. Students must obtain a total of **38 units**. The courses are as follows :-

Year	Semester	Course Code	Course Title	Total Units Required
1	1	KOT 122/4	Organic Chemistry I	24
	2	KTT 112/4	Inorganic Chemistry I	
	1 or 2	MAA 101/4	Calculus (for First Year Science Students)	
		BOI 102/3	Ecology	
		BOI 115/3	Plants and Animals Biodiversity	
		BOI 116/4	Genetics	
		BOI 117/2	Biodiversity and Ecology Practical	
2	1 or 2	BOI 205/4	Biostatistics	11
		BOI 206/4	Principles of Biochemistry	
		BOI 207/3	General Microbiology	
4	1	BOI 401/3	Scientific Writing, Seminar and Current Topics in Biology	3

(ii). REQUIRED CORE COURSES (36 – 38 UNITS)

Required Core courses are those courses offered at Levels 300 and 400 that have been identified according to each specialisation programme namely **Agrobiology**, **Aquatic Biology**, **Entomology and Parasitology**, **Biotechnology** and **Environmental Biology.** Students must enrol in all the required core courses that are listed in their respective field of specialisation.

FINAL YEAR PROJECT (8 UNITS)

All final year Biology students are given the option to register for a final year project of 8 units which spans over 2 semesters. At the end of the second semester, a thesis based on the existing regulations and format must be submitted for examination.

Before a student is allowed to register for the final year project in their respective field of specialisation, the student must have achieved these **minimum cumulative unit requirement**.

- Total overall unit = 89 - 95 units
- Total unit for Biology courses = 59 - 65 units

Students who do not wish to register for a final year project must substitute the 8 units with BOE 400/2 – Special Topics in Biology (which carries 2 units), while the remaining 6 units are fulfilled by taking elective courses that are suitable with his/her field of specialisation and approved by the programme chairperson.

FIELD OF SPECIALISATIONS

a. AGROBIOLOGY

Objectives: The Agrobiology programme encompasses the use of modern biological techniques in the agricultural output system. The main objective of this programme is to explore various approaches in the agriculture system to ensure optimum and economical plant health and yield. Students learn basic entomology and roles of insects in agricultural systems, and an introduction to plant pathology centered on an understanding of plant diseases, disease mechanisms and pathogen interactions. Students are also equipped with basic knowledge in insect pest management strategies to gain an insight to the development of plant disease control methods and management strategies. The ultimate goal of the program is to be able to handle problems related to plant productivity in the development of agriculture based industry in the country.

Course Code	Course Title	Semester	Course Prerequisite	
Required Core - Level 300 = 16 Units				
BET 305/4	Insect Biology and Systematics	1	BOI 115/3	(S)
BGT 301/3	Plant Pathology	1	BGT 302/2	(C)
BGT 302/2	Basic Practical In Plant Pathology	1	BGT 301/3	(C)
BBT 305/4	Plant Physiology and Development	2	BOI 115/3	(S)
BST 306/3	Soil Science and Environment	1	BOI 102/3	(S)
Required Core - Level 400 = 20 Units				
BGT 400/3	Agriculture, Forest and Stored Product Pests	1	BET 305/4	(S)
BGT 401/8	Agrobiology Project	1 & 2		
or	or			
*BOE 400/2	Special Topics in Biology			
BGT 402/4	Tropical Plant Disease Management	1	BGT 301/3 BGT 302/2	(S)
BGT 403/2	Advanced Plant Pathology Laboratory	2	BGT 302/2 BGT 402/4	(S) (S)
BGT 404/3	Horticultural Science	2	BOI 116/4	(S)
* requires 6 more units from Elective courses				

Elective = 14 Units				
BOE 201/3	Biological Instrumentation	1 & 2	BOI 206/4	(C)
BOT 205/3	Microscopy and Histological Techniques	1 & 2		
BTT 306/3	Techniques in Biotechnology	1 & 2	BOI 206/4	(S)
BMT 310/3	Bacteriology	1	BOI 207/3	(S)
BMT 308/3	Mycology	1	BOI 115/3	(S)
BMT 306/3	Virology	1	BOI 207/3	(S)
BEE 305/3	Pesticide Science	2	BET 305/4	(S)
BET 306/3	Insect Ecology	2	BOI 115/3	(S)
BOA 301/4	Industrial training	2		
BBT 404/3	Economic Botany	1	BOI 115/3	(S)
BBT 405/3	Plant Tissue Culture	2	BOI 115/3	(S)
			BOI 206/4	(S)
BBT 402/3	Plant Genetics	1	BOI 116/4	(S)
			BOI 206/4	(S)
BST 402/3	Ecology of Invasive Species	1	BOI 102/3	(S)
			BOI 117/2	(S)
BET 406/3	Integrated Pest Management	2	BET 305/4	(S)
BME 401/3	Soil Microbiology	2	BOI 207/3	(S)

Elective (<u>14 units under Minor structure</u> or 30 units under Elective structure)

- Students must choose among listed courses to complete a total of 14 or 30 units for Electives.

(S) = Course must be taken in sequential order.

(C) = Course must be taken concurrently.

b. AQUATIC BIOLOGY

Objectives : The main objective of the Aquatic Biology specialisation is to expose students to the basic principles of aquatic science. With the basic knowledge acquired in this thrust area, students can then utilise it in applied fields. Students will be exposed to the structures and functions of aquatic flora and fauna. They will also be exposed to ecological aspects of various ecosystems, as well as management, sustainable utilization and conservation of aquatic resources for various purposes. Upon successful completion of the programme, students are expected to have grasped the necessary knowledge and skills to manage the aquatic resources.

Course Code	Course Title	Semester	Course Prerequisite	
Required Core - Level 300 = 16 Units				
BAT 306/3	Oceanography	1	BOI 102/3	(S)
BAT 307/3	Ichthyology	1	BOI 115/3	(S)
BAT 308/3	Limnology	1	BOI 102/3	(S)
BAT 304/4	Coastal and Marine Ecosystems	2	BOI 102/3	(S)
BAT 305/3	Benthic Biology and Ecology	2	BOI 102/3	(S)
Required Core - Level 400 = 21 Units				
BAT 401/8	Project in Aquatic Biology	1 & 2		
or	or			
*BOE 400/2	Special Topics in Biology	1 & 2		
BAT 404/4	Aquaculture	1	BOI 102/3	(S)
BET 404/3	Parasites of Aquatic Animals	1	BET 304/4	(S)
BAT 402/3	Fisheries Management	2	BAT 307/3	(S)
BAT 403/3	Management of Aquatic Systems	2	BAT 304/4	(S)
* requires 6 more units from other biology elective courses				
Elective = 14 Units				
BOE 201/3	Biological Instrumentation	1 & 2	BOI 206/4	(C)
BOT 205/3	Microscopy and Histological Techniques	1 & 2		
BOA 301/4	Industrial Training	2		
BET 304/4	Introductory Parasitology	1	BOI 115/3	(S)
BST 305/3	Environmental Pollution	1	BOI 102/3	(S)
BST 306/3	Soil Science and Environment	1	BOI 102/3	(S)
BST 307/3	Population and Community Ecology	2	BOI 102/3	(S)

BST 308/3	Tropical Ecosystems and Climate Change	2	BOI 102/3	(S)
BMT 307/3	Environmental Microbiology	2	BOI 207/3	(S)
BZT 304/3	Invertebrate Zoology	1	BOI 115/3	(S)
BZT 305/3	Vertebrate Zoology	1	BOI 115/3	(S)
BZT 307/3	Animal Physiology	2	BOI 115/3	(S)
BST 405/3	Conservation Ecology and Natural Resources	1	BST 308/3	(S)
BST 402/3	Ecology of Invasive Species	1	BOI 102/3	(S)
			BOI 117/2	(S)
BST 403/3	Environmental Management	2	BST 305/3	(S)
BST 404/3	Wildlife Ecology and Management	2	BST 307/3	(S)
BZT 404/3	Animal Conservation Genetic	2	BOI 116/4	(S)
			BOI 115/3	(S)
Elective (<u>14 units under Minor structure</u> or 30 units under Elective structure) - Students must choose among listed course to complete a total of 14 or 30 units for Electives.				

(S) = Course must be taken in sequential order.

(C) = Course must be taken concurrently.

c. ENTOMOLOGY AND PARASITOLOGY

Objectives : Even in the midst of modernization, many tropical and temperature countries continue to be affected by the vector-borne diseases like malaria, filariasis, dengue/haemorrhagic dengue and other diseases. These issues have brought high rate of illness and mortality to many tropical nations. The field of Entomology and Parasitology was initiated with the objective of increasing the knowledge and understanding of the biology of insect vectors such as mosquitoes and house-flies, and their relationships with the disease parasites or pathogens that they transmit. In this thrust area, students are exposed to the structure and function, life history, ecology and vector and parasite behaviour that will assist in the understanding of disease epidemiology as well as various management strategies. In addition, students specializing in the field will also learn the biology, ecology, behaviour and management of important urban and industrial insect pests such as cockroaches, pest ants, termites, bed bugs and stored product insects that are most relevant to the pest management industries.

Course Code	Course Title	Semester	Course Prerequisite	
Required Core - Level 300 = 14 Units				
BET 304/4	Introductory Parasitology	1	BOI 115/3	(S)
BET 305/4	Insect Biology and Systematics	1	BOI 115/3	(S)
BET 306/3	Insect Ecology	2	BOI 115/3	(S)
BET 307/3	Insect Physiology and Biochemistry	2	BET 305/4	(S)
Required Core - Level 400 = 24 Units				
BET 401/8 or *BOE 400/2	Research Project in Entomology and Parasitology or Special Topics In Biology	1 & 2 1 & 2		
BET 402/4	Medical and Urban Entomology	1	BET 305/4	(S)
BET 404/3	Parasites of Aquatic Animals	1	BET 304/4	(S)
BET 403/3	Medical and Veterinary Protozoology	2	BET 304/4	(S)
BET 405/3	Medical and Veterinary Helminthology	2	BET 304/4	(S)
BET 406/3	Integrated Pest Management	2	BET 305/4	(S)
* requires minimum 6 more units from Elective courses				

Elective = 14 Units				
BOE 201/3	Biological Instrumentation	1 & 2	BOI 206/4	(C)
BOT 205/3	Microscopy and Histological Techniques	1 & 2		
BST 307/3	Population and Community Ecology	2	BOI 102/3	(S)
BMT 311/3	Immunology	2	BOI 207/3	(S)
BST 403/3	Environmental Management	2	BST 305/4	(S)
BZT 304/3	Invertebrate Zoology	1	BOI 115/3	(S)
BZT 305/3	Vertebrate Zoology	1	BOI 115/3	(S)
BZT 306/3	Animal Behaviour	2	BOI 115/3	(S)
BZT 307/3	Animal Physiology	2	BOI 115/3	(S)
BZT 402/3	Biology of Vertebrate Pest Animals	1	BOI 115/3	(S)
BEE 305/3	Pesticide Science	2	BET 305/4	(S)
BOA 301/4	Industrial Training	2		
BGT 400/3	Agriculture, Forest and Store Product Pests	1	BET 305/4	(S)

Elective (<u>14 units under Minor structure</u> or 30 units under Elective structure)

- Students must choose among listed course to complete a total of 14 or 30 unit for Electives.

(S) = Course must be taken in sequential order.

(C) = Course must be taken concurrently.

d. BIOTECHNOLOGY

Objectives : Biotechnology, an area of applied biology, involves the practical application of cells or their components in the manufacturing and service industries. Biotechnology is multidisciplinary, involving the integration of knowledge from microbiology, biochemistry, genetics, molecular and structural biology, chemistry as well as chemical and process engineering. The programme offered, aims to provide students with a sound understanding of cellular biology involving microbiology, biochemistry, genetics, molecular biology and some chemical engineering principles. The programme begins with core courses in the sciences especially biology, to build a strong foundation, which is then followed by an introduction to the various techniques employed in the biotechnological industries and several key aspects of microbiology. This is followed by several advanced topics of biotechnology that cover animal and plant cell culture, enzyme technology, chemical engineering principles, bioinformatics, structural biology and an in-deepth treatment of genetic engineering.

Course Code	Course Title	Semester	Course Prerequisite	
Required Core - Level 300 = 15 Units				
BTT 305/3	Protein Biochemistry	2	BOI 206/4	(S)
BTT 306/3	Techniques In Biotechnology	1 & 2	BOI 206/4	(S)
BMT 305/3	Microbial Physiology	2	BOI 115/3	(S)
			BOI 206/4	(S)
			BOI 207/3	(S)
BMT 309/3	Microbial Genetics	2	BOI 207/3	(S)
BMT 311/3	Immunology	2	BOI 207/3	(S)
Required Core - Level 400 = 23 Units				
BTT401/8	Biotechnology Research Project	1&2		
or	or			
*BOE 400/2	Special Topics in Biology	1&2		
BTT 402/3	Fermentation Technology	1	BOI 207/3	(S)
			BOI 206/4	(S)
BTT 404/3	Genetic Engineering	1	BMT 309/3	(S)
BTT 403/3	Biochemical Engineering	2	KOT 122/4	(S)
			BOI 206/4	(S)
			MAA 101/4	(S)
BBT 403/3	Plant Molecular Biology	2	BOI 116/4	(S)
			BOI 206/4	(S)
			BBT 402/3	(S)
BBT 405/3	Plant Tissue Culture	2	BOI 115/3	(S)
			BOI 206/4	(S)
* requires 6 more units from Elective courses				

Elective = 14 Units				
BOE 201/3	Biological Instrumentation	1 & 2	BOI 206/4	(C)
BOT 205/3	Microscopy and Histological Techniques	1 & 2		
BOA301/4	Industrial Training	2		
BBT 402/3	Plant Genetics	1	BOI 116/4 BOI 206/4	(S) (S)
BMT 308/3	Mycology	1	BOI 115/3	(S)
BMT 310/3	Bacteriology	1	BOI 207/3	(S)
BMT 307/3	Environmental Microbiology	2	BOI 207/3	(S)
BET 304/4	Introductory Parasitology	1	BOI 115/3	(S)
BET 305/4	Insect Biology and Systematics	1	BOI 115/3	(S)
BGT 301/3	Plant Pathology	1	BGT 302/2	(C)
BGT 302/2	Basic Practical in Plant Pathology	1	BGT 301/3	(C)
BMT 402/3	Medical Microbiology	1	BOI 207/3	(S)
BMT 403/3	Industrial Microbiology	2	BOI 207/3	(S)
BME 401/3	Soil Microbiology	2	BOI 207/3	(S)
BME 402/3	Microbial Genomics	2	BOI 207/3	(S)
BTE 401/2	Animal Cell Culture Technology	2	BOI 206/4	(S)
BZT 404/3	Animal Conservation Genetics	2	BOI 116/4 BOI 115/3	(S) (S)
BZT 403/3	Plant-Animal Interaction	1	BOI 115/3	(S)
BBT 305/4	Plant Physiology and Development	2	BOI 115/3	(S)
BBT 306/4	Plant Biosystematics and Taxonomy	2	BOI 115/3	(S)
BST 305/3	Environmental Pollution	1	BOI 102/3	(S)
BAT 307/3	Ichthyology	1	BOI 115/3	(S)
BAT 404/4	Aquaculture	1	BOI 102/3	(S)

Elective (<u>14 units under Minor structure</u> or 30 units under Elective structure)

- Students must choose among listed course to complete a total of 14 or 30 units for Electives.

(S) = Course must be taken in sequential order.

(C) = Course must be taken concurrently.

e. ENVIRONMENTAL BIOLOGY

Objectives : This field of specialisation is structured to strengthen the knowledge and understanding of various concepts of ecology, function and interaction between abiotic and biotic components of various ecosystems. This will give a broad understanding about the diversity together with structure and function of tropical ecosystems, the importance of environmental protection and conservation of natural resources. Students will also gain valuable exposure on various methods to manage and conserve the natural resources.

Course Code	Course Title	Semester	Course Prerequisite	
Required Core - Level 200 = 18 Units				
BST 305/3	Environmental Pollution	1	BOI 102/3	(S)
BST 306/3	Soil Science and Environment	1	BOI 102/3	(S)
BAT 306/3	Oceanography	1	BOI 102/3	(S)
BAT 308/3	Limnology	1	BOI 102/3	(S)
BST 307/3	Population and Community Ecology	2	BOI 102/3	(S)
BST 308/3	Tropical Ecosystems and Climate Change	2	BOI 102/3	(S)
Required Core - Level 300 = 20 Units				
BST 401/8 or BOE 400/2	Environmental Biology Research Project or Special Topics in Biology	1 & 2 1 & 2		
BST 402/3	Ecology of Invasive Species	1	BOI 102/3 BOI 117/2	(S) (S)
BST 405/3	Conservation Ecology and Natural Resources	1	BST 308/3	(S)
BST 403/3	Environmental Management	2	BST 305/3	(S)
BST 404/3	Wildlife Ecology and Management	2	BST 307/3	(S)
* requires 6 more units from Elective courses				
Elective = 14 Units				
BOE 201/3	Biological Instrumentation	1 & 2	BOI 206/4	(C)
BOT 205/3	Microscopy and Histological Techniques	1 & 2		
BOA 301/4	Industrial Training	2		
BAT 304/4	Coastal and Marine Ecosystem	2	BOI 102/3	(S)
BAT 305/3	Benthic Biology and Ecology	2	BOI 102/3	(S)
BET 305/4	Insect Biology and Systematics	1	BOI 115/3	(S)
BET 306/3	Insect Ecology	2	BOI 115/3	(S)
BMT 307/3	Environmental Microbiology	2	BOI 207/3	(S)
BBT 308/3	Tropical Plant Ecology	1	BOI 115/3	(S)

BBT 306/4	Plant Biosystematics and Taxonomy	2	BOI 115/3	(S)
BBT 307/3	Ethnobotany	2	BOI 115/3	(S)
BAT 307/3	Ichthyology	1	BOI 115/3	(S)
BAT 404/4	Aquaculture	1	BOI 102/3	(S)
BAT 402/3	Fisheries Management	2	BAT 307/3	(S)
BAT 403/3	Management of Aquatic Systems	2	BAT 304/4	(S)
BET 406/3	Integrated Pest Management	2	BET 305/4	(S)
BBT 404/3	Economic Botany	1	BOI 115/3	(S)
BZT 403/3	Plant-Animal Interaction	1	BOI 115/3	(S)
BZT 404/3	Animal Conservation Genetics	2	BOI 116/4	(S)
			BOI 115/3	(S)

Elective (14 units under Minor structure or 30 units under Elective structure)

- Students must choose among listed course to complete a total of 14 or 30 unit for Electives.

(S) = Course must be taken in sequential order.

(C) = Course must be taken concurrently.

PROGRAMME OUTCOMES

Upon completion of the programme, students will be able to :-

a. Knowledge

- Acquire knowledge and understand the concepts of applied biology.
- Apply knowledge to solve problems related to applied biology.

b. Practical Skills

- Plan and execute experiments according to scientific methods.
- Use modern instrumentation and procedures as well as classical techniques, to design and conduct experiments and to properly record the results of experiments.
- Perform laboratory techniques safety, accurately and effectively.

c. Scientific Methods Critical Thinking & Problem Solving Skills

- Interpret data and express the results in clearly written laboratory reports and in oral presentations.
- Identify, analyse and solve problems in applied biology by using systematic methods.

d. Communication Skills

- Express ideas in an informed and effective manner, articulate and develop a sustained argument, both orally and in writing.
- Interpret data and communicate the results to biologists and non-biologists.

e. Social Skills, Team Working and Responsibility

- Demonstrate the ability to work effective with peers and in teams.
- Execute the tasks given responsibly.
- Perform multi-tasking and function in multidisciplinary teams and communicate effectively.

f. Professionalism, Humanities Value, Attitudes, Ethics

- Demonstrate commitment on ethical issues.
- Compile, analyse and interpret data honestly and ethically.
- Develop interest, curiosity, persistence, eagerness and confidence as applied biologist.

g. Life Long Learning & Information Management

- Use knowledge gained for self development and continuous improvement.
- Demonstrate the ability to use various retrieval methods to obtain information on issues related to applied biology.
- Identify the relationship between biology and other disciplines, the applications and impact of applied biology in society.

h. Managerial & Entrepreneurial Skills

- Apply basic knowledge and principles of management and entrepreneurship related to applied biology field.

i. Leadership Skills

- Demonstrate the ability to lead/facilitate teams.

SYNOPSIS OF COURSES

BOI102/3 Ecology

This is an introductory course on general ecology for students to understand various principles of ecology. The concept of ecology will be defined in terms of basic components, structures and processes that occur in ecosystems, fundamental populations ecology, communities and ecosystems together with the analysis and interpretation of the distribution patterns of organisms. Biotic and abiotic factors which characterize terrestrial, freshwater and marine ecosystems will also be discussed. The productivity of these ecosystems will be compared. At the end of this course, knowledge in ecology will be applied to evaluate human impacts towards ecosystems, which have caused environmental disasters such as greenhouse effect, depletion of ozone layer and eutrophication. The definition, reasons and aims of conservation will also be defined.

Learning Outcomes

Upon completion of this course, students are able to :

1) Interpret basic concepts in ecology.
2) Describe factors that could influence formation and dissemination of different ecosystems and the uniqueness inherent in each and all ecosystems.
3) Verify relationships between effects of human activities with components, structures and processess occuring in ecosystems.

BOI115/3 Plants and Animals Biodiversity

This course covers elements of biodiversity involving genes, species and ecosystem. Emphasis will be on biological diversity including discussion on characteristics of various biological groups. Students will also be exposed to the problems of species loss, habitat and ecosystem and the importance of biodiversity conservation as well as efforts taken by the government in biodiversity conservation. Discussion will also include topics on legislations and international agreements for the protection of biodiversity and will conclude with discussion on biodiversity hotspots.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the importance of plant and animal diversity as well as importance of the relationship between biodiversity with economic values, ecological importance and conservation.
2) Differentiate and identify general features of plants and animals, and will be able to apply awareness about the richness of biodiversity especially in the tropical area.
3) Understand and enhance awareness on the meaningful preservation of biodiversity nationally and internationally.

BOI116/4 Genetics

This course covers topics on basic concepts and principles of genetics including Mendelian laws, molecular and population genetics, and advances in genetic technology. The aim of the course is to introduce the principle or concept of basic genetics which is important in understanding various aspects of biology.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand Mendel's Law and extensions, linkage and crossovers concepts, statistical analysis to confirm the results of breeding and genetic population studies.
2) Understand mitosis and meiosis, different types of mutations which caused impact on life, how DNA and RNA has been shown to be the genetic material and recognize the composition and structure of DNA, RNA and chromosomal organization.
3) Understand the concept of central dogma which include transcription, replication, translation and reverse transcription, the regulatory gene (*lac* and *trp* operon) and genetic engineering basic concepts of and methods employed.
4) Perform basic genetics techniques and experiments.

BOI117/2 Biodiversity and Ecology Practical

This field and laboratory based course will introduce students to basic concepts in ecology and biodiversity. Introduction to biodiversity will be done from species and ecosystem perspective. Emphasise will be given to practical and hands-on approach. Students will be taken on field sampling trips to study forest, coastal, river and soil ecosystems. Students will be introduced to the biodiversity of both plants and animals in laboratory based practicals.

Learning Outcomes

Upon completion of this course, students are able to :

1) Recognize and comprehend research methods in the laboratory and field in the field of biodiversity and ecology.
2) Conduct field work such as sample collection, preparation, identification, processing and storage.
3) Use practical methods to analyze animal, plant, water and soil samples.
4) Show skills pertaining to analysis and interpretation of data.

BOI205/4 Biostatistics

The course includes discussion on variability in biological data; probability distribution for binomial, Poisson and normal distributions. Basic training on the use of statistics for data analysis in biological research will be given. Topics to be discussed include variability of biological data, hypothesis testing (including non-parametric), as well as correlation and regression. After taking this course, students are expected to acquire skills and ideas in presenting their data appropriately and will be able to analyze their data using suitable statistical method/s to produce accurate inferences and conclusions of their research results.

Hypothesis testing for one and two samples, including parametric and non-parametric methods; correlation and regression. The second part of this course will discuss sampling designs and sample sizes (for one and two samples), one and two way analysis of variance, experimental design such as randomized complete block and Latin square, factorial experiments and special techniques in biology. Students will also be introduced to software used for statistical analysis.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the concept of basic statistic.
2) Interpret, arrange and conclude data based on descriptive statistics.
3) Describe the results of big datasets using inferential statistics and solve problems in biological studies using applications in biostatistics.
4) Apply computer software to analyse and understand results.

BOI206/4 Principles of Biochemistry

This course is an integrated introduction to the structure of macromolecules and a biochemical approach to protein function. It covers two distinct areas of biochemistry. The first part explains the importance of water, function of buffers and understanding of pH and pKa in biochemical processes. This part also addresses the hierarchical structure of biological macromolecules such as protein, lipid, carbohydrate and nucleic acid and their assembly into complexes responsible for specific biological processes. Students will also learn protein functions which includes enzyme kinetics. The second part of this course will cover major metabolic pathways and their interconnection into highly regulated networks. This involves basics of metabolism, enzymes as catalyst of metabolic pathways and energetics principles in general. Details on vital metabolic pathways and processes such as glycolysis, fermentation of sugars, pentose phosphate pathway, gluconeogenesis, citric acid cycle, electron transport chain, oxidative phosphorylation, fatty acid oxidation and biosynthesis, photosynthesis as well as their regulation will be covered in detail. Laboratory component of the course will expose students to basic experimental approach in biochemistry such as the importance of buffers and pH and enzyme kinetics.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the importance of water and buffers in biochemical processes, important biological macromolecules and their properties, enzymes as biocatalysts, bio-energy, and the basis of a variety of metabolic pathways and regulatory.
2) Analyze the relevance of each metabolic pathway and regulators involved.
3) Use basic knowledge on how various metabolic pathways are regulated for use in biochemistry, microbiology, genetics and biotechnology research.

BOI207/3 General Microbiology

The course is intended to provide basic knowledge in microbiology and students will gain both background and experimental experience in the broad field of microbiology, setting

the foundation needed for more advanced and specialized courses. Topics that would be covered include the historical development of microbiology field, basic cell biology, structures and functions of cell components, prokaryote microbes, eukaryote microbes, viruses, microbial taxonomy, basic techniques in microbiology (media, microbe cultures, growth) and various microbe applications. The laboratory component would expose the students to basic microscopy, slide preparation and observation, aseptic techniques, pure culture techniques, bacterial population counts and bacterial growth curve.

Learning Outcomes

Upon completion of this course, students are able to :

1) Explain microbiology as a specialisation in general biology.
2) Describe various basic groups of microbiology (bacteria, archaea, virus and eukaryotic microbes) and the differences between them.
3) Clarify the basic concepts in microbiology and its applications in life.
4) Show competency in basic techniques in microbiology.

BOI401/3 Scientific Writing, Seminar and Current Topics in Biology

It is an interdisciplinary course incorporating biology, chemistry, ecology, molecular biology and biotechnology for botany, agrobiology, microbiology, entomology and parasitology, plant biology, animal biology, environmental biology and aquatic biology majors. This course was designed to introduce students to current issues and related emerging challenges in their fields. Students are expected to use critical thinking, scientific approach and major information resources for scientific discipline to examine and discuss current issues and related problems in their fields. The course also covers effective communication in biology, such as oral presentation of research findings, thesis writing and publishing process in scientific journals.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand current issues and challenges in the field of life sciences, building generic skills to conduct research and analyze information critically.
2) Understand and possess the ability to develop methods / scales to examine current issues / events in life sciences.
3) Discuss and involve in scientific presentations at the general level. In addition to verbal communication skills, students will also gain insights into journal publication process and thesis writing.

BAT304/4 Coastal and Marine Ecosystem

This course provides a foundation of knowledge on the habitats in the marine and coastal environment and the main types and requirements of biota found in these habitats. This course will introduce the conceptual basis for ecosystem ecology and then consider the characteristics of key marine and coastal ecosystems, including the oceanic, rocky and sandy intertidal and subtidal, mangroves, coral reefs and seagrass systems; productivity of oceans; and energy flow, food webs and nutrient pathways in marine and coastal

ecosystems. Emphasis will be on the interaction of the organisms with each other and with their environment. Specific topics covered include: adaptations of marine organisms for life in the intertidal vs. subtidal zones; different modes of feeding and reproduction in marine organisms; and the importance of predation, competition, adult/larval interaction and dispersal mechanism.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand basic knowledge of the habitat in the coastal and marine environments and how organisms adapted to these environments.
2) Identify the characteristics and role of the various ecosystems in the coastal and marine environment and how they are related to each other.
3) Conduct a survey and assessment on selected marine and coastal ecosystems.
4) Demonstrate skills of teamwork and scientific presentation.

BAT305/3 Benthic Biology and Ecology

In this course, students will be introduced to the different types of benthic ecosystems, interactive processes of benthic organisms with their environment, including organism-sediment-flow interactions, feeding strategies, recruitmemt, succession and population interactions. This course will cover the analysis of benthic community data to assess spatial and temporal change. Studies of changes in benthic community structure in relation to environmental gradients, and the analysis and interpretation of seasonal impact of bioturbation on benthic community structure will be taught. The importance of benthic organisms in biotic indices and biomonitoring studies which include bioindicator species, benthic organisms and water pollution, tolerance values and benthic organisms as tools in biotic indices are included in this course.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand interactive processes among benthic organisms and environments.
2) Understand the function and ecological role of benthic ecosystem.
3) Distinguish various of benthic systems.
4) Understand how benthic organisms can be used to monitor and detect changes in the environment.
5) Identify benthos in the field and in the laboratory.

BAT306/3 Oceanography

This course encompasses all four aspects of oceanography – biological, chemical, geological and physical oceanography. Lectures will include topics such as sea explorations, the cycle of elements and materials in the marine systems and the introduction to water flow phenomena such as tides, waves and ocean currents. Sampling techniques, use of oceanographic equipment and seawater analysis will be taught during laboratory classes. Field studies to exposure students to experimental design, sampling methods and analysis in oceanography will be conducted. At the end of the course, students should be

able to have a basic understanding of oceanography and the processes that keeps our oceans ecologically healthy.

Learning Outcomes
Upon completion of this course, students are able to :
1) Define various aspects of the ocean, including geology, chemistry, biology and biological processes that involved physical characteristics, including tides, currents and waves.
2) Demonstrate skills in the use of various equipments related to the oceanographic and skills to carry out simple field studies

BAT307/3 Ichthyology

This course will discuss various aspects of the biology, taxonomy, evolution and ecology of fish. Emphasis will be given on the aspects of adaptation for living in the aquatic hábitat, including anatomy, and external morphology, physiology, respiratory and circulatory systems, feeding and digestion, excretion and osmotic control, nerves and sensory organs, muscle and movement, reproduction and development of larvae, and also pattern of behaviour. The economic importance, zoogeography, ecology and life history of a few species of fish will be highlighted. At the end of this course, the students should be able to identify the fish species, to understand the behaviour of fishes and their adaptation to the environment and to specify the importance of fish species as a food source of world population and research on fish biology for conservation and management.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the biology, taxonomy, evolution, and diversity of fish
2) Understand various structures and forms of fishes and adaptation to different environment
3) Understand the role and function of internal organ to the different ecological environment
4) Understand the behavior of fish including the movement, communication, reproduction, feeding, development and growth in relation to different environment
5) Understand the ecology and zoogeography of freshwater and marine fishes
6) Understand the importance of fish biology in assessment and conservation.
7) Identify fishes in the laboratory and in the field by using systematic identification key for fish.

BAT308/3 Limnology

Limnology is the study of fresh or saline waters contained within continental boundaries, including lakes, ponds, reservoirs, streams, rivers, wetlands and estuaries. Limnology includes standing and running waters, both salt and fresh, as long as the body of water is not oceanic. Emphasis will be given on the characteristics of these inland water bodies, the biotic community and the dynamic activities within this environment. Both the physical and chemical aspects of these aquatic ecosystems will be discussed.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the facets of Limnology
2) Understand the physico-chemical and biological aspects of lentic and lotic environments (inland water bodies)
3) Understand the functional relationships and productivity of freshwater biotic communities as they are affected by the dynamics of abiotic and biotic environmental parameters
4) Perform water quality analysis and its relation with biotic communities

BAT401/8 Project in Aquatic Biology

In this course, the final year student is offered a research project that introduces the students to research methods for solving scientific problems. This course will require the student to manage time as well as carrying out scientific research. At the end of this course student will have hands-on experience in solving scientific problems through research, and present it as a scientific report in the form of a seminar and an academic thesis.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand a research topic on Aquatic Biology.
2) Understand methods and protocols of doing laboratory analysis and handling equipment in the field and laboratory to obtain data related to Aquatic Biology.
3) Carry out scientific research in Aquatic Biology and present their research work in written thesis and oral presentation.
4) Perform data analysis and interpretation.
5) Convey/present scientific ideas clearly and effectively

BAT402/3 Fisheries Management

This course encompasses the freshwater (inland fishery and paddy field fishery) and marine fishery (capture fishery) in Malaysia. The fisheries principles and methods used in Malaysia will be discussed in relation to the sustainable exploitation of marine fishery resources. Basic concepts on fish stock assessment and fish population dynamics for fisheries management will also be discussed. The principle of ecosystem approach and comunities in fishery management is emphasized. The fishery law and administration for conservation and its management are also discussed. The course also includes the fishery industries in term of fishery products, models and marketing strategies. At the end of the course the students should be able to understand and aware the importance of fisheries management for sustainable fishery resources for future generation.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the effect of fish population size and catch to exploit fish resources.
2) Understand the concept and application of fish stock assessment for fisheries management.

3) Expose students on inland and marine capture fishery resources and type of gears and methods used for exploitation.
4) Interlink the fish population dynamics for fisheries management.
5) Utilise the knowledge on the different fisheries management tools for sustainable fishery.

BAT403/3 Management of Aquatic Ecosystems

In this course, students will be introduced to the types of aquatic pollution, the causes of these pollutions and methods of pollution abatement and prevention. The types of pollution discussed will include pollution by heavy metals, organic wastes, natural pollutions, and pollutions by other toxic wastes. The course also includes the conservation and management of the aquatic environment including the riparian systems, limnological systems, marine and coastal systems. Aspects of aquatic system modelling as well as case studies involving local examples will be discussed.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the basic management and usage of aquatic ecosystems.
2) Understand the usage of aquatic water by diverse consumer and the impact to the environment and how to reduce the impact.
3) Master the skill in the management of aquatic ecosystem.
4) Use the management principle in the development of sustainable aquatic ecosystems.

BAT404/4 Aquaculture

This course introduces the culture principles of commercially important aquatic organisms of freshwater, brackish water and marine origins. Case studies involving examples from all over the world with a focus on Asian tropical aquaculture will be discussed. The biology of cultured species, the choice of culture sites, culture systems, management strategies, disease prevention, breeding, nutrition as well as the economics and environmental impact of aquaculture will be discussed. Field visits to aquaculture sites will be an important component of this course.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the objectives and practices of the local and global aquaculture industry.
2) Conduct laboratory experiments and use laboratory equipment for obtaining data related to several aspects of aquaculture.
3) Obtain practical experience in managing an aquaculture farm.

BST305/3 Environmental Pollution

This course covers the origin of various types of pollutions that are found in the aquatic, terrestrial and atmospheric environment. Noise pollution, solid wastes, radioactive wastes and toxic and hazardous residues and their effects on the biota and man will be examined. The course will conclude with a discussion on the principles and implementation of pollution control and environmental monitoring. The main objective of this course is to expose students on various issues pertaining to environmental pollution. Although global issues will be discussed, emphasis will be on local problems. Discussions will involve kinds of pollutants that are received by the aquatic and terrestrial environment as well as air and noise pollution. Sources of various kinds of pollutants such as industrial discharges, municipal wastes, radioactive and other hazardous wastes and their impacts on human health and environment integrity will also be discussed. The course will end with a look at the existing legislation as well as principle of control strategies and environmental monitoring and to assess their effectiveness in protecting the environment.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the kinds of main pollutants, their sources and their effects on the environment and living organisms.
2) Understand the existing legislation, particularly in Malaysia, that can be used to overcome environmental pollution.
3) Understand the management and control efforts carried out by the Malaysian Department of Environment and improvement suggestions.
4) Demonstrate the ability to analyse and interprate data.

BST306/3 Soil Science and Environment

The aim of this course is for students to understand the basic chemical, physical and biological principles of soils. Students will be able to relate the principles of soil science to ecological systems, agricultural production, world food needs, engineering uses of soils and waste disposal. Soils are complex biogeochemical materials on which plants may grow. The soils have the structural and biological properties that distinguish soils from rocks and sediments. Soil supports dynamic ecological systems and provides plants with support, water, nutrients and air. Soil can support all ecosystems on land including large populations of microorganisms that recycle the materials of life, providing the entire human population with food, fiber, water and building materials, and sites for construction and waste disposal. Human population relies on soils to protect the groundwater by filtering out toxic chemicals and pathogenic microorganisms from wastewater. Soil also plays an important role in carbon sequestration and prevention of global warming. Understanding soil and managing it well is essential to human welfare.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the basic chemical, physical and biological properties of soils and the effects to the environment.

2) Identify the source of problems related to soils and how to draw potential steps to remedy the situations.
3) Aquire basic knowledge on soil functions as affected by the environment with special emphasis on human population activities.

BST307/3 Population and Community Ecology

Population and Community Ecology introduce and expose students to population and community based partly on mathematical approaches. Unique ecological characteristics acquired by a population or community will be discussed and the community distributions are mainly based on multivariate analysis. The first part will focus on habitat distributions based on the vegetation patterns; random, uniform and change. This includes density, degree of survival, biotic capability, age distribution and life tables. Types of association between populations like neutralism, cooperation, mutualism, comensalism, predation, and ecological niches as well as principles of competitive exclusion will be discussed. The second part touches upon the basic characteristics of a natural community including a number of important concepts like form and structure of terrestrial communities, dominance, species diversity and community succession.

Learning Outcomes
Upon completion of this course, students are able to :
1) Introdue fundamental and advanced principles in population and community ecology**.**
2) Apply ecological knowledge in the estimation of population size and to construct the population life table.
3) Inter-correlate between species richness concept, species diversity and population abundance and community.
4) Apply mathematical formulas for the calculation on vegetation pattern and community dispersion.

BST308/3 Tropical Ecosystems and Climate Change

This course provides an overview to tropical ecosystems and ecology. The main themes revolve around key concepts and characteristics of terrestrial and aquatic ecosystems of the tropics with emphasis on Malaysia. The focus will be on the ecology, processes and interactions of biotic and abiotic elements in tropical rain forest, mangrove, inland water bodies, marine and coral reef ecosystems, in relations to global climate change. Current and pressing issues on anthropological impact, especially on climate change locally as well as globally will also be discussed with coverage on ecological principles for these ecosystem conservation.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand various tropical ecosystems and their diversity including ecosystem processes involved.

2) Understand the issues related to global climate change and its implication towards tropical ecosystem.
3) Understand and appreciate the delicate processes involved in changing global environmental scenarios.

BST401/8 Environmental Biology Research Project

In this course, the final year student is offered a research project that introduces the students to research methods for solving scientific problems. This course will require the student to manage time as well as carrying out scientific research. At the end of this course student will have hands-on experience in solving scientific problems through research, and present it as a scientific report in the form of a seminar and an academic thesis.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand a research topic on Environmental Biology.
2) Understand methods and protocols of doing laboratory analysis and handling. equipment in the field and laboratory to obtain data related to Environmental Biology.
3) Carry out scientific research in Environmental Biology and present their research work in written thesis and oral presentation.
4) Perform data analysis and interpretation.
5) Convey scientific ideas clearly and effectively.

BST402/3 Ecology of Invasive Species

Invasive species comprise one of the greatest immediate threats to global biodiversity. This course is designed to provide students with an up-to-date perspective on invasive species and focuses on the ecological and evolutionary impacts of such species, the factors influencing their establishment, and the theory and practice of controlling invasive species. In this course, the ecological-management of invasive species will be discussed. It is crucial to understand the role of fundamental ecological concepts, especially the relationship of the invasive species to be manipulated for an effective invasive species management, so that the ecosystem can be protected. Biological and ecological aspects of invasive species need to be studied in order to control and manage their populations in an effort to maintain or improve an ecosystem.

Learning Outcomes
Upon completion of this course, students are able to :
1) Recognize and understand the local and global invasive species.
2) Understand how to implement practical session and scientific equipments.
3) Review and assessment of selected ecosystems.
4) Demonstrate the skills of teamwork and scientific presentations.

BST403/3 Environmental Management

The course is developed to introduce environmental management within the context of sustainability. The concept of sustainability is heavily emphasized throughout the course content in many forms and applications. Topics focus on integrated management of potential impacts to the environment during development activities and their mitigation measures. Discussion also covers management of protected areas, various methods in Integrated Waste Management (IWM), approaches and processes in Environmental Impact Assessment (EIA) operated in the context of Malaysia. The role and importance of stakeholders, legislation, the media and environmental education in the community are further emphasized.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the concept of sustainability and the interaction between mankind and the environment
2) Discuss on assessment techniques for development and its impact towards the environment
3) Perform critical analysis on the practical aspect of sustainability and to enhance knowledge in decision making in environmental management issues.

BST404/3 Wildlife Ecology and Management

The purpose of this course is to increase understanding of students about the ecology and management of wildlife in tropical areas especially in Malaysia. The students will be exposed to ecosystem regulation, population dynamic and other aspects in wildlife ecology and management. Field work is one of the important components in this course where students will be exposed to field experience on natural setting and wildlife techniques in wildlife ecology and management.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the ecological concept and biological terminologies related to wild life, conservation and various methods in wild life management
2) Develop the skills to solve problems related to wild life management
3) Present and discuss issues related to wild life management.

BST405/3 : Conservation Ecology and Natural Resources

This course focuses on the importance and need for ecological conservation for all species and natural ecosystems in the world and in Malaysia in particular. The concept of endangered species and ecosystems will be discussed. The role and design of conservation areas and national parks for protection of species and natural ecosystems will be touched upon. Protection of species or ecosystems under present legislation and strategies for conservation world-wide and in Malaysia will be discussed. The course also covers the

elements of natural resources involving soil, geology and earth resources, water, macro and microorganisms, fisheries, wildlife and alternative energy.

Learning Outcomes:-
Upon completion of this course, students are able to :
1) Understand the fundamental composition of natural resources in Malaysia and other parts of the world.
2) Explain the relationships that exist between different levels of ecological organizations and conservation systems.
3) Understand issues on protected areas and other related systems involved.
4) Apply concepts of sustainable use and conservation of natural resources.

BMT305/3 Microbial Physiology

This course begins with a discussion on microbial growth, aerobic and anaerobic metabolism, energy production, fermentation pathways, autotrophic metabolism. This course also introduces the following topics: cell constituents from chemical elements, macromolecule, biopolymer and its assembly to form cellular components like membrane and flagella, regulation of macromolecule synthesis, the different types of regulation eg. feedback inhibition and repression, global control networks, microbial stress response and modern techniques to study microbial physiology.

Learning Outcomes
Upon completion of this course, students are able to :
1) Explain the basic concepts of microbial physiology
2) Clarify basic concept on aerobic and anaerobic metabolism
3) Apply basic knowledge on microbial physiology in cultivation of microorganisms

BMT309/3 : Microbial Genetics

This course will discuss the basic concept and principles of microbial genetics which include characteristics of bacterial and viral chromosomes, mutagenesis and mutants, genetic transfer in bacteria such as transformation, transduction and conjugation, recombination and gene mapping using all of the above mechanisms. The characteristics and importance of plasmids and transposons will also be discussed. The second half of the course will discuss the principles of operons and gene regulations using the lactose, and tryptophan operons as well as the complexity of the bacteriophage genetic system as examples. The development of the field of microbial genomics and bioinformatics will also be covered.

Learning Outcomes :-
Upon completion of this course, students are able to :
1) Understand the characteristics of bacterial chromosomes and virus, mutagenic processes and DNA repair, gene transfer and DNA recombination, plasmid and transposon characteristics, principles of genetic regulation, bacteriophage genetics, microbial genomics and bioinformatics.

2) Analyse the relationship between each microbial genetic system and gene regulation.
3) Use basic knowledge on microbial genetics and gene regulation in future genetics and biotechnology research.

BMT311/3 Immunology

This course describes the principles of and basic concepts of immunology. The areas to be studied include the historical development and the scope of immunology, natural immunity, acquired immunity, the complement system, antigen, antibodies, antigen-antibody interactions, fundamental of cellular immunity responses, hypersensitivity (allergy) – immediate and late type, graft immunity, autoimmunity and immunity against cancer. The application of immunology in the development of diagnostic testing would also be included. The laboratory component would give the students the chances to simulate bacterial infection in animal models (chicken and rabbit). The students would assess the humoral immunity respond by using one of the diagnostic tests.

Learning Outcomes
Upon completion of this course, students are able to :
1) Explain basic concepts on immunology.
2) Explain basic concept on immune disorders.
3) Apply basic immunological to face infection and immunity.
4) Apply basic immunological knowledge in diagnostic tests.

BTT306/3 Techniques in Biotechnology

The objective of this course is to enhance students' skills for the biotechnology industry, such as the use of molecular biological techniques required for genetic engineering of microorganisms to the culture process, purification and characterization of proteins. At the end of this course, students are expected to understand the principles involved gene cloning to manipulate DNA and find out how to culture microorganisms to obtain the desired protein. Students will be exposed to several chromatography techniques for purification.

Learning Outcomes
Upon completion of this course, students are able to :
1) Gain knowledge and able to perform DNA cloning principles and analysis techniques.
2) Describe bioreactor designs, their characteristics and functions of their major components.
3) Explain various downstream processes and enrichment techniques.
4) Describe various purification techniques and chromatography principles.

BTT305/3 Protein Biochemistry

This course discusses the biochemistry of protein in detail beginning from the chemistry of amino acids and how it affects the biochemistry of proteins, protein folding and its relationship to protein stability, Ramachandran plot, levels of protein structure and the

techniques to determine protein structure. Students will also be introduced to the different protein databases and bioinformatics servers available in the internet and how it can be used to characterise and analyse protein molecules. The various physical techniques available to analyse protein will also be discussed. Other topics that will be discussed include enzyme mechanisms, protein structure prediction and the application of protein structure information to design drugs.

Learning Outcomes

Upon completion of this course, students are able to :

1) Gain understanding of protein structure stages and the roles of amino acid in determine the biochemistry of proteins, classes of protein, structure detemining techniques, enzyme catalyst from thermodynamic perspective, enzyme mechanisms and related examples, prediction of protein structure and techniques in confirming the predictions, as well as molecular modelling and the usage of protein structure information.
2) Analyze protein and predict its structure based on the database available.
3) Use information collected to understand the function of the proteins.

BTT401/8 Biotechnology Research Project

In this course, the final year student is offered a research project that introduces the students to research methods for solving scientific problems. This course will require the student to manage time as well as carrying out scientific research. At the end of this course student will have hands-on experience in solving scientific problems through research, and present it as a scientific report in the form of a seminar and an academic thesis.

Learning Outcomes

Upon completion of this course, students are able to :

1) Have good time management skill in doing research and attending lectures.
2) Manage and conduct research project including standard operation procedure and lab safety.
3) Perform dissertation writing and presenting the research results.

BTT402/3 Fermentation Technology

This course includes microorganism selection, improvement and preservation, coordination of microbial metabolism, substrate and inoculum preparation, fermenter design and operation, industrial waste treatment and biotransformations involving free and immobilised cells/enzymes. The technology and fermentations kinetics will also be discussed.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the basic fermentation process, preparing substrate and inoculum.
2) Relate microbe metabolism in producing selected fermentation products.
3) Discuss biological reactions involving free and immobilized cell.

BTT403/3 Biochemical Engineering

This course introduces the involvement of engineering methods and principles in industrial fermentation processes. The course includes engineering processes in large scale fermentation and process control for product formation. Topics to be discussed will include fermentation kinetics in batch and continuous cultures, broth rheology, agitation and aeration, scale-up processes, sterilization of media and air, instrumentation for process control and downstream processes such as centrifugation, filtration, extraction, industrial chromatographic techniques and purification. The operational stability and selectivity and performance of bioreactor systems will also be discussed.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the principles and the operation of a bioreactor and its supporting equipment, as well as biochemical processes involved in microbe product or synthesized using enzyme.
2) Appreciate the important engineering principles in applied science, especially in operation stability, selection and factors involved in controlling bioreactor system.
3) Elaborate bioprocess (catalyst by enzyme or microbe) using mathematical modeling.

BTT404/3 Genetic Engineering

This course covers theory and practical knowledge of DNA manipulation, cloning and DNA library construction, transgenic plants, knock-out mouse, expression of recombinant proteins, Synthetic Biology, introduction to Bioinformatics, sequence analysis and phylogeny and Genomics.

Learning Outcomes

Upon completion of this course, students are able to :

1) Describe the basic concept of genetic engineering.
2) Elaborate the basic concept of DNA manipulation.
3) Apply knowledge and practical in constructing recombinant bacteria.

BTE401/2 Animal Cell Culture Technology

This course provides a comprehensive overview on various aspects of conventional and current development of animal cell culture technology. The course covers the history of animal tissue culture development, the basic requirements of an animal culture laboratory, preparation of culture medium, the establishment of aseptic cells, factors affecting the growth of the different types of *in vitro* cultures, development of disease free cell cultures, and cryopreservation techniques. At the end of the course, the students are capable of practicing proper animal cell culture techniques and understand the basic techniques involved.

Learning Outcomes
Upon completion of this course, students are able to :
1) Exposure to the latest knowledge on various techniques used for animal cell culturing technology.
2) Understand the principles in animal cell culture and able to practise the related techniques.
3) Able to identify safety and bioethics issues.

BEE305/3 Pesticide Science

This course discusses the continued needs for pesticide (specifically insecticide, fungicide, herbicide and rodenticide) and their pattern of use, the various formulations, laws and regulations governing their use and classification of pesticide. Toxicological aspect such modes of action, resistance mechanism, metabolism of pesticide and their effects on the environment will be discussed in detailed. The students will also learn how toxicity of pesticide is being evaluated, probit analysis and the factors that caused variation in toxicity tests.

Learning Outcomes
Upon completion of this course, students are able to :
1) Have basic knowledge on insecticide classification, insecticide formulation, insecticide mode of action, and insecticide resistance.
2) Carry out insecticide toxicity evaluation, probit analysis and interpretation of results obtained.
3) Evaluate and identify situation when pesticide is required and its impact to the environment.

BET304/4 Introductory Parasitology

This course covers the introduction to topics in parasitology which include fundamental principles of parasitology parasites from variety of animal protozoa, Platyhelminthes, nematoda and also acanthocephala. Parasites fundamental the fungi and arthropods will also be discussed in general. Transmission and pathology of the parasitic infection will also be discussed. Students will be exposed to several identification techniques such as gross morphology observation and the latest detection methods, using molecular techniques. In addition, this course will also discuss the importance and usefulness of parasites in the medical field. At the end of the course, students will learn important methods usually used in parasitic infection control management programme.

Learning Outcomes
Upon completion of this course, students are able to :
1) Clearly state the groups of important parasites of humans and animals.
2) Describe the diversity of transmission / methods and pathology of parasitic infection to the host.
3) Distinguish theoretically the parasite detection techniques.

4) Show differences between the control and treatment and imply the knowledge of parasite biology to optimize the final outcome of treatment and control.

BET305/4 Insect Biology and Systematics

This course covers insects from five fundamental perspectives: structure and function, insect and its environment, insect as a unit and its diversity, applied entomology, and modern molecular approach. The subjects covered include the integument system, nervous system, glands and muscles, breeding and development, sensory mechanism, movement and behavior. Communication between insects and its biotic and abiotic environment will also be discussed. In addition, students will be exposed to the methods and principles of taxonomy and the evolution of the insecta class. This course will also discuss the advantages and disadvantages of insects, conservation of biodiversity, control of insects, and integrated pest management of some important agriculture pests.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the internal and external morphology of insect.
2) Understand insect physiology and its role in environment.
3) Understand the role of insect and their relationship with humans and the environment.
4) Acquire knowledge on the basic methodology in systematics including nomenclature, taxonomy and phylogenetic.

BET306/3 Insect Ecology

This course is designed for student to understand the interacters between and their environment, in which also include ecology will investigate how the plants and other animals. Emphasis will be given to insect population and community, biodiversity and conservation. Some quantitative approach to insect ecology will also be discussed.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand basic and applied ecological concepts in relation to the population dynamics of insect.
2) Understand the role of insect in the development and assessment of ecological theory.
3) Acquire knowledge in the quantitative aspects of insect ecology.

BET307/3 Insect Physiology and Biochemistry

Physiology and biochemistry are biological functions in living organisms. There are many unique aspects of physiology and biochemistry in insects for adaptation in environment. In this course, students are exposed to the functions (e.g. the nervous system, digestive system, etc.), and physiological processes in insects. Emphasis will be given to

physiological and biochemical processes that help insects to overcome extreme environmental conditions.

Learning Outcomes
Upon completion of this course, students are able to :
1) Expose the basic knowledge of insect functions and processes for each part of insect's body.
2) Understand each modification that occurs in insects and its adaptation to its environment.
3) Expose the insect's metabolic conditions involving chemical processes.
4) Understand the complex situation/process that occurs in insects for their successful adaptation to their environment.

BET401/8 Research Project in Entomology and Parasitology

In this course, the final year student is offered a research project that introduces the students to research methods for solving scientific problems. This course will require the student to manage time as well as carrying out scientific research. At the end of this course student will have hands-on experience in solving scientific problems through research, and present it as a scientific report in the form of a seminar and an academic thesis.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand a research topic on Entomology and Parasitology fields.
2) Understand methods and protocols of doing laboratory analysis and handling equipment in the field and laboratory to obtain data related to Entomology and Parasitology fields.
3) Carry out scientific research in Entomology and Parasitology fields and present their research work in written thesis and oral presentation.
4) Perform data analysis and interpretation.
5) Convey/present scientific ideas clearly and effectively.

BET402/4 Medical and Urban Entomology

This course discusses the biology, behaviour, ecology and management of medically- and veterinary-important insects (mosquitoes, house flies, biting flies, ticks, mites, fleas and lice) and urban insects (cockroaches, termites, ants, bed bugs, bees, wasps and hornet), especially those that are important in the tropics. The role of insects in transmission of tropical diseases (malaria, filariasis, dengue, Japanese encephalitis B, and others) will be discussed. In addition, students will also be exposed to the philosophy of urban entomology, and the concepts of human environment, biocoenoses and urban ecosystem.

Learning Outcomes
Upon completion of this course, students are able to :

1) Acquire knowledge on the biology, behaviour, ecology and management of insects of medical, veterinary and urban importance, as well as the roles of insects in vector-borne diseases.
2) Recognize and identify important insect vectors and urban pests in tropical regions.
3) Establish management strategies against insect vectors and urban pests based on individual situation.

BET403/3 Medical and Veterinary Protozoology

This course will expose students to the important protozoan parasites in human and animals. Students will be exposed to the identification, the morphology, function, life cycle, symptomatology and pathogenesis of parasitic protozoan infections. In this course there are new elements of the latest technology to be introduced, particularly in the application of new technology, such as advanced studies on taxonomy, molecular biology, pathogenesis, immunology and serology of protozoa infections.

Learning Outcomes

Upon completion of this course, students are able to :

1) Distinguish the variety of taxonomy, anatomy, physiology, epidemiology, life-cycle, pathology, pathogenesis and control of protozoan infections.
2) Clearly state the morphological differences of protozoan parasites.
3) Correlate the latest technology application in protozoology.
4) Demonstrate the skills in the use of microscope for parasite identification and at the same time to be able to explain clearly the types of parasite including its morphology and the stages of infection.

BET404/3 Parasites of Aquatic Animals

This course will expose students to the general aquatic animal parasites with medical, veterinary and economic importance. Students will learn to identify the morphology, function, life cycle, symptoms and pathogenesis of the parasite infection of aquatic animals, especially fish. Emphasis will be given to parasitic infections of freshwater and marine fishes. At the end of the course, students have the opportunity to apply their knowledge and theory they have learned during course field works.

Learning Outcomes

Upon completion of this course, students are able to :

1) State the major groups of fish parasites and examples of parasites for each of these groups.
2) Identify symptoms of parasite infection and their control measures.
3) Explain the life-cycle and infective stages of important group of fish parasites.
4) Demonstrate the capability of using microscopes and to be able to recognise the preparations of the various parasite stages, and to explain the identified parasites including their life-cycle.

BET405/3 Medical and Veterinary Helminthology

This course will expose students to the helmintic parasites of medical and veterinary importance. Students will learn to identify the morphology, function, life cycle, symptoms and pathogenesis of the parasite infections in human and animals. In addition, students will be exposed to diagnostic techniques such as ELISA and also identifying the important symptoms of parasitic infections.

Learning Outcomes

Upon completion of this course, students are able to :

1) List down the major groups of helminth parasites as well as able to quote an example of parasite for each group.
2) Recognize the symptoms of infections by helminth parasites and their control measures.
3) Explain the life-cycle and the infective stages of important groups of helminth parasites.
4) Demonstrate the skills in the use of microscope for parasite identification and at the same time to be able to explain clearly the types of parasite including its life cycle. Student will be exposed to diagnostic techniques for helminth infection e.g. ELISA and to identify important symptoms of parasite infection.

BET406/3 Integrated Pest Management

This course exposes to the students the various environmental factors affecting insect populations, basic principles of surveillance and sampling, economic decision levels, and the various management strategies against insects such as cultural, physical, biological, chemical, genetic, plant resistance and quarantine methods. Other aspects that will be discussed include integration of management strategies, and their suitability from the perspectives of economy, environment and safety to non-target organisms.

Learning Outcomes

Upon completion of this course, students are able to :

1) Possess a basic knowledge regarding factors affecting insect population dynamics, monitoring principle, and common insect pest management approaches.
2) Decide the most appropriate management method based on the situation, monitoring outcome and economic injury level.
3) Establish integrated pest management programme based on the biology of the pest and its monitoring outcome.
4) Evaluate the situation in which pesticide is required and its impact on the environment.

BBT403/3 Plant Molecular Biology

Students will learn about the size and complexity of plant genome. Insights into the plant nuclear, plastid and mitochondrial DNA, their organization and interactions will be highlighted. They will also be exposed to the process and stages of embryogenesis, seed

development and germination, the genes, hormones and regulation involved. One of the vital topics of plant biotechnology that is genetic engineering of plants will also be taught in which an overview about recombinant DNA technology, the strategies for transformation and controlling gene expression and case studies of genetically modified plants/crops will be discovered. The students will also be exposed to the various components of a plant cells, functions and synthesis. The concept of differential gene expression will be discussed. The genetic basis of flowering, incompatibility, *Agrobacterium* infection leading to crown gall formation, and the nitrogen fixing nodules in the roots will also be discussed.

Learning Outcomes

Upon completion of this course, students are able to :

1) Describe the process and the level of embryogenesis, seed development and germination, including genes involved, hormones and regulation involved at every level.
2) Distinguish nuclear DNA, plastid and mitochondrial plant, organization and interaction of each.
3) Explain the concepts of biotechnology, especially in genetic recombinant DNA technology, strategies for transformation and gene expression.
4) Demonstrat the function of various components of plant cell including membranes and formation of the cell wall.

BBT405/3 Plant Tissue Culture

This course provides a comprehensive overview on various aspects of conventional and current development of plant tissue culture technology. Some of these techniques were used as tools for propagation of plantlets and germplasm conservation. The course also covers the history of plant tissue culture development, the basic requirements of a plant tissue culture laboratory, preparation of culture medium, the establishment of aseptic tissues, factors affecting the growth of the different types of *in vitro* cultures, development of disease free plants, protoplast cultures, somatic hybridization, haploid cultures and plant cryopreservation techniques. In addition, this course presents an overview of the techniques and the underlying theory of genetic engineering, commercial applications, ethical and regulatory issues in the area of plant biotechnology.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the various techniques of plant tissue culture and the need to establish a tissue culture laboratory.
2) Provide an overview of plant tissue culture to enhance plant propagation, preservation of germplasm and production of new hybrids.
3) Explain the basic concepts, techniques and training of genetic manipulation of plants and applications in biotechnology
4) Provide exposure to the application of tissue culture technology in the field of agro-industry.

BME401/3 Soil Microbiology

Soil microbiology study encompasses soil and the organisms living in it. This field of study includes the sustainable agricultural practices, environmental study, agronomy, plant pathology, food science and ecology. Unifying the seemingly different areas of interest is the fundamental need to understand the relation of the soil environment to the presence and functioning of species and communities of soil organisms Sustainable land use and management which affects soil organisms, methods of determining diversity and functioning of soil microorganisms, means to optimize land use and management towards development of specific soil organisms and their functions will be discussed further. Other topics for this course include soil ecosystem, measurement of soil microbial biomass and the diversity, energy transformations and metabolic activities of soil microbes, process control in soil, soil enzymes as indicators of ecosystem status, the rhizosphere and mycorrhizosphere, nitrogen fixation process and the principles of bioremediation.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the principles of microorganismal behaviour in soil ecosystem
2) Manage the soil and optimise it towards development of specific organisms and their functions
3) Study the role of microorgansims in the soil ecosystem and identify microbial activity that has a huge impact on its surrounding

BME402/3 Microbial Genomics

This course introduces fundamental concepts and related tools in microbial genomics and bioinformatics. The course emphasizes the strong interdependence of the field of genomics and bioinformatics. Genomics produces large scale data sets that require bioinformatic methods for analysis of raw DNA sequence data, data storage, handling and analysis. This course will also give students the ability to understand genome-based gene expression such as transcriptomics, proteomics as well as metagenomics and relate this knowledge to current applications in the field of microbiology.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the process involved in the technology of genomics and bioinformatics, in addition to the characteristics and the evolution of microbial genome
2) Analyse microbial genome using bioinformatics tools
3) Apply basic knowledge on microbial genomes and bioinformatics processes in the study of microbiology and biotechnology

BGT301/3 Plant Pathology

The course introduces the concept of disease as a result of interaction between pathogens and hosts under the influence of environmental factors, definition of basic terminologies in symptomatology and aethiology, inoculum potential, pathogenicity and virulence, process

and mechanism of entrance of pathogens and pathogenesis, and mechanisms by which plants resist a particular disease. Plant pathogens such as viruses and viroids, prokaryotes (mollicutes and bacteria), fungi, nematodes, and higher parasitic plants will be explained with emphasis to their life and disease cycles, production, survival and dispersal of inoculum.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the principle of basic plant pathology.
2) Diagnosis of symptoms and signs of plant diseases.
3) Characterize group of pathogens that caused plant diseases.

BGT302/2 Basic Practical in Plant Pathology

This course introduces students to the basic methods used in plant pathology. The methods to be learned including media preparation, sterilization techniques, isolation of pathogens, inoculation technique, preservation and maintenance of culture, disease diagnosis, identify signs and symptoms of plant diseases, the collection and preservation of plant disease specimens and microscopy techniques. In addition, field research methods such as experimental design in plant house and in the field were also studied.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand techniques / procedures used in plant pathology.
2) Identify disease symptoms and signs of pathogens that caused plant diseases.
3) Apply of knowledge obtained to solve problems related to plant diseases.

BBT305/4 : Plant Physiology and Development

The course introduces the principles of bioenergetics which involves energy metabolisms and assimilation of C and N. The next emphasize is on cell and plant water relations and the uptake of mineral nutrients. The next subjects are plant growth and development and their control by hormones, light and temperature. Discussion proceeds to the physiology and biochemistry of plant acclimation to environment and biotic stress. Lastly, the importance of plant physiology in modern biotechnology will also be reviewed. This organization of ideas represents a logical flow of concepts and information essential to an understanding of plant forms and functions. Students will understand the importance of sunlight as the ultimate source of energy for the planet in order to understand the critical dependence of water relations, growth, development and metabolisms on the fundamental principles of energy flow.

Learning Outcomes:-
Upon completion of this course, students are able to :
1) Explain the physiology concept and development of plants from the perspective of the biochemical and genetic process.

2) Explain the fundamentals of biochemistry and metabolism of plant photosynthesis and the role of hormones in the growth and development of plants
3) Explain the relationship between morphology and function in plants and plant adaptations to the environment, especially in extreme environment
4) Relate the concepts of genetics and environment in modern methods of plants regeneration of high economic importance

BGT400/3 Agriculture, Forest and Store Product Pests

This course deals with the biology of pests of economic importance in agricultural, forestry and stored product sectors in Malaysia. The main pests infesting the crops or manufactured products and their roles in the production of these sectors are emphasized. In the agricultural sector, pests of important crops such as rice, oil palm, coconut, cocoa, rubber, vegetables and fruits are emphasized. The main group of pests infesting various parts of forest trees and forest products are discussed. In the stored product sector, discussions encompass the storage system and the role of the stored product pests in causing physical damage or reduction of product quality of various stored products in the market especially cereal grains.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand on characteristics of agricultural, forest and stored product ecosystems and management problems in each ecosystem.
2) Identify of pests and their damage symptoms on agricultural crops, forest trees and stored products.
3) Manage and control of pests in each ecosystem.
4) Planning of management method or technique for major (most important) pests in each ecosystem.

BGT401/8 Agrobiology Project

In this course, the final year student is offered a research project that introduces the students to research methods for solving scientific problems. This course will require the student to manage time as well as carrying out scientific research. At the end of this course student will have hands-on experience in solving scientific problems through research, and present it as a scientific report in the form of a seminar and an academic thesis.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand a research topic on Agrobiology field.
2) Understand methods and protocols of doing laboratory analysis and handling equipment in the field and laboratory to obtain data related to Agrobiology field.
3) Carry out scientific research in Agrobiology field and present their research work in written thesis and oral presentation.
4) Perform data analysis and interpretation.
5) Convey/present scientific ideas clearly and effectively.

BGT402/4 Tropical Plant Disease Management

This course discusses various aspects in relation to the basic principles of plant disease management (protection and control) and the effectiveness in tropical areas (especially Southeast Asia). The methods of management include chemical, biological, and cultural controls, use and manipulation of resistant cultivars, and finally through legislation particularly plant quarantine. Integrated disease management and application of biotechnology and molecular biology techniques also will be discussed by using global examples. This course will conclude with a detail discussion on important diseases and pathogens in the tropics (mainly Malaysia) and their effective management currently being practiced.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the need to manage plant diseases especially in the tropics and globally.
2) Analysis the basic principles of plant disease management.
3) Integrate plant disease management components.
4) Apply biotechnology and molecular biology methods in integrated plant disease management.
5) Synthesis of recommendation framework towards methods of management of important plant diseases in the tropics especially in Southeast Asia (Malaysia).

BGT403/2 Advanced Plant Pathology Laboratory

In this course, students will be exposed to the various methods used in plant disease management by using biological and chemical methods, and cultural practices. The students will also visit a few research stations/laboratories to study the implementation of integrated plant disease management of key crops in Malaysia. In addition, methods of documentation on signs and symptoms of plant disease will also be studied.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand methods used in management of plant diseases.
2) Identify methods used to conduct experiments in plant pathology.
3) Document signs and symptoms of plant diseases.

BGT404/3 Horticultural Science

This course will provide information about the diversity of crops, including agronomic and horticultural crop species important in the tropics. The first part of this course provides basic knowledge in agriculture farming and the standard practice around the world, particularly in Malaysia. Students will be introduced briefly to plant house design and management, plant breeding and cultivation, farm irrigation and fertilization and soil and weed management. The course also covers topics related to organic farming practices and major industrial and food crop. The second part of the course is a general introduction to

the principles of crop breeding. At the end of this course, students will be able to apply both conventional and modern methods of plant breeding programs.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the standard practices of agricultural farming.
2) Identify and analyze factors affecting sustainability of agricultural science.
3) Mechanism of selection for crop improvement influenced by plant mating systems, genetic variation and environmental influences.
4) Exhibit problem-solving skills based on quantitative and analytical thinking on specific topics related to agronomy and crop breeding.

BOA301/4 Industrial Traning

Industrial training will be carried out for 8 weeks in semester 2 during the 3rd year. Students will be assigned in the industry, government and private agencies/institutions which are identified by the school and the students. From industrial training, students will be exposed to working environment. The final assessment of students after completing this course is only pass or fail.

Learning Outcomes
Upon completion of this course, students are able to :
1) Apply the knowledge learned in lectures into real working environment.
2) Have a clear training outcome.
3) Practice their knowledge, skill and capability.

BOE201/3 Biological Instrumentation

The course is divided into theory and practical, with emphasis being given to the practical aspects. Among the principles/techniques that will be discussed are assay principles, extraction and purification and analysis such as Kjeldahl, spectrophotometry, electrophoresis and chromatography. Emphasis will be given to the use of extractor equipment (centrifuge, electrophoresis, chromatography, freeze drying) and analysis equipment (Kjeldahl, atomic spectrophotometer, UV/Vis, flame photometer and pH, CO_2 & O_2 meters). This course is geared for students who are interested in courses that involve the study and efficient use of laboratory equipment in research.

Learning Outcomes
Upon completion of this course, students are able to :
1) Understand the theoretical principles of laboratory equipments such as centrifuge, spectrophotometer, electrophoresis, freeze dryer, atomic absorption spectrophotometer (AAS), gas chromatography, flame photometer and other analysis equipments.
2) Understand the techniques and use of laboratory equipments.

BOE400/2 Special Topics in Biology

Each student will be assigned a topic and supervised by a lecturer at the beginning of semester 1 or semester 2 (4th year of study). The students will be introduced to written research assignments. The students will also be trained to make a literature survey. At the end of the semester, each student is required to write an essay and present their written research assignment. The evaluation of this course will be based on the essay, oral presentation and evaluation by supervisor based on student's effort in completing tasks given.

Learning Outcomes

Upon completion of this course, students are able to :

1) Understand the best method for collecting information based on scholarly journals and texts that can be used in conducting their scientific research.
2) Logically and analytically analyze the findings published in scholarly journals.
3) Communicate scientifically to deliver effective oral and written reports.

BOT205/3 Microscopy and Histological Techniques

This course is aimed at introducing students to the basic principles and concepts of microscopy and histological techniques. Applications of light, colour and electromagnetic wave in microscopy; basic principles of bright-field, dark-field, phase contrast, fluorescence, confocal and electron microscopes will be taught. Concepts such as magnification, resolution, contrast, image formation, numerical aperture, illumination, and depth of field will be elaborated. Basic histopathology of animals and plants dealing with the structures of cells, tissues and organs in relation to their functions will be taught and discussed. Students will be given extensive laboratory demonstrations on the different techniques of microscopy and also perform techniques in fixation and preservation of specimens, staining and sectioning, construction and use of the microtome, and the preparation of histological slides.

Learning Outcomes

Upon completion of this course, students are able to :

1) Explain the basic principle on the main functions of a microscope (magnification, resolution and contrast), and to identify, compare and distinguish microscopy images by different techniques.
2) Explain the basic principle on different histological techniques through slide preparation and staining of samples from animals and plants.
3) Manage bright field microscopy; perform general staining and basic histological techniques with confidence.
4) Critically evaluate new applications in microscopy and histological techniques with the use of basic principles simultaneously with latest developments.

Index

SCHOOL OF CHEMICAL SCIENCES

SCHOOL OF CHEMICAL SCIENCES
(https://chem.usm.my)

VISION

To realise the aspiration of Universiti Sains Malaysia in Transforming Higher Education for a Sustainable Tomorrow.

MISSION

- To produce chemistry graduates who are knowledgeable, highly skilled, well-mannered and possess excellent work ethics suited for the requirements of the public and industrial sectors.
- To provide chemistry students with quality education.
- To instill awareness among chemistry students towards the welfare of the society.
- To provide modern facilities for chemistry teaching and research.
- To attract excellent students from Malaysia and overseas to study chemistry.

OBJECTIVES

- To provide a broad, balanced and in depth education in chemistry and related areas at the undergraduate level.
- To develop students into graduates with theoretical and practical knowledge and the ability to apply the knowledge for employment to further studies in chemistry or other related postgraduate programmes.
- To develop students with various skills including practical, social, communicative, leadership and entrepreneurial skills.
- To develop students with the ability to assess and solve problems critically, logically and creatively.

INTRODUCTION

The School of Chemical Sciences (SCS), established in 1969, is one of the pioneering Schools of USM. With an academic staff of more than 38 and over 44 supporting staff, the School has been entrusted to provide professional training in chemistry to meet the demands of the industries and society.

The programme is designed not only to produce graduates with a solid knowledge of chemistry but also to equip them with attributes so that they can adapt readily to a dynamic and rapidly developing working environment. The academic programmes, Bachelor of Science with Honours, B.Sc. (Hons) and Bachelor of Applied Science B.App.Sc. (Hons) from the School of Chemical Sciences, USM are planned to produce graduates who are knowledgeable, highly skilled, well-mannered and possess excellent work ethics suited for the requirements of the industrial and public sectors.

In line with this aspiration, the School of Chemical Sciences has designed courses which can be modified and adjusted from time to time to suit the requirements of an unpredictable future. The School practice a system which is liberal and multi-disciplinary in nature.

Our programmes are recognised nationally by the Malaysian Institute of Chemistry (Institut Kimia Malaysia), and internationally by the Royal Society of Chemistry starting from the Academic Session of 2015/2016 to 2020/2021.

PROGRAMMES OFFERED

The School offers two undergraduate programmes leading to:

- Bachelor of Science (B.Sc.) with Honours degree.
- Bachelor of Applied Science (B.App.Sc.) with Honours degree, majoring either in Analytical Chemistry or Industrial Chemistry.

These programmes include 8 weeks of industrial training with industrial partners, commercial and research laboratories. Students are also encouraged to register for the final year research project (which covers 2 semesters) during their final year.

The postgraduate programmes offer the research mode leading to M.Sc. and Ph.D. or the mixed-mode M.Sc. (Chemical Instrumentation) which have managed to attract fellow Malaysians and many foreign nationals.

PROGRAM AIMS

PURE CHEMISTRY

To nurture dynamic, respected and referred chemists who are socially responsible in supporting national and global aspirations in science, technology and innovations for a sustainable tomorrow.

ANALYTICAL CHEMISTRY

To nurture dynamic, respected and referred analytical chemists who are socially responsible in supporting national and global aspirations in science, technology and innovations for a sustainable tomorrow.

INDUSTRIAL CHEMISTRY

To nurture ethical, referred and respected industrial chemists who contribute to the current industrial needs and development of the country in supporting the social, economic and environmental well- being of the nation.

SPECIALISATION

The School has been given priority in creating a healthy research environment with a total of over 88 postgraduate students engaging in various areas of research including natural products, organic synthesis, nanoscience, electrochemistry, liquid crystals, organometallics, environmental chemistry, material chemistry and chemical education. Many of our academic staff have been well endowed with research grants and funding from government bodies and industries to support these research activities.

MAIN ADMINISTRATIVE STAFF

DEAN

Prof. Dr. Rohana Adnan

DEPUTY DEANS

Assoc. Prof. Dr. Melati Khairuddean
(Academic, Career & International)

Assoc. Prof. Dr. Oo Chuan Wei
(Research, Innovation & Industry-Community Engagement)

PROGRAMME MANAGERS

Assoc. Prof. Dr. Ng Eng Poh
(Physical Chemistry)

Dr. Mohd Rizal Razali
(Organic & Inorganic Chemistry)

Dr. Faiz Bukhari Mohd. Suah
(Analytical Chemistry)

Assoc. Prof Dr. Noor Hana Hanif Abu Bakar
(Industrial Chemistry)

ASSISTANT REGISTRAR

Mr. Subramaniam Govindan
Principal Assistant Registrar
(HR & Postgraduates)

Ms. Fauziah Rastam
Senior Assistant Registrar
(Academic)

ADMINISTRATION	TELEPHONE EXTENSION	E-MAIL
DEAN		
Prof. Dr. Rohana Adnan	3262/3549	r_adnan@usm.my
DEPUTY DEANS		
Academic, Career & International		
Assoc. Prof. Dr. Melati Khairuddean	3913/3576	melati@usm.my
Research, Innovation & *Industry-Community Engagement*		
Assoc. Prof. Dr. Oo Chuan Wei	4049/3576	oocw@usm.my
PROGRAMME MANAGERS		
Analytical Chemistry		
Dr. Faiz Bukhari Mohd. Suah	3686	fsuah@usm.my
Industrial Chemistry		
Assoc. Prof. Dr. Noor Hana Hanif Abu Bakar	6022	hana_hanif@usm.my
Organic and Inorganic Chemistry		
Dr. Mohd Rizal Razali	6021	mohd.rizal@usm.my
Physical Chemistry		
Assoc. Prof. Dr. Ng Eng Poh	3550	epng@usm.my
ASSISTANT REGISTRARS		
Principal Assistant Registrar		
Mr. Subramaniam Govindan	3540	subrag@usm.my
Senior Assistant Registrar		
Ms. Fauziah Rastam	3541	rfauziah@usm.my

ACADEMIC STAFF	TELEPHONE EXTENSION	E-MAIL
PROFESSORS		
Dato' Hasnah Osman, PhD	3558	ohasnah@usm.my
Rohana Adnan, PhD	3549	r_adnan@usm.my
Rosenani S.M. Anwarul Haque, PhD	3578	rosenani@usm.my
Yeap Guan Yeow, PhD	3568	gyyeap@usm.my
ASSOCIATE PROFESSORS		
Melati Khairuddean, PhD	3560	melati@usm.my
Mohamad Nasir Mohamad Ibrahim, PhD	3554	mnm@usm.my
Ng Eng Poh, PhD	3550	epng@usm.my
Noor Hana Hanif Abu Bakar, PhD	6022	hana_hanif@usm.my
Oo Chuan Wei, PhD	3680	oocw@usm.my
SENIOR LECTURERS		
Ahmad Faiz Abdul Latip, PhD	3546	afaiz@usm.my
A.K.M. Shafiqul Islam	3559	shafiqul@usm.my
Chua Yong Shen, PhD	4022	yschua@usm.my
Faiz Bukhari Mohd. Suah, PhD	3686	fsuah@usm.my
Hairul Hisham Hamzah, PhD	3480	hishamhamzah@usm.my
Lee Hooi Ling, PhD	3547	hllee@usm.my
Lim Gin Keat, PhD	4028	limgk@usm.my
Mardiana Saaid, PhD	3569	mardiana@usm.my
Mazidatulakmam Miskam, PhD	3561	mazidatul@usm.my
Mohammad Anwar Mohamed Iqbal, PhD	3565	anwariqbal@usm.my
Mohamad Nurul Azmi M. Taib, PhD	3562	mnazmi@usm.my
Mohammad Rashid Mohd Tahir, PhD		rashidchem@usm.my
Mohd Hazwan Hussin, PhD	6378	mhh@usm.my
Mohd Rizal Razali, PhD	6021	mohd.rizal@usm.my
Muhammad Bisyrul Hafi Othman, PhD	4032	bisyrul@usm.my
Ng Si Ling, PhD	6013	slng@usm.my
Noor Haida Mohd Kaus, PhD	3598	noorhaida@usm.my
Norazizi Nordin, PhD	4030	azzizi@usm.my

SENIOR LECTURERS	TELEPHONE EXTENSION	E-MAIL
Nur Farhana Jaafar, PhD	3566	nurfarhana@usm.my
Nurul Yani Rahim, PhD	4043	nurulyanirahim@usm.my
Oh Wen Da, PhD	3548	ohwenda@usm.my
P. Bothi Raja, PhD	6015	bothiraja@usm.my
Shangeetha Ganesan, PhD	4026	shangeetha@usm.my
Wan Nazwanie Wan Abdullah, PhD	3091	wanazwanie@usm.my
Wong Yong Foo, PhD	4031	wongyongfoo@usm.my
Yam Wan Sinn, PhD	6017	wansinn@usm.my
Yeoh Kar Kheng, PhD	5179	kkyeoh@usm.my

TECHNICAL STAFF

CHIEF SCIENCE OFFICERS

Khairul Izwan Saruddin	4033	kizwan@usm.my

SENIOR SCIENCE OFFICERS

Nurul Arlita Kushiar	4058	arlita@usm.my

SCIENCE OFFICERS

Alia Syazana Roslan	5148	aliasyazana@usm.my
Nor Hasniza Zulkepli	3687	hasnizazulkepli@usm.my
Nur Ainina Abdollah	6251	aininaabdollah@usm.my

SENIOR ASSISTANT SCIENCE OFFICERS

Organic Chemistry

Wan Zulilawati Wan Zulkipli	3865	wanzulilawati@usm.my

Makmal Ujian Perkhidmatan Analisis (MUPA)

Saripah Azizah Mansor	4057	saripahazizah@usm.my

SENIOR ASSISTANT SCIENCE OFFICER	TELEPHONE EXTENSION	E-MAIL
Physical Chemistry Division		
Ami Mardiana Othman	5177	amimardiana@usm.my
Analytical Chemistry		
Mohd Zamri Rosidi	5176	zamri5083@usm.my
ASSISTANT SCIENCE OFFICERS		
Industrial Chemistry Division		
Ali Zaini Hassan	4036	alizani@usm.my
Azizo Daud	3577	azizo@usm.my
Kamarulazwan Abdul Kayum	4037	kamarulazwan@usm.my
Mohd Nazri Saed	3026	mnazri_saed@usm.my
Sobri Aziz	4038/5023	azsobri@usm.my
Inorganic Chemistry Division		
Azhar Ramli	5178	azharramli@usm.my
Razly Effendy Khalid@Khalib	3579	razly@usm.my
Makmal Ujian Perkhidmatan Analisis (MUPA)		
Megat Hasnul Zamani Ismail	4493/6379	mzhasnul@usm.my
Organic Chemistry Division		
Nur Asma Ismail	5178	asma_isma@usm.my
Physical Chemistry Division		
Mohammad Noor Zakaria	3545	mohdnoorz@usm.my
Sivaraj Panir Selvam	3573	sivaraj@usm.my
Analytical Chemistry		
Muhammad Fauzan Mat Fuzi	4039	mfauzanmp@usm.my
Norhayati Abdul Kadir	4041	rozeyanti@usm.my
Sujayendran Rajagopal	6019	sujayendran@usm.my
First Year		
Mohd Fahmi Mohd Yusoff	3919	mohdfahmi@usm.my
Sobri Aziz	5023/4038	azsobri@usm.my

SUPPORT / TECHNICAL STAFF	TELEPHONE EXTENSION	E-MAIL
Electronic Workshop		
Abd Razak Hashim	3544	rp_chs@usm.my
Mohd Fairoz Shahul Hamid	3544	mohdfairoz@usm.my
Glass Blowing Workshop		
Mohd Nazeef Ahmad	6116/3574	mohdnazeef@usm.my
Ramlee Abdul Wahab	3542	awramlee@usm.my
ADMINISTRATIVE STAFF		
Senior Secretary		
Nurul Izzati Md Rashid	3262	nurul_izzati@usm.my
Siti Nor Aishah Abdul Rashid	3576	snaar@usm.my
Senior Administrative Assistant		
Siti Haida Idris	3851	siti_haida@usm.my
Administrative Assistants		
Amir Hafifi Ahmad Nazir	5455	amirafifi@usm.my
Faezah Harun	3543	faezahharun@usm.my
Ibrahim Mahmad Sallih	3973	ims@usm.my
Idzhar Ahmat	4955	idzhar@usm.my
Jagathesan Ramasamy	3570	jegannie@usm.my
Kausalya Ramanei	3593	kausi@usm.my
Mohd Hafez Khairi	5455	mhafez@usm.my
Mohd Syafiq Mohd Sukari	3593	syafiqsukari@usm.my
Norshamila Zulkefli	4955	shamilazulkefli@usm.my
Roziana Mohamed Idros	5459	roziana_idros@usm.my
Chemical Store		
Zainah Saleh	5459	zainah@usm.my

MAJOR EQUIPMENTS	**LOCATION (G09/G09A)**	**TELEPHONE EXTENSION**
Analytical Services and Testing Laboratory (MUPA)	017	4057/4058/4059
Atomic Absorption Spectrometers (AAS)	MUPA, K316	4059/2059
Carbon Hydrogen Nitrogen Analyser (CHN)	363	3579
Capillary Electrophoresis (CE)	K214	-
Differential Scanning Calorimeter (DSC)	K013	-
Electrochemical Systems	K316 / K011	-
Fourier Transform Infrared Spectrometers (FTIR)	370	3577/5032
Gas Chromatographs (GC)	MUPA, 274 & K213	4059/4040/4493
Gas Chromatography-Mass Spectrometer (GC-MS)	MUPA	4059
Gel Permeation Chromatograph (GPC)	K113	4038
High Performance Liquid Chromatograph (HPLC)	K319	-
Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES)	MUPA	4057
Liquid Chromatography-Mass Spectrometer (LCMS)	MUPA	4059/4058
Nuclear Magnetic Resonance Spectrometers (NMR 400 & 500 MHz)	032	3589
Polarised Optical Microscope (POM)	366	-
Porosimeter	166	-
Thermogravimetric Analysers (TGA)	K013	-
Total Organic Carbon Analyser (TOC)	364	-
Ultraviolet-Visible Spectrophotometers (UV-VIS)	175, 367 & 244	-

GENERAL INFORMATION

Careers

The School of Chemical Sciences was established in 1969 and has produced quality graduates who possess experience and skills in line with the programmes offered. The School is staffed with experienced lecturers and equipped with modern instruments in both teaching and research laboratories. As such, the graduates can pursue careers in public agencies such as the Malaysian Palm Oil Board (MPOB), Malaysian Agricultural Research and Development Institute (MARDI), Rubber Research Institute of Malaysia (RRI), Forestry Research Institute Malaysia (FRIM) and Jabatan Kimia Malaysia (JKM). Graduates can also work in scientific instrument companies such as Perkin Elmer. In addition, there are opportunities for graduates to serve as chemists and engineers in the electronics industry, such as Intel, Infineon, Osram and Silterra. Graduates can also venture into other fields or pursue postgraduate degrees at the School of Chemical Sciences.

Alumni of the School of Chemical Sciences

All graduates of the School of Chemical Sciences are automatically members of the Chemistry Alumni. It is hoped that participation in activities organised by the Chemistry Alumni Association of the School of Chemical Sciences will foster better relationship and cooperation among members and the School for the benefits of all. It is hoped that nostalgia and love towards the alma mater can be brought back through the Chemistry Alumni.

All graduates of the School of Chemical Sciences can update their information or register as members using the on-line form via http://chem.usm.my/.

AWARDS AND DEAN'S CERTIFICATE

(a) **Royal Education Award by the Malaysian Rulers' Council**

For the best final year students in all fields.

(b) **Tuanku Chancellor Gold Medal Award**

For the best final year student in all fields.

(c) **USM Gold Medal Award (awarded by Woman's Association USM)**

For the best female final year student in all fields.

(d) **USM Gold Medal Award (awarded by Tun Dato' Seri Dr. Lim Chong Eu)**

For the best final year student in the Bachelor of Science

(e) **USM Gold Medal Award (awarded by Chemical Company of Malaysia Bhd. - CCM)**

For the best final year student in the field of Chemistry.

(f) **USM Book Award (awarded by Hoechst Malaysia Sdn. Bhd.)**

For the best final year student in the field of Industrial Chemistry.

(g) **Dean's Certificate** will be awarded to any student in the School of Chemical Sciences who have achieved academic excellence. The certificate will be awarded every semester.

CHEMICAL SCIENCE SOCIETY *(PERSATUAN SAINS KIMIA)*

Students in the School of Chemical Sciences are encouraged to be active in extra-curricular and self-development activities. This is made possible through *Persatuan Sains Kimia* which provides a platform for them to cultivate their interests in various fields.

INDUSTRY/COMMUNITY ADVISORY PANEL (ICAP) MEMBERS

1. Mr. Amir Hamzah Bin Yasak

   ESPEK Sdn. Bhd.

2. Mdm. Syazrin Syima Sharifuddin

   National Hydraulic Research Institute of Malaysia (NAHRIM)

3. Mr. Lye Poh Huat

   Penchem Technologies Sdn. Bhd.

POSTGRADUATE STUDIES

Students who are interested to pursue postgraduate studies can choose any of the following programmes:

(a) Full-time or part-time programme leading to degrees in Master of Science and Doctor of Philosophy by research.

(b) Full-time or part-time mixed-mode programme (a combination of course work and research) leading to a Master of Science degree.

Further information can be obtained from the Institute of Postgraduate Studies, USM.

FACILITIES

The School is equipped with teaching and research laboratories. Existing analytical and characterisation instruments include the NMR (400 MHz for solid state analysis) and NMR (500 MHz for liquid state analysis), ICP-MS, ICP-OES, GCMS, LCMS (TOF), DSC/TGA, TOC, GPC, CHN Analyser, HPLC, GC, FTIR with Microscope, UV-Vis, FTIR, AAS and Fluorescence spectrophotometers, Electrochemical systems and Surface Area Analyser, Guoy-Balance, POM and other supporting equipments. The School is also equipped with Electronics and Glass-Blowing Workshops.

The expertise and facilities available in the School of Chemical Sciences are always tapped by the industries and government agencies in solving their problems. In line with the desire to improve the consultation services, the School of Chemical Sciences has taken a proactive step by setting up an Analytical Services and Testing Laboratory (MUPA) in the year 2000, which offers effective services for the industrial sectors.

COURSE STRUCTURE

(i) Structure of Study Programme

Course Component	Credit Requirement B.App.Sc. (Hons.)
Core **(T)**	72
Elective **(E)** or Minor **(M)**	30
University **(U)**	18
Total	**120**

(ii) Industrial Training

Students are encouraged to apply for Industrial Training (KIE361/4) after the 6th semester.

(iii) Final Year Project

Students are encouraged to register for Chemistry Project (KUE409/6) during their final year of studies. This involves conducting research work for 2 semesters and submitting a Final Year Project report.

Students who do not wish to register for the Chemistry Project (KUE409/6) may fulfill the 6 credits requirement by registering other Elective courses offered by the School.

(iv) Assessment

Course assessment will be based on:

a) Examination

b) Course Work

The assessment will cover knowledge, applications, analytical and writing skills. Skills will be assessed through the course work in the form of assignments, quizzes, tests, presentations and laboratory reports.

LIST OF COURSES OFFERED

(a) B.App.Sc. (Hons.) (Analytical Chemistry)		
(i) Core Courses (T) - 72 credits		**Prerequisites**
MAA101/4	Calculus for Science Students 1	
MAA102/4	Calculus for Science Students 2	
ZCT103/3	Physics III (Vibrations, Waves and Optics)	
ZCT104/3	Physics IV (Modern Physics)	
KUT101/2	General Chemistry Practical I	
KUT102/2	General Chemistry Practical II	
KTT112/4	Inorganic Chemistry I	
KOT122/4	Organic Chemistry I	
KUT206/2	Organic Chemistry Practical	KUT102 (s), KOT122 (s)
KTT212/3	Inorganic Chemistry II	KTT112 (s)
KOT222/3	Organic Chemistry II	KOT122 (s)
KFT233/4	Physical Chemistry I	KTT112 (s) or KOT122 (s)
KAT245/4	Analytical Chemistry I	KTT112 (s) or KOT122 (s)
KFT332/3	Physical Chemistry II	KFT233 (s), KUT304 (c)
KAT340/2	Analytical Practical II	
KAT344/4	Separation Methods	KAT245 (s)
KAT345/4	Spectroscopic Methods	KAT245 (s)
KAT346/4	Electroanalytical Methods	KAT345 (s)
KFT431/3	Physical Chemistry III	KFT332 (s)
KAT442/4	Environmental Pollution Chemistry	KAT344 (s), KAT345 (s)
KUE409/6 or 6 credits	Chemistry Project or Other theory courses from Analytical, Industrial or Pure Chemistry	

(ii) Elective Courses (E) - 30		
(a) Compulsory Components - 16 credits		**Prerequisites**
MAT181/4	Programming for Scientific Applications	
KUT304/2	Physical Chemistry Practical	KUT102 (s), KFT332 (c)
KUE306/2	Research Methodology in Chemistry	
KAE348/2	Analytical Chemistry Practical III	KAT345 (s) or KAT349 (s)
KIT358/3	Polymer Chemistry	KOT122 (s)
KAE445/3	Bioanalysis	KAT344 (s) or KAT349 (s)
(b) Selection of 14 credits		
KIE361/4	Industrial Training	

Additional of **10** or **14 credits** to fulfill the elective component must be taken from Analytical Chemistry, Industrial Chemistry and other courses from the Schools of Physics, Mathematical Sciences, Biological Sciences, Industrial Technology and Centre for Global Archaeological Research.

* All the courses offered are subjected to changes when the need arises.

(s) = sequential (Course must be taken earlier)
(c) = concurrent (Course can be taken concurrently)

(iii) Minor (M) & Elective (E) Programmes – 30 credits		
Elective (E) Components		**Prerequisites**
(a) Selection of 10 credits or more		
MAT181/4	Programming for Scientific Applications – (*Compulsory*)	
KIT257/3	Materials Chemistry	
KUT304/2	Physical Chemistry Practical – (*Compulsory*)	KUT102 (s), KFT332 (c)
KUE306/2	Research Methodology in Chemistry – (*Compulsory*)	
KIT358/3	Polymer Chemistry	KOT122 (s)
KAE348/2	Analytical Chemistry Practical III	KAT345 (s) or KAT349 (s)
KIE361/4	Industrial Training	
KAE445/3	Bioanalysis	KAT344 (s) or KAT349 (s)
Minor (M) Components		
(b) Selection of 20 credits		
Select from any minor programme. Please refer to the book of Minor Programme Guideline		
All Minor Programmes offered by other Schools can be taken by the Chemistry Students subject to the requirements imposed by the School which offers the Minor Programmes such as Management, Computer, Communication, Psychology, English or other Sciences		

*All the courses offered are subjected to changes when the need arises.

(s) = sequential (Course must be taken earlier)
(c) = concurrent (Course must be taken concurrently)

LIST OF COURSES OFFERED

B.App.Sc. (Hons.) (Industrial Chemistry)		
(i) Core Courses (T) - 72 credits		**Prerequisites**
MAA102/4 or MAA161/4	Calculus for Science Students 2 or Statistics for Sciences Students	
MAA101/4	Calculus for Science Students 1	
ZCA101/4	Physics I (Mechanics)	
ZCT104/3	Physics IV (Modern Physics)	
KUT101/2	General Chemistry Practical I	
KUT102/2	General Chemistry Practical II	
KTT112/4	Inorganic Chemistry I	
KOT122/4	Organic Chemistry I	
KTT212/3	Inorganic Chemistry II	KTT112 (s)
KOT222/3	Organic Chemistry II	KOT122 (s)
KFT233/4	Physical Chemistry I	KTT112 (s) or KOT122 (s)
KAT245/4	Analytical Chemistry I	KTT112 (s) or KOT122 (s)
KIT257/3	Materials Chemistry	
KIT258/4	Unit Operations	
KUT305/2	Analytical Chemistry Practical I	KUT101 (s), KAT349 (c)
KFT332/3	Physical Chemistry II	KFT233 (s)
KAT349/3	Analytical Chemistry II	KAT245 (s), KUT305 (c)
KIT355/2	Unit Operations Practical	KIT258 (s)
KIT357/2	Industrial Practical	KIT257 (s)
KIT358/3	Polymer Chemistry	KOT122 (s)
KIT458/3	Chemical Processing	KTT112 (s), KOT122 (s)
KUE409/6 or 6 credits	Chemistry Project or Other theory courses from Analytical, Industrial or Pure Chemistry	

(ii) Elective Courses (E) – 30 credits		
(a) Compulsory Components – 12 credits		**Prerequisites**
KUT203/2	Inorganic Chemistry Practical	KUT101 (s)
MAT223/4	Differential Equations I	
KUE306/2	Research Methodology in Chemistry	
KIE361/4	Industrial Training	
(b) Selection of 2 credits (minimum)		
KUT206/2	Organic Chemistry Practical	KUT102 (s), KOT122 (s)
KUT304/2	Physical Chemistry Practical	KUT102 (s)
(c) Selection of 16 credits (minimum)		
KUT407/2	Inorganic and Analytical Chemistry Practical	KUT203 (s), KUT305 (s)
KAE445/3	Bioanalysis	KAT344 (s) or KAT349 (s)
KIE456/3	Food and Palm Oil Chemistry	
KIE458/3	Selected Topics in Industrial Chemistry	
*Additional 5 credits to fulfill the elective component must be taken from Pure Chemistry, Analytical Chemistry or other courses from Science Schools.		

(iii) Minor (M) & Elective (E) Programmes - 30 credits		
Elective (E) Components		
(a) Selection of 10 credits or more		
KUE306/2	Research Methodology in Chemistry – *(Compulsory)*	
KIE361/4	Industrial Training - *(Compulsory)*	
KUT203/2	Inorganic Chemistry Practical	KUT101 (s)
KUT206/2	Organic Chemistry Practical	KUT102 (s), KOT122 (s)
MAT223/4	Differential Equations I	
KUT304/2	Physical Chemistry Practical	KUT102 (s)
KIE456/3	Food and Palm Oil Chemistry	
KIE458/3	Selected Topics in Industrial Chemistry	
Minor (M) Components		
(b) Selection of 20 credits		
Select from any minor programme. Please refer to the book of Minor Programme Guideline		

(s) = sequential (Course must be taken earlier)
(c) = concurrent (Course must be taken concurrently)

Proposed Schedule by Semester

B.App.Sc. (Hons.) (Analytical Chemistry)

YEAR 1					
COMPONENT	**SEMESTER 1**		**SEMESTER 2**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	WUS101	2	HTU223	2	
			LKM 400	2	
Core Courses (T)	KTT112	4	KAT245	4	
	KUT102	2	KUT101	2	
	KOT122	4	MAA102	4	
	MAA 101	4			
Elective (E) or Minor (M) Courses					
TOTAL CREDIT HOURS		**16**		**14**	**30**

YEAR 2					
COMPONENT	**SEMESTER 3**		**SEMESTER 4**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	SHE101	2	Refer to page 27-38	2	
Core Courses (T)	ZCT103	3	ZCT104	3	
	KUT206	2	KTT212	3	
	KOT222	3	KAT345	4	
	KFT233	4			
Elective (E) or Minor (M) Courses	Elective / Minor	2	MAT181	4	
TOTAL CREDIT HOURS		**16**		**16**	**32**

YEAR 3					
COMPONENT	**SEMESTER 5**		**SEMESTER 6**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	LSP300	2			
	Refer to page 26-35	2			
Core Courses (T)	KFT332	3	KAT346	4	
	KAT340	2			
	KAT344	4			
Elective (E) or Minor (M) Courses	KUT304	2	KUE306	2	
			KAE348 / Minor	2	
			KIT358 / Minor	3	
			Elective / Minor	4	
TOTAL CREDIT HOURS		**15**		**15**	**30**

YEAR 4					
COMPONENT	**SEMESTER 7**		**SEMESTER 8**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	Refer to page 26-35	2	LSP402	2	
Core Courses (T)	KUE409	3	KUE409	3	
	KFT431	3	KAT442	4	
Elective (E) or Minor (M) Courses	KIE361 / Elective / Minor	4	KAE445 / Minor	3	
			Elective / Minor	4	
TOTAL CREDIT HOURS		**12**		**16**	**28**
GRAND TOTAL CREDIT HOURS					**120**

B.App.Sc. (Hons.) (Industrial Chemistry)

YEAR 1					
COMPONENT	**SEMESTER 1**		**SEMESTER 2**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	WUS101	2	HTU223	2	
Core Courses (T)	KTT112	4	KOT122	4	
	KUT102	2	KUT101	2	
	MAA101	4	MAA102 / MAA161	4	
	ZCA101	4	ZCT104	3	
TOTAL CREDIT HOURS		**16**		**15**	**31**

YEAR 2					
COMPONENT	**SEMESTER 3**		**SEMESTER 4**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	SHE101	2	LSP300	2	
Core Courses (T)	KOT222	3	KTT212	3	
	KAT245	4	KFT233	4	
	KIT257	3	KIT258	4	
Elective (E) or Minor (M) Courses	Elective / Minor	3	KUT203 / Minor	2	
TOTAL CREDIT HOURS		**15**		**15**	**30**

YEAR 3					
COMPONENT	**SEMESTER 5**		**SEMESTER 6**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	LKM400	2	LSP402	2	
	Refer to page 27-38	2			
Core Courses (T)	KFT332	3	KAT349	3	
	KIT357	2	KUT305	2	
			KIT358	3	
			KIT355	2	
Elective (E) or Minor (M) Courses	KUT206 / KUT304 / Minor	2	KUE306	2	
	MAT223	4			
TOTAL CREDIT HOURS		**15**		**14**	**29**

YEAR 4					
COMPONENT	**SEMESTER 7**		**SEMESTER 8**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	Refer to page 27-38	2	Refer to page 27-38	2	
Core Courses (T)	KUE409	3	KUE409	3	
			KIT458	3	
Elective (E) or Minor (M) Courses	KIE361	4			
	Elective / Minor	4	Elective / Minor	9	
TOTAL CREDIT HOURS		**13**		**17**	**30**
GRAND TOTAL CREDIT HOURS					**120**

Program Learning Outcomes: Upon completion of this programme, students will be able to:

PO1	**Knowledge (of the discipline)**	• Apply fundamental knowledge of chemistry to chemistry related practices.
PO2	**Practical Skills (of the discipline)**	• Perform safe handling of chemicals and proficient manipulation of laboratory apparatus and analytical instruments.
PO3	**Social Skills and Responsibilities**	• Demonstrate social skills and responsibility for the well-being of society.
PO4	**Values, Attitudes and Professionalism**	• Balance and uphold positive values, ethics and accountability in societal and professional engagement.
PO5	**Communication, Leadership and Teamwork Skills**	• Lead and collaborate with diverse team members and demonstrate effective communication.
PO6	**Problem Solving and Scientific Skills**	• Provide practical solutions to chemistry related issues by employing appropriate and relevant chemistry knowledge and skills.
PO7	**Information Management and Life-long Learning Skills**	• Manage information and seek new knowledge and skills independently.
PO8	**Managerial & Entrepreneurial Skills**	• Display relevant and appropriate managerial and entrepreneurial skills.

SYNOPSIS OF COURSES

KUT101/2 General Chemistry Practical I

General chemistry practical on theory involving inorganic and analysis chemistry. Separation of the Components of a Mixture. Chemical Formulas. Chemical Reactions of Copper and Percent Yield. Titration of Acids and Bases. Analysis of Water for Dissolved Oxygen. Preparation of Sodium Bicarbonate and Sodim Carbonate. Gravimetric Determination of Phosphorus in Plant Food. Titration Curves of Polyprotic Acids. Determination of the Solubility-Product Constant for a Sparingly Soluble Salt. Preparation and Reactions of Coordination Compounds:Oxalate Complexes. Oxidation - Reduction Titration II:Analysis of Bleach. Microscale Chemistry Experiments Titration of Acid and Bases

Learning Outcomes

Upon completion of this course, students are able to:

1. Demonstrate competency in appropriate basic laboratory techniques in analytical and inorganic chemistry.
2. Interpret data from laboratory observations and measurements with appropriate use of chemical equations and calculations.
3. Display safe laboratory practices.
4. Write reports clearly, concisely and appropriately.

KUT102/2 General Chemistry Practical II

The General Chemistry Practical II contains two parts which are the organic part and the physical part. This subject applies theoretical knowledge in practice to understand the methods of measuring and recording the experiment data in a clear, concise, and appropriate manner, from laboratory observations and measurements as follows;

1. Stereochemistry
2. Extraction & Crystallization using Acid Base Properties
3. Paper Chromatography - Separation of Cation & Dyes
4. Determination of the Dissociation Constant of a Weak Acid
5. Preparation of Aspirin and Oil of Wintergreen
6. Analysis of Aspirin
7. Behaviour of Gases: Molar mass of Vapor
8. Determination of R: The Gas Law Constant
9. Colorimetric Determination of an Equilibrium Constant in Aqueous Solution
10. Heat of Neutralization
11. Rate of Chemical Reaction I: A Clock Reaction
12. Rate of Chemical Reaction I: Rate and Order of H_2O_2

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competency in appropriate basic laboratory techniques in organic and physical chemistry.
2. Interpret data from laboratory observations and measurements with appropriate use of chemical equations and calculations.
3. Display safe laboratory practices.
4. Write reports clearly, concisely and appropriately.

KTT112/4 Inorganic Chemistry I

This course will introduce topics in basic chemistry such as stoichiometry, atomic structure, nuclear chemistry, periodic table, chemical bonding and properties of matter.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the knowledge of stoichiometry to discuss and solve problems on stoichiometric problems.
2. Apply the knowledge of the atoms in the periodic table to discuss the relationship between the elements in the group and in a particular period.
3. Apply the Bohr Theory and wave mechanics to understand the electronic configuration and bonding theory in chemical bond formation.
4. Apply the knowledge of nuclear chemistry to explain radioactive decay and to understand the safe and unsafe uses of radioactive elements.
5. Apply the knowledge of structures, properties of solids to explain the various types of materials.

KOT122/4 Organic Chemistry I

Electronic structure and bonding. Acids and bases. An introduction to organic compounds: functional groups, nomenclature and representation of the structure. Reactions of alkanes, alkenes and alkynes. Stereochemistry: the arrangement of atoms in space and the stereochemistry of addition reactions. Delocalised electrons and resonance. Reactions at the sp^3 hybridized carbon: nucleophilic substitution reactions of alkyl halides, elimination reactions of alkyl halides and compounds with leaving groups other than halogen. Structure, synthesis and reactions of alcohols, ethers and epoxides.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply knowledge of structure and bonding to explain the properties of various classes of compounds such as alkanes, alkenes, alkynes, alcohols, ethers and epoxides.

2. Apply the correct chemical nomenclature in naming the organic compounds.
3. Apply the knowledge of organic reactions to discuss and solve problems on various organic reactions.
4. Demonstrate the ability to apply the organic chemistry principles in order to explain the stereochemistry of the organic reactions.

KUT203/2 Inorganic Chemistry Practical **KUT101 (s)**

Basic techniques of preparation and characterisation of the inorganic compounds. This course includes the following list of experiments. Students need to carry out the experiments selected from the list by referring to the Practical Manual KUT203:

1. Studies on a metal complex, potassium trioxalatoaluminate(II) trihydrate, $K_3[Al(ox)_3].3H_2O$.
2. Preparation and conductivities of complex compounds $[Co(NH_3)_4CO_3]NO_3$ and $[Co(NH_3)_5Cl]Cl_2$.
3. Synthesis of bis(triphenylphosphine)copper(II) borohydride, $(Ph_3P)_2CuBH_4$.
4. Complex ion composition using Job's method.
5. The chemistry of vanadium.
6. Electronic spectra of coordination compounds.
7. Preparation and resolution of tri(ethylenediamine)cobalt(III) ion into its optical antipodes.
8. Characterisation of the linkage isomers: nitropentaaminecobalt(III) chloride, $[Co(NH_3)_5NO_2]Cl_2$ and nitritopentaaminecobalt(III) chloride, $[Co(NH_3)_5ONO]Cl_2$
9. The electronic spectra of some copper(II) complexes.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate the common techniques on the synthesis of inorganic compounds and methods of characterisation.
2. Interprete data associated with the synthesis and the products obtained at laboratory scale.
3. Use the data obtained to illustrate the inorganic chemistry principles.
4. Demonstrate safety practices in inorganic laboratory.
5. Write reports following the appropriate format.

KUT206/2 Organic Chemistry Practical **KUT102 (s), KOT122 (s)**

Basic organic techniques in chromatography (thin-layer, column and gas-liquid), fractional distillation, extraction and isolation techniques, spectroscopy (NMR, IR, UV & MS) and classical qualitative analysis are introduced through a series of compulsory experiments. This is followed by several experiments which expose the students to a selection of techniques in physical organic chemistry (such as the investigation of resonance energy related to unsaturated α, β carbonyl system) and preparative organic

chemistry involving some distinct reactions e.g. the Diels-Alder, pinacol-pinacolone rearrangement and the Michael conjugate addition.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competency when conducting and applying various separation techniques
2. Deduce the structures of simple organic compounds from their chemical and physical characteristics using the IR and NMR spectra.
3. Perform various multi-step small scale syntheses including purification of the end products.
4. Write reports clearly and appropriately for all the experimental reactions conducted.
5. Display safe laboratory practices.

KTT212/3 Inorganic Chemistry II **KTT112 (s)**

Introduction on transition metal complexes and coordination chemistry. Structure, isomerism and nomenclature, formation constant for transition metal complexes, preparation of coordination compounds and spectroscopy, bonding theory in the formation of transition metal complexes, introduction on the reaction mechanism, transition metal complexes in organometallic and basic concept on group theory.

Learning Outcomes

Upon completion of this course, students are able to:
1. Describe all the fundamental properties and characteristics related to the transition metals and their complexes.
2. Apply the knowledge of coordination compounds to explain the formation of metal-ligand complexes.
3. Apply various chemical bond theories to explain the compounds containing metal-ligand and metal-metal bonding.
4. Apply the knowledge of coordination chemistry in reaction mechanisms, organometallics and group theory.

KOT222/3 Organic Chemistry II **KOT122 (s)**

Identification of organic compounds: mass spectrometry, infrared spectroscopy, ultraviolet/visible spectroscopy and NMR spectroscopy. Oxidation, reduction and radical reactions. Aromatic compounds: aromaticity, reactions of benzene and substituted benzenes. Introduction to carboxylic acids: nomenclature, structure, preparation and reactions and acidity. Introduction to carbonyl chemistry: organometallic reagents, nucleophilic acyl substitution and the use of protecting groups.

Learning Outcomes

Upon completion of this course, students are able to:
1. Describe and name the carbonyl and aromatic compounds and propose the synthesis of these compounds.
2. Predict the products and propose appropriate mechanisms for the reactions of the above compounds.
3. Identify and determine the structure of an unknown compound with different spectroscopic techniques.
4. Discuss the concept of resonance to account for the stabilities of conjugated dienes, allylic radicals and cations.
5. Predict the products and propose the appropriate mechanisms for oxidation, reduction and radical reactions.

KFT233/4 Physical Chemistry I **KTT112 (s) or KOT122 (s)**

Properties of gases: gas laws, van der Waals equation, kinetic theory of gases, principle of the corresponding states, Maxwell-Boltzmann distribution, collision theory, effusion, diffusion, viscosity and thermal conductivity.
Chemical kinetics: rate laws, temperature effect, experimental methods, complex reactions. First law of thermodynamics: work, heat, energy, enthalpy change, heat capacity, adiabatic and isothermal processes, reversible and irreversible processes. Thermochemistry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the van der Waals and other equation of states to distinguish between ideal and real gases.
2. Apply the knowledge of kinetic theory of gases to explain various molecular collisions, speeds and transport properties of gases.
3. Demonstrate how kinetic and thermodynamic principles can be used to determine the reaction rates and various thermodynamic parameters of the reversible and irreversible processes, respectively.
4. Demonstrate the ability to apply equations, to discuss and solve problems on gas properties, chemical kinetics and thermodynamics.

KAT245/4 Analytical Chemistry I **KTT122 (s) or KOT122 (s)**

Stoichiometry calculations, statistical data treatment, good laboratory practices, concepts of equilibrium, gravimetric analysis, acid-base equilibria, acid-base titrations, complexometric titrations, precipitation reactions and titrations, electrochemical cells and redox titrations.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply knowledge of basic concepts to calculate various concentrations.
2. Apply knowledge of statistical concepts in analytical chemistry to make calculation and to make correct conclusions.
3. Apply knowledge of various chemical equilibria including acid-base, complexometry, gravimetry and redox to explain various titration methods.
4. Demonstrate the ability to apply appropriate equations to solve problems in chemical equilibrium using systematic methods.

KIT257/3 Materials Chemistry

Introduction: Classification of materials; Relation between structure, processing and properties.

Atomic Structure and Chemical Bonding: Atomic structure; Types of chemical bonding; Properties from bonding; Unit cell; Crystal structure of solids; Crystallographic directions and planes; Determination of crystal structure.

Imperfection in Solids: Types of imperfections/defects; Defects in ceramic structures; Defects in alloys; Characterization of defects.

Diffusion in Solids: Types of diffusion; Diffusion mechanisms; Factors that influence diffusion; Effects of diffusion to the structure and properties of materials.

Ceramics: Basic categories of ceramics; General properties of ceramic materials, structure of ceramics, silicates and glasses; New and modern ceramics; Biodegradable and bioactive ceramics; Applications of ceramic materials.

Polymers: Polymer molecules; Types of polymers; Structure of polymer; Molecular weight, degree of polymerisation and degree of crystallisation, polymer crystals; Synthesis of polymer; Phase transition of polymer.

Metals and Alloys: Classification of metals and alloys; Bonding in metals; Metallic structure; Phase diagram of metal (iron).

Composites: General requirements for composite; Types of composites; Form of matrices and reinforcement phases; Concrete and hybrid composites; Benefits and application of composite materials.

Phase Diagrams: Basic concept of phase equilibrium; Classification of phase diagrams; Interpretation of phase diagram; Lever Rule; Development of microstructure; Phase transformations; Factors that influence the phase transformation.

Properties of Materials: Mechanical properties: Stress, strain, elastic and plastic behavior, strength, hardness, ductility and toughness. Electrical properties: Conductivity, electron energy bands, electron mobility, semiconductors and dielectric materials. Magnetic properties: Magnetic force, magnetic field, classification of magnetic materials and its magnetic properties. Thermal Properties: Heat capacity, thermal conductivity, thermal expansion and thermal stress/shock. Optical Properties: Reflection, refraction, absorption and transmission, color and fiber optic.

Corrosion and Degradation of Materials: Corrosion of metals: Corrosion reaction and corrosion rate, factors that influence the corrosion, forms of corrosion, corrosion protections. Degradation of Polymer: Swelling, dissolution, bond rupture and weathering.

Learning Outcomes

Upon completion of this course, students are able to:
1. Describe the types of bonds and planes within a unit cell and to distinguish between single crystals and polycrystalline materials.
2. Comprehend the mechanism and factors that influence diffusion on the structure and properties of materials.
3. Explain the types of bonding and structures in ceramics, polymers, metals, alloys and composites.
4. Analyse the mechanical, electrical, magnetic, thermal and optical properties of materials.
5. Analyse the corrosion reaction, the factors that influence the corrosion and methods of corrosion prevention.

KIT258/4 Unit Operations

Unit conversion. Material balance: flowsheet prototype of chemical process; general balance equation, technique in material balance, various unit balances, chemical reactions, stoichiometry, extent of reactions, recycles. Energy balance: energy balance equations for closed systems, approximation of enthalpy changes and applications, heat capacity, reactive systems, enthalpy, balance equations and energy balance techniques. Liquid flow: type of liquids, compressible and incompressible. Newtonian and non-Newtonian, flow region, laminar flow and turbulent, Reynolds number, boundary layer, balance equation for materials and energy, momentum equations, flow in pipes. Heat transfer: mechanism, shell and tube heat exchangers, basic equations, general coefficient of heat transfer. Separation process, characteristic of separation, phase equilibrium, binary distillation. Some examples of unit operations equipment.

Learning Outcomes

Upon completion of this course, students are able to:
1. Comprehend and write material balance equations and stoichiometric equations for the chemical reaction equilibria.
2. Distinguish between positive work and negative work and use the stoichiometric equation in solving problems of energy balance.
3. Comprehend and calculate mass flow rate, speed, discharge rate and other flow parameters using Bernoulli's equation.
4. Differentiate between steady and unsteady state heat transfer using temperature-distance relationship and to calculate heat transfer and heat flux in homogeneous and non-homogeneous systems.

KUT304/2 Physical Chemistry Practical KUT102 (s), KFT332 (c)

This course contains the following set of experiments: Primary salt effect. Determination of the vapour pressure and molar enthalpy of vapourisation of 2-propanol. Determination of the rate constant of a second order reaction using electrical conductance. Simultaneous determination of chloride-iodide mixture: Evaluation of K_{sp} for AgCl and AgI. Determination of heat and entropy of solution of potassium hydrogen tartrate ($C_4H_5O_6K$) at 35 ºC. Determination of the dissociation constant of an indicator. Thermodynamics of electrochemical cells. Fractional distillation. Heterogeneous equilibrium: The three component liquid system with incomplete miscibility. Determination of the molecular weight of high polymer by viscosity method. Hydrogen bonding between phenol molecules. Electrochemistry of solution. Adsorption photometry - simultaneous analysis of a two-component mixture of Cr^{3+} and Co^{2+} spectrophotometrically. Kinetics of the persulfate-iodide reaction. Only 12 out of 14 experiments will be selected for each semester.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the principles of thermodynamics and kinetics in illustrative experiments.
2. Demonstrate competence in a variety of physico-chemical measurement techniques.
3. Analyse and interprete the experimental data obtained.
4. Demonstrate the ability of scientific communications through written reports.
5. Display safe laboratory practices.

KUT305/2 Analytical Chemistry Practical I KUT101 (s), KAT349 (c)

Experiments involving ultraviolet-visible and infrared spectroscopy, ion exchange resin, fluoride selective electrode, flame emission and atomic absorption spectroscopy, high performance liquid chromatography, gas chromatography and electrogravimetry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competency in instrumental analysis based on spectroscopic methods such as UV/Visible spectrophotometry, infrared spectrometry, atomic absorption and flame emission spectroscopy.
2. Apply methods of instrumental analysis based on electrochemical techniques.
3. Apply methods of instrumental analysis based on separation methods such as gas chromatography and high performance liquid chromatography.
4. Display safe laboratory practices.
5. Write reports on the basis of experimental results and to draw correct conclusions

KUE306/2 Research Methodology in Chemistry

The student will conduct a comphrehensive study on a particular issue or topic related to chemistry. Students will conduct literature search, write a research proposal and make an oral presentation.

Learning Outcomes

Upon completion of this course, students are able to:
1. Identify problems and show problem-solving skills.
2. Demonstrate the ability to use a variety of methods to obtain information.
3. Analyse and interprete information, write reports and discuss orally.
4. Demonstrate the ability to manage time for a particular task.

KFT332/3 Physical Chemistry II **KFT233 (s), KUT304 (c)**

First, second and third laws of thermodynamics, work, heat and energy, enthalpy change, heat capacity, adiabatic process, Gibbs and Helmholtz free energies, chemical potential, fugacity and composition change.
Changes of State: physical transformation of pure substances and mixture. Phase diagram, stability of phases, Clapeyron equation, partial molar quantities, thermodynamics of mixing, properties of solution, activity, phase diagram for systems with two and three components.
Electrochemistry: Debye Hückel theory, electrochemical cell, electrode potential and thermodynamics of cells.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the first, second and third laws of thermodynamics to solve problems in physical chemistry.
2. Describe the partial molar quantities of a mixture.
3. Use appropriate equations to calculate the chemical potential.
4. Use the Debye Hückel equation to calculate the thermodynamic equilibrium constant.
5. Relate the thermodynamic principles to electrochemical cells including the derivation of the Nernst equation.

KAT340/2 Analytical Chemistry Practical II

Experiments based on ion chromatography, high performance liquid chromatography, gas chromatography, flame atomic absorption spectroscopy, graphite furnace atomic absorption spectroscopy, inductively coupled plasma mass spectrometry, electroanalytical methods, ultraviolet visible spectrometry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competence in appropriate laboratory techniques.
2. Interpret data from laboratory observations and measurements.
3. Display safe laboratory practices.
4. Apply chemistry principles to solve problems in the practical area.
5. Write reports clearly, concisely and appropriately.

KAT344/4 Separation Methods **KAT245 (s)**

Sample preparation. Solvent extraction. Solid-phase extraction. General principles of chromatography. Gas chromatography. High performance liquid chromatography: partition, adsorption, ion and size exclusion (gel) chromatography. Planar chromatography: thin layer and paper chromatography. Capillary electrophoresis. Selected methods.

Experiments based on the following methods: extraction, gas chromatography, high performance liquid chromatography.

Learning Outcomes

Upon completion of this course, students are able to:
1. Comprehend the underlying principles in solvent extraction and sample preparation techniques.
2. Describe and discuss the parameters that govern retention and band broadening behavior.
3. Apply gas and liquid chromatography, and electrophoretic methods to separate analytes of interest.
4. Use instrumentations based on separation methods.
5. Write reports clearly, concisely and appropriately. Display safe laboratory practices.

KAT345/4 Spectroscopic Methods **KAT245 (s)**

Basic principles, instrumentation and the applications in qualitative and quantitative analyses of the following techniques: Molecular ultraviolet and visible absorption spectrometry, infrared absorption spectrometry, fluorescence spectrometry, atomic absorption spectrometry (flame and non-flame methods), atomic emission spectrometry, X-ray fluorescence, atomic mass spectrometry, X-ray photoelectron spectroscopy and Auger electron spectroscopy.

Experiments based on the following methods: infrared spectrophotometry, ultraviolet-visible spectrophotometry, spectroflurometry, flame photometry, atomic absorption spectrometry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate an understanding of the basic principles of spectroscopic methods such as ultraviolet-visible spectrometry, infrared spectrometry, fluorescence, atomic absorption spectrometry (flame and non-flame method), flame emission spectrometry, atomic emission spectrometry with plasma and electrical discharge sources, mass spectrometry, X-ray fluorescence and Auger electron spectroscopy.
2. Identify main components of instrumentation used in spectroscopic methods.
3. Select the appropriate spectroscopic technique for a particular analysis.
4. Write reports clearly, concisely and appropriately. Display safe laboratory practices.

KAT346/4 Electroanalytical Methods **KAT345 (s)**

Electrochemistry principles, signal generation, double layer, polarisation and overvoltage. Potentiometry: Ion selective electrodes (ISE). Solid state ISE. Voltammetry: Polarography (Hg electrode) and metal and non-metal analyses. Amperometry (C and Pt electrodes) and analysis of organics and complexes.

Experiments based on the following methods: Ion selective electrode, differential pulse polarography, anodic stripping voltammetry, cyclic voltammetry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Comprehend the physical-chemical principles of electroanalytical methods.
2. Select the appropriate electrochemical techniques for a particular analysis.
3. Demonstrate awareness of the limitations of the various methods.
4. Use of instrumentation based on electroanalytical methods.
5. Write reports clearly, concisely and appropriately. Display safe laboratory practices.

KAE348/2 Analytical Chemistry Practical III **KAT345 (s), KAT349 (s)**

Practical applications of analytical techniques in areas such as forensic sciences, food and adulteration of milk, cooking oil and drinks, toxic materials, toxic metals.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply instrumental methods of analysis in solving analytical problems.
2. Write reports on the basis of experimental results and draw correct conclusions.
3. Display safe laboratory practices.

KAT349/3 Analytical Chemistry II **KAT245 (s), KUT305 (c)**

Basic principles, instrumentation and applications in qualitative and quantitative analyses of the following techniques: electroanalytical, spectroscopic and chromatographic.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate the understanding of basic principles of atomic and molecular spectroscopic, separation and electrochemical methods.
2. Describe and discuss the instrumentation and techniques of various analytical methods.
3. Discuss the applications of the various methods for the analyses of samples.

KIT358/3 Polymer Chemistry **KOT122 (s)**

Introduction to polymer: Polymerisation processes; Step-reaction polymerisation; Ionic polymerisation: Cross-linking and network formation; Molecular weight of polymer; Physical and mechanical behaviours of polymer; Characterisation and analysis of polymer.

Learning Outcomes

Upon completion of this course, students are able to:
1. Comprehend the importance, classification, properties of polymers.
2. Construct kinetic equations for radical chain polymerisation and chain transfer reactions.
3. Write polymerisation reaction mechanism and crosslinking reaction mechanism involved in ionic polymerisation.
4. Identify the methods used to determine the structure, physical and mechanical properties of polymers.

KIT355/2 Unit Operations Practical **KIT258 (s)**

Laboratory experiments on the basic theory and practice of unit operations. Fluid flow, rheology, mixing process, conductivity, evaporation, absorption, distillation, extraction, humidification, drying and filtration.

Learning Outcomes

Upon completion of this course, students are able to:
1. Recognise the various unit operations used in industries.
2. Demonstrate skills in operating the various laboratory-scale unit operations.
3. Display good laboratory practices.

4. Interpret and evaluate data obtained from laboratory measurements.
5. Analyse and present reports in clearly written forms.

KIT357/2 Industrial Practical KIT257 (s)

Industrial related practical: Preparation and application of dyes, wood analysis, metal extraction and electroplating, metal corrosion, food chemistry, ceramics and polymers.

Learning Outcomes

Upon completion of this course, students are able to:
1. Relate chemical principles in laboratory experimental work.
2. Demonstrate skills in several chemical techniques related to industrial processes.
3. Display good laboratory practices.
4. Interpret and evaluate data obtained from laboratory measurements.
5. Analyse and present reports in clearly written forms.

KIE361/4 Industrial Training

This training programme is opened to students who have completed at least 6 semesters of their studies. The duration for this course is 8-10 weeks (during the semester break between 3rd and 4th year). The students are required to undergo industrial training at various industries/organizations or at Centres of Excellence in USM. At the end of the training, students must submit a report and present their work. Students who have passed the course will also be awarded with a Certificate of Completion for the Industrial Training and the result (Pass/Fail) will appear in their academic transcript.

Learning Outcomes

1. Exhibit competencies and competitiveness in their respective areas of expertise.
2. Relate work experience with knowledge learned at universty.
3. Demonstrate interacting skills and communicating effectively.
4. Obtain experience and knowledge that can be utilised to choose the right job after graduation.

KUT407/2 Inorganic and Analytical Chemistry Practical KUT203 (s), KUT305 (s)

The spectra of metal carbonyls. Electronic spectra of coordination compounds. Preparation and resolution of *tris*(ethylenediamine)cobalt(III) into optical isomers. Preparation of ferrocene and its acetyl derivative. Application of IR spectroscopy to characterise linkage isomer, nitropentaaminecobalt(III) chloride. Photometric titrations with UV-VIS spectroscopic method. Determination of aluminium with 8-hydroxyquinoline through fluorimetric method. Flame photometry. Atomic absorption spectrometry. Kinetic method for the determination of selenium.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate the advanced techniques on the synthesis, isolation and characterisation of the inorganic compounds.
2. Demonstrate advanced skills in various spectroscopic and separation techniques.
3. Write clear and concise practical reports which are related to the experimental work.
4. Display safe laboratory practices.

KUE409/6 Chemistry Project

Research projects on various chemistry topics.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competency in various measurement techniques.
2. Identify problems and demonstrate problem solving skills.
3. Analyse and interprete the data, write concise reports and discuss the result orally.
4. Demonstrate the ability to use various retrieval methods to obtain information.
5. Display safe laboratory practices.

KFT431/3 Physical Chemistry III **KFT332 (s)**

Quantum theory: Wave-particle duality, postulates, uncertainty principle, Schroedinger equation, particle in a one-, two- and three-dimensional box, harmonic oscillator and rigid rotor.
Statistical thermodynamics: Boltzmann distribution, ensemble, partition functions, calculation of thermodynamic functions.
Kinetics: transition state theory, thermodynamics of reactions, reaction in solution, reactive species, photochemistry, oscillating reactions.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the postulates to formulate the modern quantum theory.
2. Solve the Schroedinger equation for the particle-in-a-box problems.
3. State and calculate the thermodynamic quantities from partition functions.
4. Demonstrate competence in applying the collision and transition-state theories.
5. Apply the Michaelis-Menten mechanism to explain an enzyme-catalysed reaction.

KAT442/3 Environmental Pollution Chemistry KAT344 (s), KAT345 (s)

Water pollution: The concept of water pollution, environmental quality acts and water quality standards, water quality index, the chemistry and effect of nutrients, heavy metals and organics pollution, analysis of pollutants, oxygen sag curve in polluted river.

Air pollution: Types and sources of air pollutants; photochemistry in air pollution; basic air pollution meteorology, chemistry of ozone layer depletion, the chemistry of smog; atmospheric dispersion and Gaussian model.

Experiments based on the following methods: various monitoring pollutants in environmental sample.

Learning Outcomes

Upon completion of this course, students are able to:
1. Comprehend the basic concepts of pollution, sustainable development and guidelines and to predict the fate of pollutants in aquatic environments.
2. Comprehend the aquatic chemistry of water pollutants and their impacts on aquatic ecology and environment.
3. Apply the analytical process of monitoring environmental pollutants.
4. Apply the meteorology and chemistry of air pollutants.
5. Construct the model of concentration of air pollutants via a simple Gaussian model.
6. Write reports clearly, concisely and appropriately. Display safe laboratory practices.

KAE445/3 Bioanalysis KAT344 (s) or KAT349 (s)

Introduction to biomolecules, proteins, nucleic acids, sample preparation, application of chromatography in life and health sciences, electrophoresis methodologies for genomics and proteomics, mass spectrometry in proteomic analysis, immunochemical methods, nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI) technologies in life sciences.

Learning Outcomes

Upon completion of this course, students are able to:
1. Differentiate the class of biomolecules including chemical, physical and their functional characteristics.
2. Demonstrate understanding on the latest developments in analytical instrumentations in bioanalysis.
3. Identify suitable chemical and biological methods for the analysis of biological compounds.
4. Demonstrate understanding of the other related methods in chemical and biological molecule.

KIT458/3 Chemical Processing **KTT112 (s), KOT122 (s)**

Introduction to industrial processes, raw materials and energy. Basics of industrial C1 syntheses, olefins, synthesis involving carbon monoxide; Oxidation products of ethylene, alcohols, vinyl-halogen and vinyl-oxygen compounds, components for polyamides, propene conversion products, aromatics and derivatives, industrial gases, salts and chlor-alkali industries, nitrogen-based industries, sulphur-based industries, phosphate-based industries, extractive metallurgy, metals and their specialty chemicals.

Learning Outcomes

Upon completion of this course, students are able to:

1. Describe the production of inorganic and organic raw materials from chemical industries.
2. Describe and explain the properties and utilisation of these raw materials.
3. State the origin and production of specialty chemicals.
4. Describe the purification methods and uses of these specialty chemicals and the related compounds.
5. Identify and apply the various sources of feedstocks used in the nitrogen-, sulphur-, and phosphate-based industries.

KIE456/3 Food and Palm Oil Chemistry

Carbohydrates: Classification of structures; dietary utilisation as food component, reaction-hydrolysis, dehydration and thermal degradation and browning; functions in foods. Proteins: Physicochemical properties. General properties: chemical reaction and interaction of amino acid and protein. Denaturation, functional properties of proteins. Oil and fats: Type; composition, physical and chemical properties, quality control, stability, oxidation and anti-oxidant, processing and technology edible oils. Flavours: Analysis and identification, structures and organoleptic quality, production of typical flavor substances (vanilin, saccharin etc). Food additives: Role of acids, bases, salt, chelating agents, antimicrobes and types of sweeteners. Stabilisers and texturisers. Structures and composition of palm oil. Chemical properties and non-fatty components. Physical properties of palm oil. Technology of palm oil. Research trends in chemistry and technology of palm oil. Practical experiments on quality controls of palm oil.

Learning Outcomes

Upon completion of this course, students are able to:

1. Identify the classification and structures of carbohydrates, proteins and oils and their physico-chemical properties.
2. Describe the chemical changes of the major food components during processing.
3. Discuss the roles and functions of food additives and flavours.
4. Describe the factors affecting the chemical deterioration of oils and fats during storage,

transportation and frying.
5. Perform analyses of quality parameters in assessing quality of oils and fats.

KIE458/3 Selected Topics in Industrial Chemistry

This course will discuss several topics or current issues in industrial chemistry.
It covers the following areas:
1. Food Chemistry.
2. Hydrogen energy.
3. Polymer based industry.
4. Unit operations and processing.
5. Catalysis and surface science.
6. Electrochemical based industry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate understanding in the current issues related to industrial chemistry.
2. Apply fundamentals of chemistry in solving current industrial chemistry problems.
3. Display the ability to discuss the current issues orally and in writing.

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